

PREMOLD CORP

DESIGN GUIDE FOR REACTION
INJECTION MOLDED PLASTIC PARTS



Low Volume Injection Molding for Your Specialty Equipment

ISO 9001:2015 CERTIFIED

PREMOLD CORP



REACTION INJECTION MOLDING

LOW:

Tooling Costs
Lead Times
Minimum Order Quantities

HIGH:

Cosmetic Finishes
Logistic Advantages
Design Flexibility

PREMOLD CORP RIM DESIGN GUIDE

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SECTION I - ABOUT THE RIM PROCESS

Advantages of the RIM Process

1. Low Cost Molds
 - Basic aluminum materials are used. The cost savings becomes greater for larger parts.
2. Shorter Tooling Lead Times
 - Softer mold materials machine faster and are easier to change.
3. Greater Design Flexibility
 - Thin and thick walls can be used in the same part.
 - Bosses can be tall with large diameters.
 - Side actions are less costly.
 - Components can be encapsulated within the RIM part.

RIM Materials

Our polyurethane materials perform similar to ABS materials. We can offer the highest UL rating, UL 94 V-0, at a thin 1/8" wall thickness. We process the best rigid RIM materials on the market. They are formulated to provide good stiffness, impact and strength-to-weight ratio for covers and enclosures. They are more notch sensitive than ABS. Therefore, please allow sufficient radii in load bearing corners.

We also offer rigid foamed materials if you need thermal insulation, acoustic control, or weight reduction. These materials can be molded in wall thicknesses up to 1.5".

Polyurethane materials have excellent resistance to most chemicals.

Copyright:

This design guide was written by Premold Corp with some artwork contributed by Bayer Corp.* This guide is intended for use by Premold Corp, its customers and prospective customers. It is also intended to promote knowledge and use of the RIM process. The ideas conveyed here are general guidelines to cover many different situations. Premold Corp's engineers can assist you with your specific needs and questions. A distinct advantage of the RIM process is its ability to deviate from many of the general guidelines shown here.

**Engineering Polymers. RIM Part and Mold Design. Polyurethanes. A Design Guide (Pittsburgh, PA: Bayer corporation, 1995).*

Understanding the Process:

In contrast to thermoplastics, RIM plastics are composed of two liquid components that chemically react in a mold to form a plastic part. This requires a lot less heat and pressure than melting a thermoplastic and injecting it at high pressure.

One of the liquids, a polyol, determines the physical characteristics of the molded part. Density, impact strength, flex modulus, color, and other properties are determined by the polyol used. The second liquid, an isocyanate (iso), reacts with the polyol to form a thermoset polyurethane plastic.

The pressurized day tanks shown in Fig 1 typically hold 30 or more gallons of iso and poly. Recirculation pumps and agitators maintain a homogeneous blend of the individual components. Heat exchangers maintain their temperatures. High pressure cylinders or pumps meter the iso and poly into the mix head in the proper ratio. Flow rates, pressures, and temperatures are controlled to achieve quality molded parts.

The mix head contains injector nozzles which impinge the isocyanate and polyol on each other at ultra-high velocities. This action plus an after mixer put into each mold, ensure complete mixing of the iso and poly.

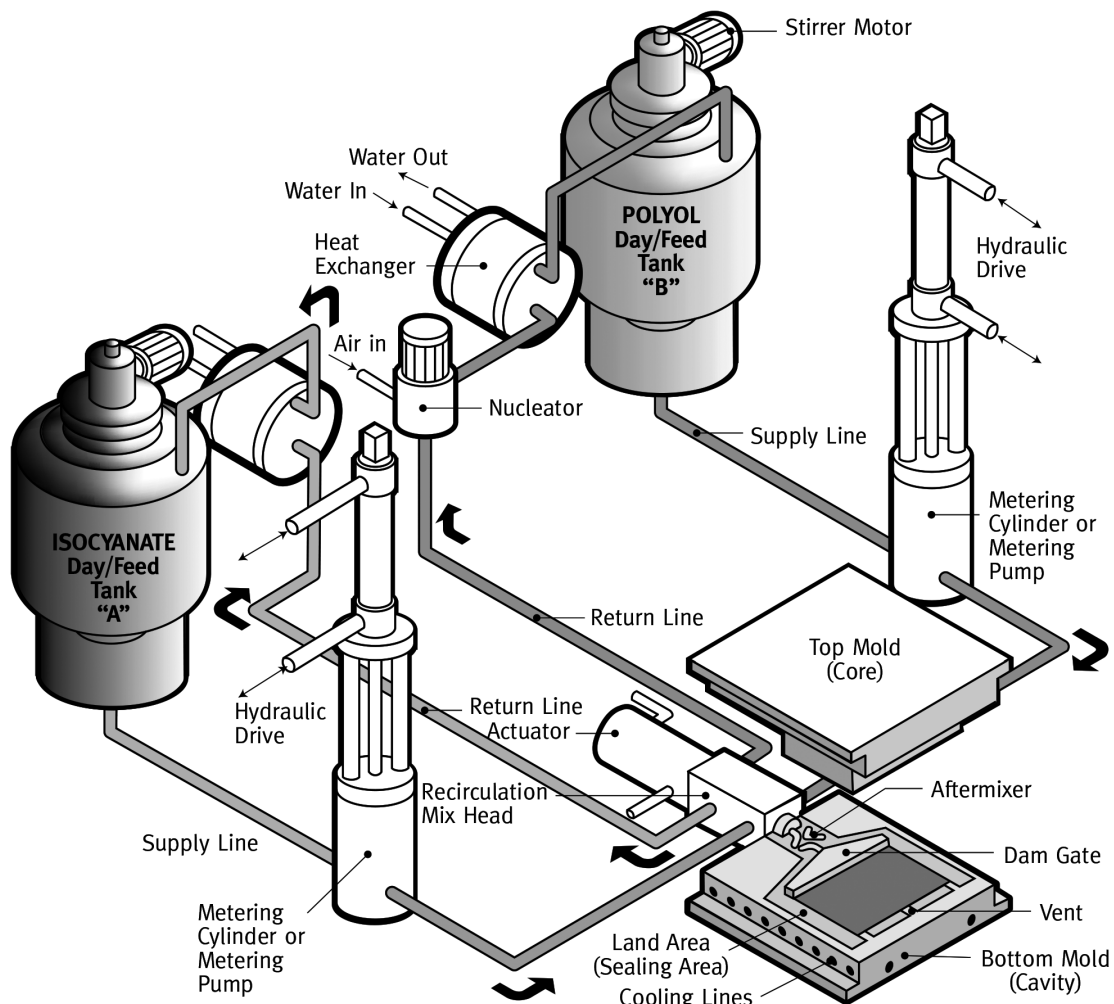


Figure 1
Typical RIM Processing Machine

Gating:

Polyurethane RIM parts are normally edge gated. The dam gate is a common edge gating method.

The iso and poly mixture leaves the mix head and flows through the after mixer in the mold at high velocity. The mixture continues through the runner until it comes to the dam gate (see Fig. 2). The dam gate's purpose is to spread out the flow front and slow it down. The resin mixture must enter the mold in a laminar flow condition.

The low viscosity mixture can easily fill large parts containing fine details. This is accomplished using low pressures (25 to 50 psi) and low temperatures (90 to 100 degrees F).

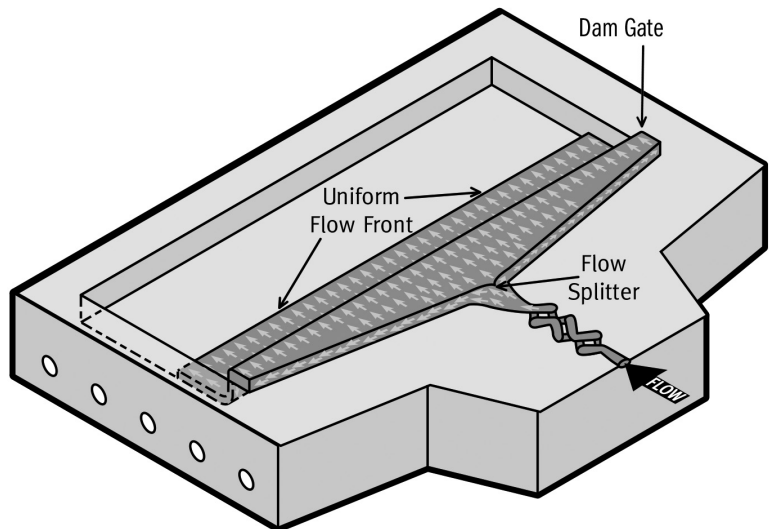


Figure 2
Resin Flow Into a Mold

Resin Flow and Venting:

The RIM process uses a low pressure, liquid flow process to fill the mold. This is in contrast to high pressure injection molding which uses high pressures to “pack out” the mold cavity. RIM does not use high pressure injection to squash air bubbles. Air bubbles must be avoided and the air in the mold must be vented out as the resin fills the mold (see Fig. 3).

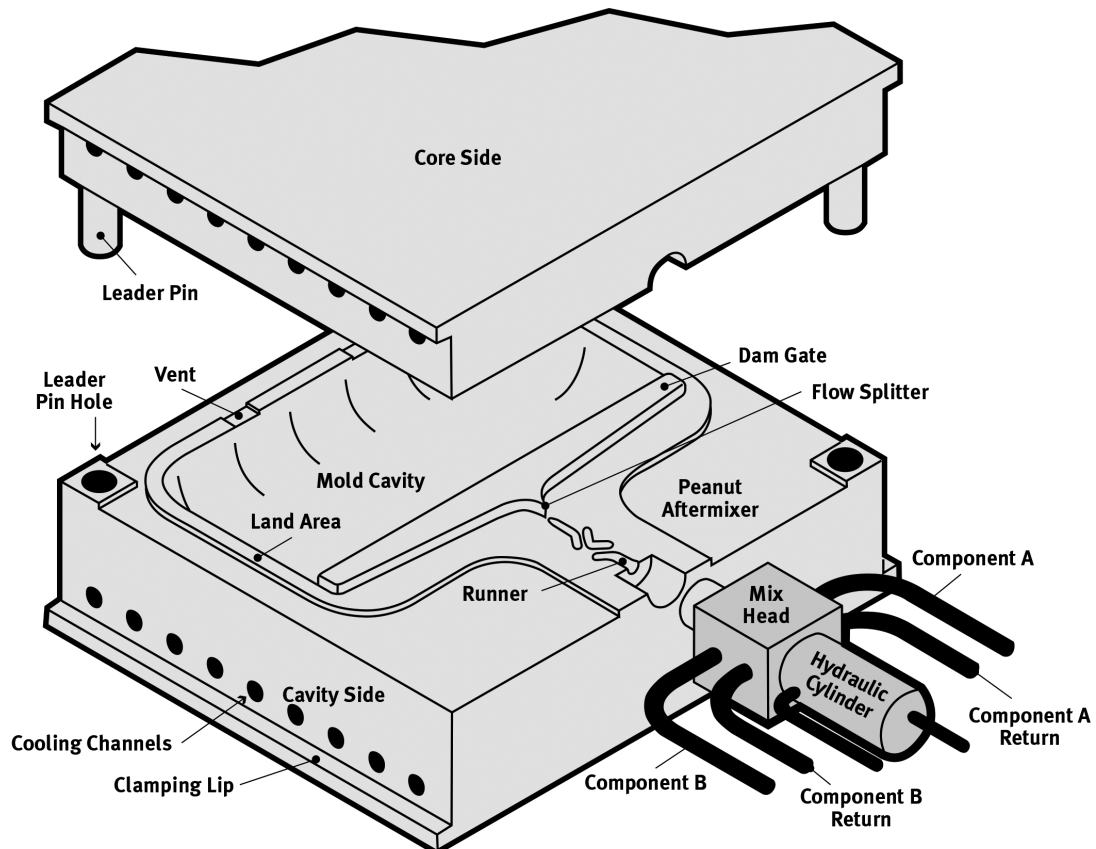


Figure 3
A typical RIM mold configuration with peanut aftermixer, dam gate, and vents

The resin is injected at the bottom of the mold and air is vented out the top (see Fig. 4A). For this reason, RIM presses are designed to tilt the molds (see Fig. 4B). Some presses tilt more than one direction. This allows maximum design freedom for both parts and mold. Premold Corp personnel can advise you on gating and venting.

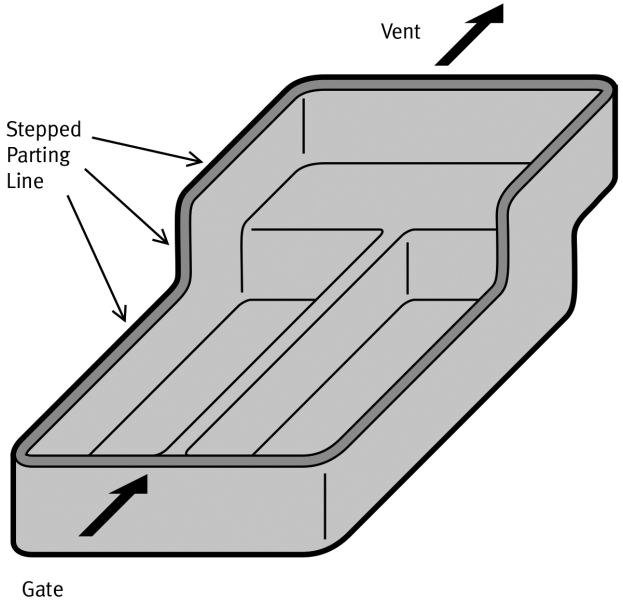
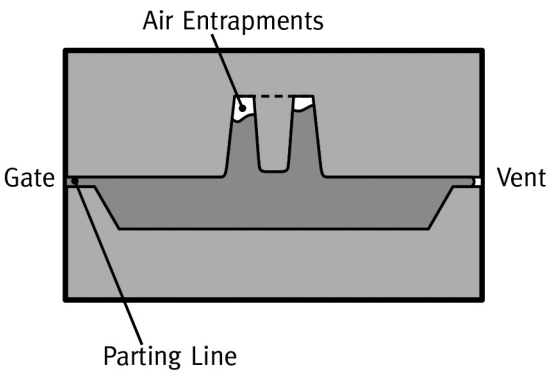
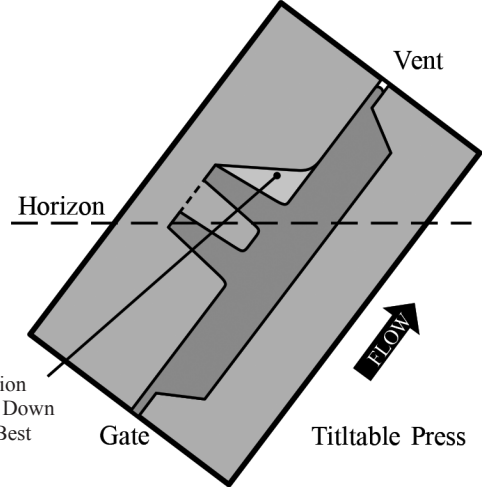


Figure 4A
Gate Low, Vent High



Mold in Conventional Press



Add Gussets in the Direction of Flow, 45 Degree Slope Down from Top of Boss Works Best

Mold in Tiltable RIM Press

Figure 4B Mold Tilt Angle

SECTION II - DESIGN GUIDELINES

Minimizing Mold Costs

The costs of RIM molds are mainly determined by:

- CNC machining time
- toolmaker time
- CNC programmer time
- mold materials

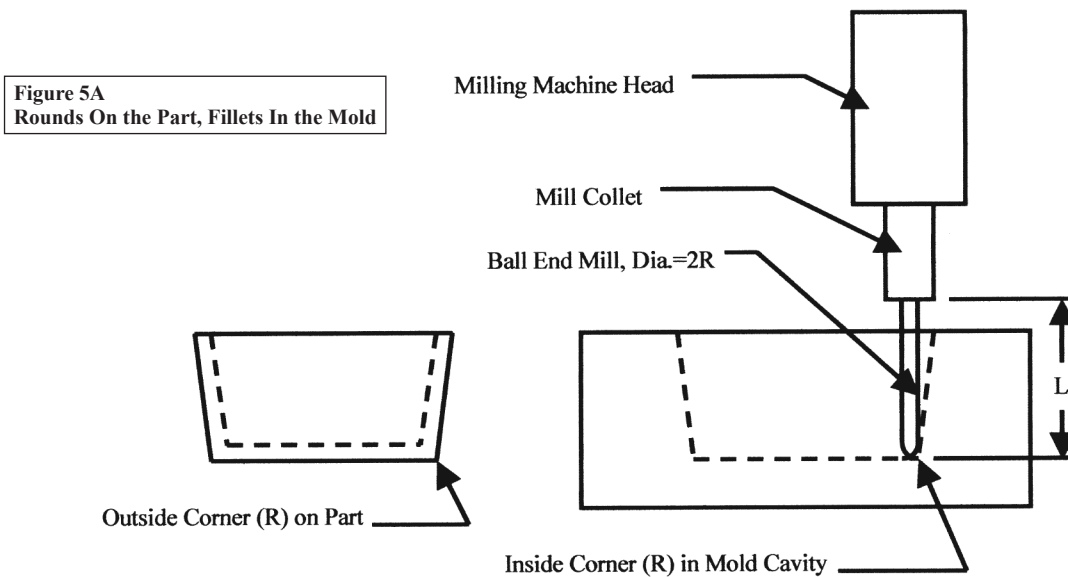
Tooling lead times are mainly determined by the first three factors.

The RIM process allows you to use softer mold materials. Therefore, part features can be machined directly into the mold. This minimizes all four cost factors by avoiding the added costs of EDM machining, inserting, benching, polishing and hardening. Minimizing mold cost also minimizes the lead time. There are certain guidelines to be aware of to allow the tool maker to machine part features directly into the mold.

Outside corners on the part are inside corners to be machined into the mold. There are exceptions like at the mold parting line. Consult with Premold Corp for details pertaining to your part. These inside corners in the mold are best machined with ball end mills. Ball end mills can cut in the X, Y, Z and compound axis. This makes them very efficient for machining molds requiring complex contours. See Figure 5A. The size of the radius and the height of the adjoining wall are the main factors determining the cost and feasibility of machining the radius directly into the mold. Toolmakers do not recommend using ball end mills smaller than 0.0625" diameter (0.0313" radius on part). They do not recommend extending them out of the mill collet farther than two times their diameters (i.e. $L < 4R$)

The efficiencies of end mills increase dramatically as their diameters increase. See Figure 5B. If you minimize the amount of your part that must have small radii, you will minimize the cost and lead time for your mold.

Inside corners on the part are outside corners in the mold. Machining them into the mold is normally not a big cost factor. Good design practice, aesthetic needs and resin flow during molding should be the primary considerations when choosing fillet radii on the part.



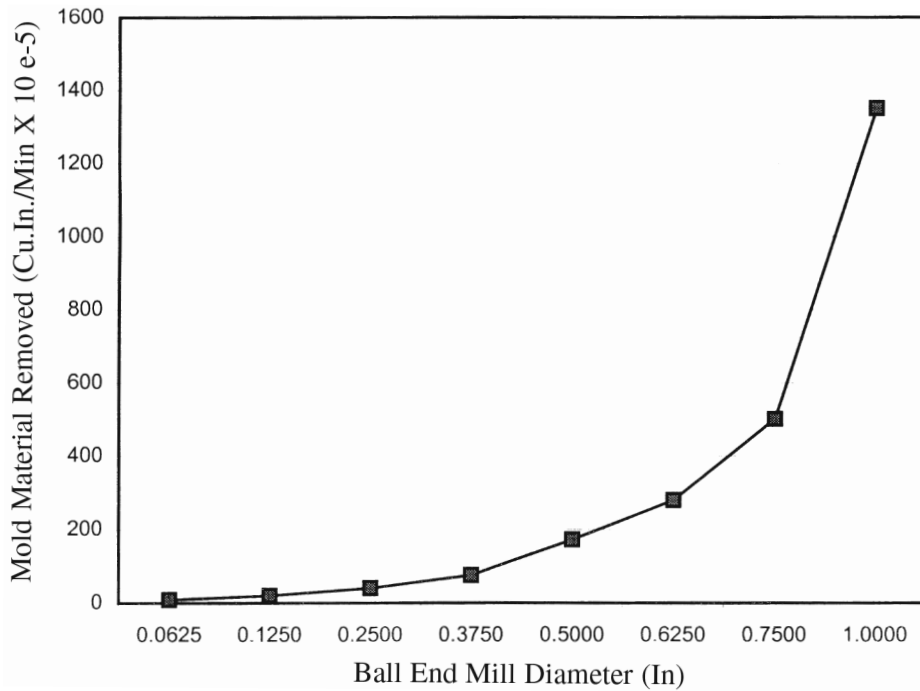


Figure 5B
Efficiencies of CNC Mill Cutters at Removing Mold Material

A raised rib on the part requires a groove cut into the mold. The width and height of the rib are the main factors determining the cost and feasibility of machining the groove directly into the mold. Remember the mill bit cuts a full radius end on the groove. See Figure 6. Therefore, it is more economical if you can allow full radii on the ends of your ribs.

In general, the larger the radius and the wider the rib, the faster the machining of the mold can be done and with less programming time.

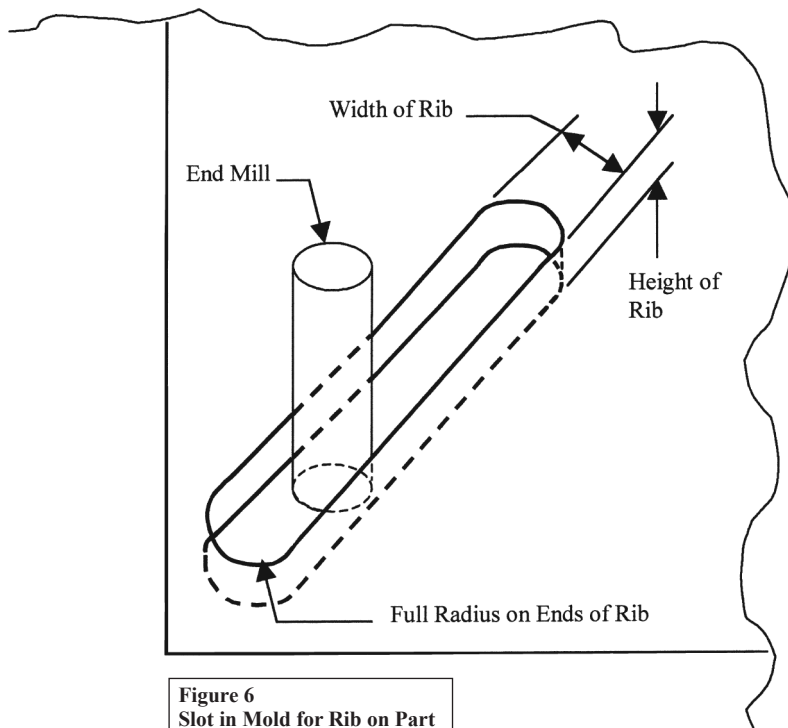
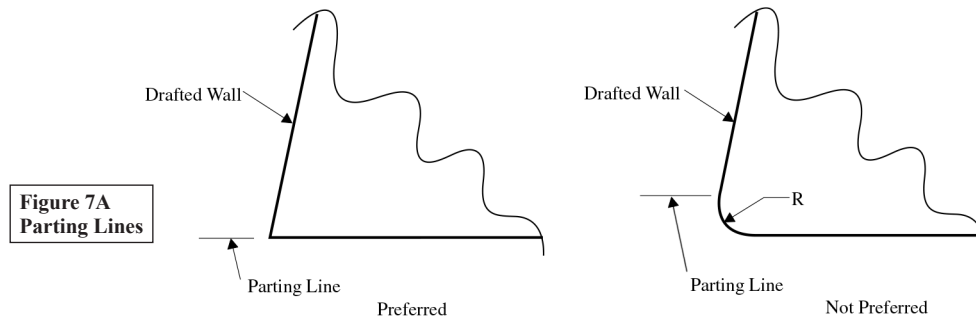


Figure 6
Slot in Mold for Rib on Part

Parting Lines:

It is more economical for mold design, mold construction, mold maintenance and for part production to use sharp edges on the parting lines of a part (see Fig 7A). These edges will be rounded to about R0.020" by the finishing and painting process. If a radius is desired at the parting line, a larger radius results in better parts.

As a rule of thumb, it is more economical to keep the parting line all in one plane instead of having it contoured or having it change from one side of the part to another.



Wall Thickness:

Design guidelines for rigid RIM materials are very similar to thermoplastic materials. This makes it easy to design RIM parts without having to learn new techniques.

RIM polyurethane parts have wall thicknesses similar to thermoplastic parts (0.060" to 0.250"). However, RIM parts can be molded to wall thicknesses as high as 1.5". Our resins are also much more forgiving of variations in wall thickness.

Minimum wall thicknesses to achieve UL 94 V-0 are typically 0.125". Consult Premold personnel for the specific requirements of each resin.

If thicker walls are required or insulation properties are desired, it is easy to insert-mold different materials during the molding process.

The best design practice is to maintain uniform wall thicknesses. Thick areas can be cored out to help achieve this. Ribs and bosses achieve the design features needed without adding unnecessary material (see Fig 7B).

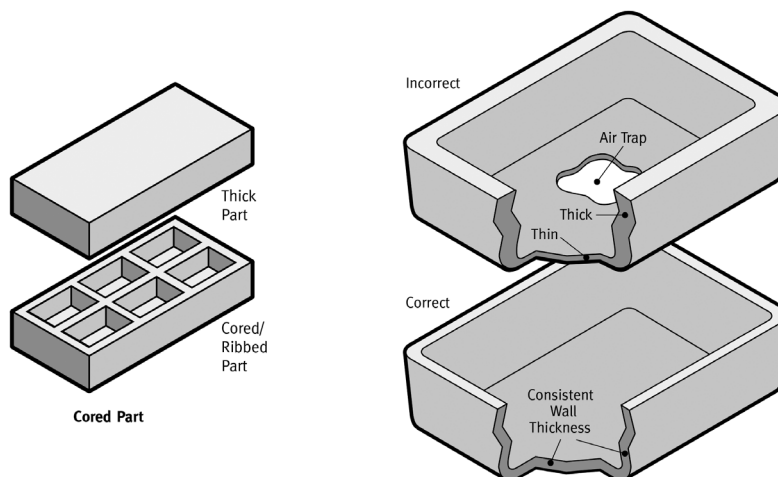


Figure 7B
Maintain Uniform Wall Thickness

Draft:

Every vertical surface of the part needs a draft angle to allow demolding of the part. Draft of 3 degrees with respect to the direction of draw is best. Draft is especially important on interior walls because parts shrink as they cure. Draft angles as low as 0.25 degrees or 1 degree can be used depending on the mold material. Low draft angles need to be applied with care. Consult Premold Corp. before you plan for these low draft angles.

Ribs:

Ribs should be thinner than the walls they adjoin. Their thickness, including fillet radii, should be no more than 75 percent of the adjoining wall's thickness (see Fig. 8). Thicker ribs can be used but sink marks may appear on the surface opposite the rib. In general, RIM polyurethane resins do not sink as readily as thermoplastic resins.

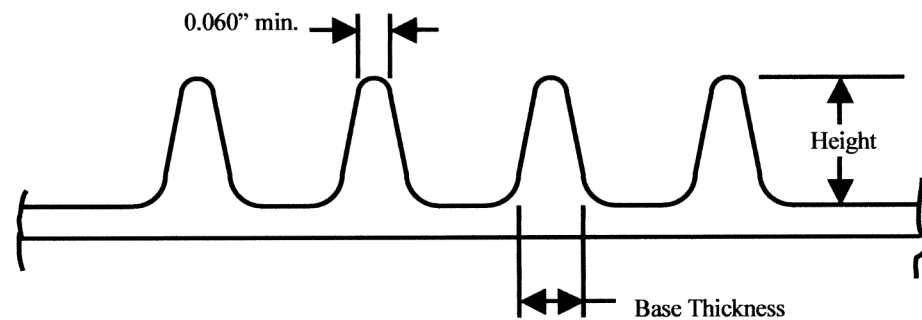
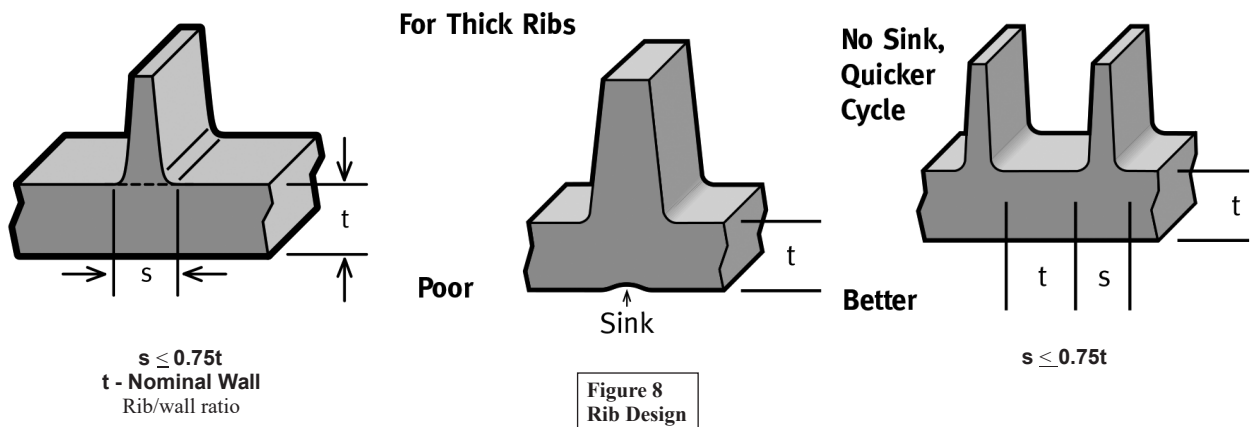


Figure 9
Series of Ribs

Ribs should be at least 0.060" thick. This is best for machining the mold and for molding the parts. Ribs this thin should be less than 0.125" in height.

Ribs can be very tall (more than 4") if the base of the rib is at least 0.188" thick, adequate draft is allowed and the top of the rib is at least 0.060" thick.

Try to avoid ribs running perpendicular to the flow direction of the resin. The diagonal ribs shown in Fig. 10 are preferred over the bidirectional ribs. The bidirectional ribs would cause turbulence in the resin as it fills the mold. The turbulence would entrap air, resulting in voids in the surfaces of the part. Voids in the part surface require secondary labor to fill.

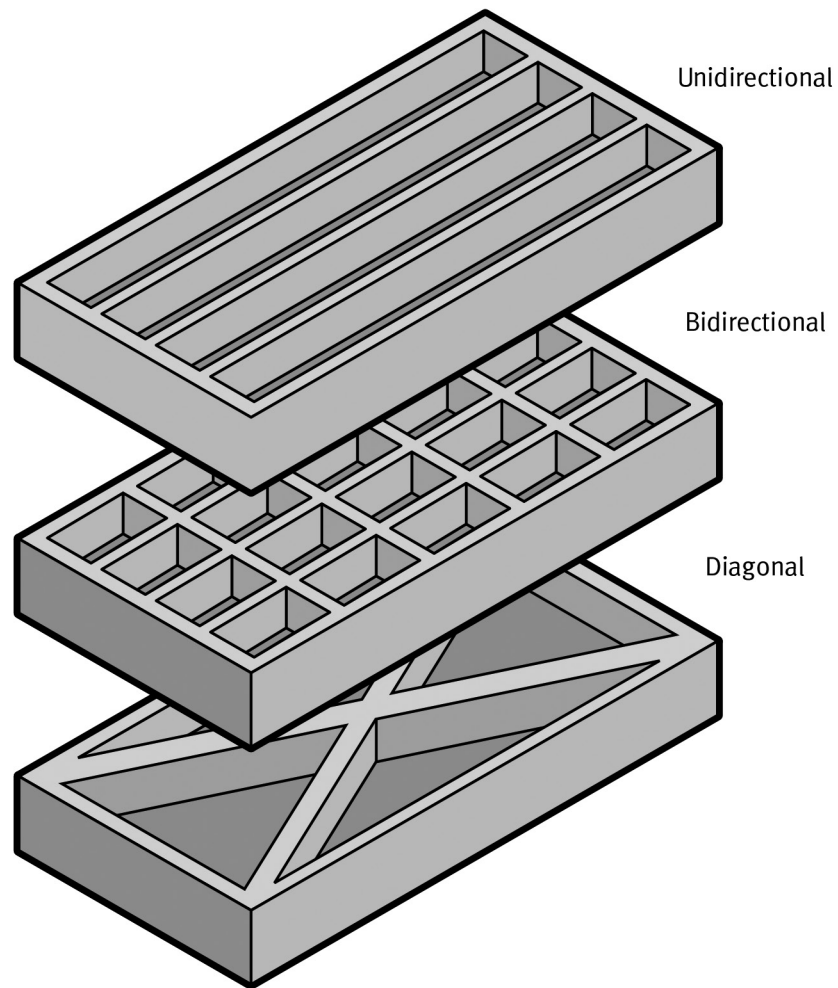
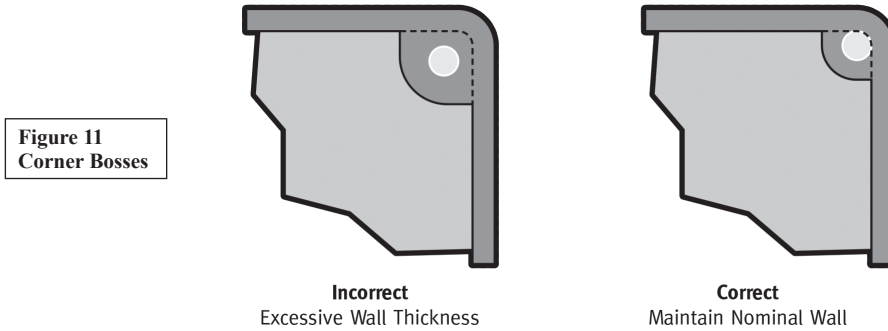


Figure 10
Design Ribs in Direction of Resin Flow

Bosses:

Bosses can be molded-in to reduce the number of parts required in an assembly. Incorporating them into the molded part also makes mating parts less costly.

Bosses located on a side wall should be incorporated into the wall (see Fig. 11). Avoid thick wall sections caused by locating bosses along walls.



Bosses located close to walls should be connected to the wall with ribs. This allows air to escape the boss during molding. Vent ribs are needed on the downstream sides of isolated bosses. The preferred angle for the vent ribs is 45 degrees. Vent ribs should start at the tops of bosses and extend down to the nominal wall at the 45 degree angle. This vents air out allowing resin to completely fill the boss. The ribs can be machined off after molding if required (see Fig. 12).

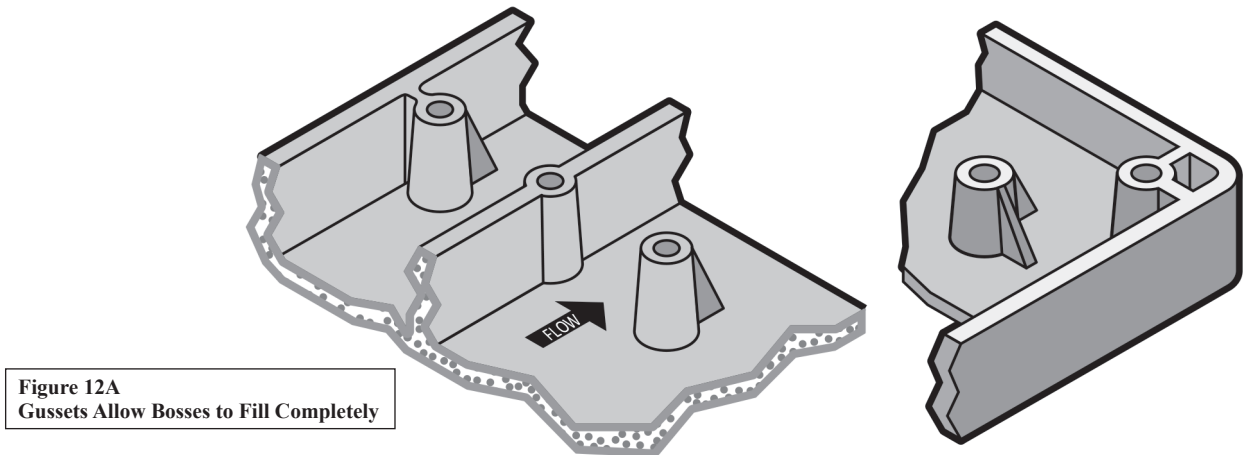
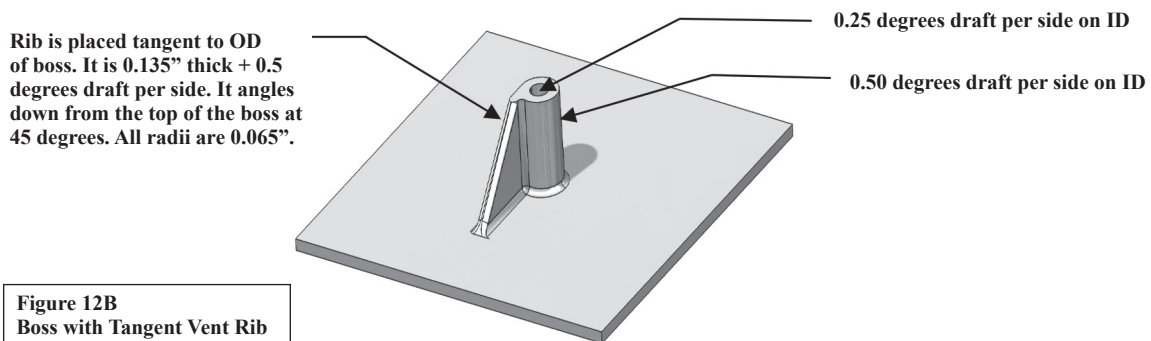


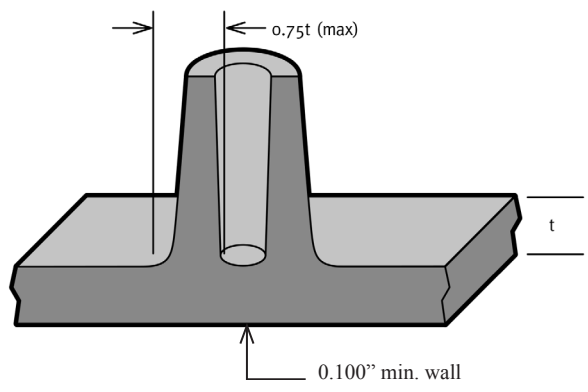
Figure 12B shows a different style of vent rib that lies tangent to a boss. Its use depends on the locations of the gate and vent. Please consult with Premold Corp’s engineers for the details of how and when to use this style of vent rib. Please see Figure 13, its discussion and the section following it titled Radii and Fillets for details about the boss and rib design.



All bosses must have fillet radii at their bases. Bosses must be cored out their entire height to prevent sink marks on the opposite surface.

Make the walls of the boss no more than 75 percent of the nominal wall thickness (see Fig. 13) Some compromises may have to be made when designing bosses for threaded inserts or self tapping screws. This is discussed in the Inserts section of this guide. It is preferable to core the holes rather than drill them. Molding forms a skin on the surface of the part that gives screws and inserts greater holding strength.

Figure 13
Boss Dimensions



Radii and Fillets:

A fillet radius of 0.125” is recommended on inside corners for best results. This is best for molding and for strength. An outside radius of at least 0.030” is best for good tool life. The inner corners of bosses can use 0.060” radii to help reduce wall thickness.

Use these radii whenever you make transitions between surfaces. Radii are important because rigid urethanes are notch sensitive materials.

In general, use a radius of at least 0.030” on all outside corners. It is important to avoid sharp or knife edges and sharp pointed features on parts. Premold Corp’s engineers can help you design your parts for highest quality and repeatability at the lowest cost.

Holes, Grooves, and Slots:

Holes can be molded in the direction of the die draw or by hydraulically retractable core pins. They can also be drilled after the part is molded. By-pass coring can be used where there is adequate draft (see Fig. 14).

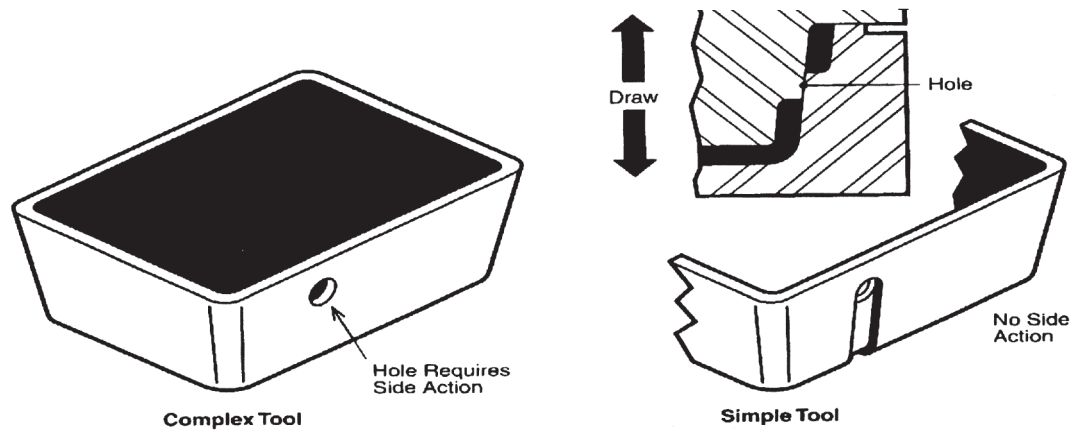
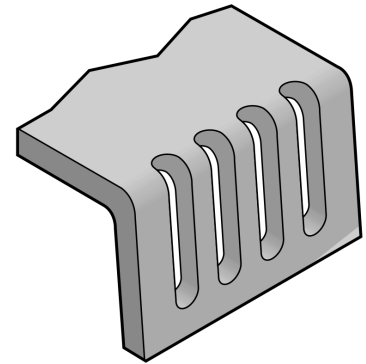


Figure 14
Simple and Complex Part Design for Undercuts

Tool costs can be minimized if slots or grooves can extend around corners (see Fig. 15).

Figure 15
Slots Curled Around Corner



Slots can also be formed on sloping walls with minimal tool cost (see Fig. 16).

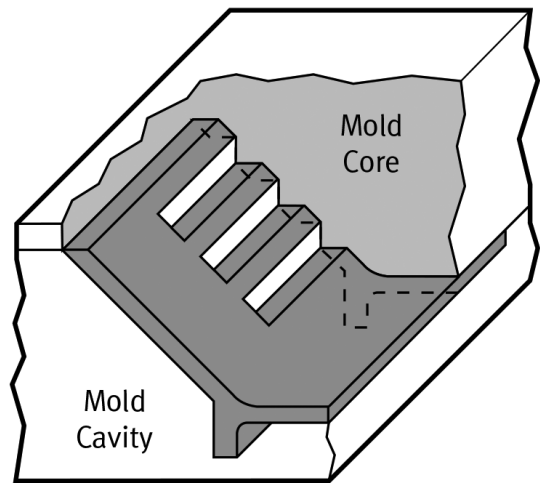
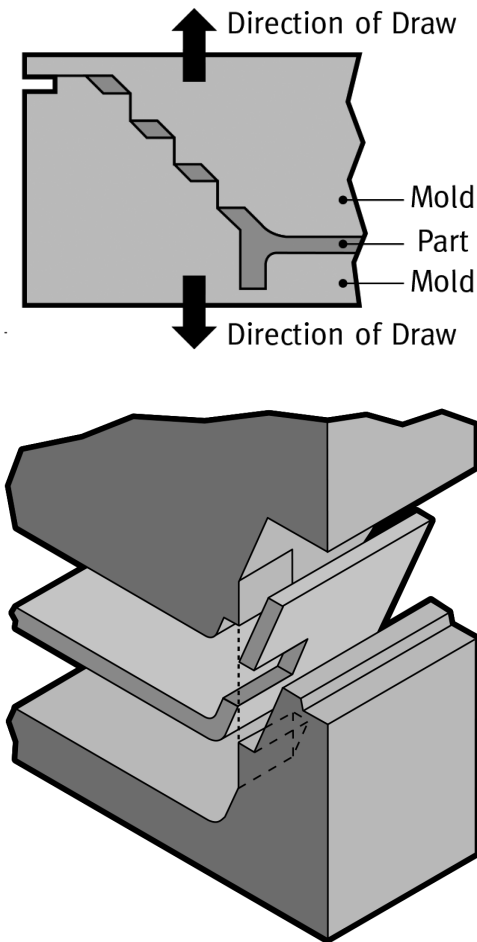


Figure 16

Slots, grooves, and ribs should be oriented in the flow direction of the resin (see Fig. 17). This minimizes air entrapment caused by turbulent flow around these features. They must have fillet radii or chamfers around them for easier flow, venting, and to eliminate stress concentrations.

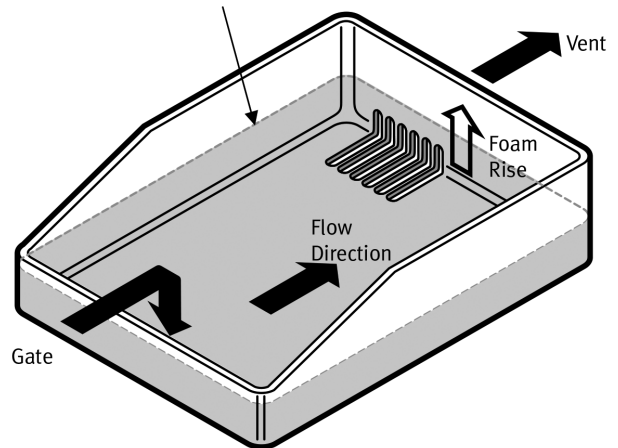
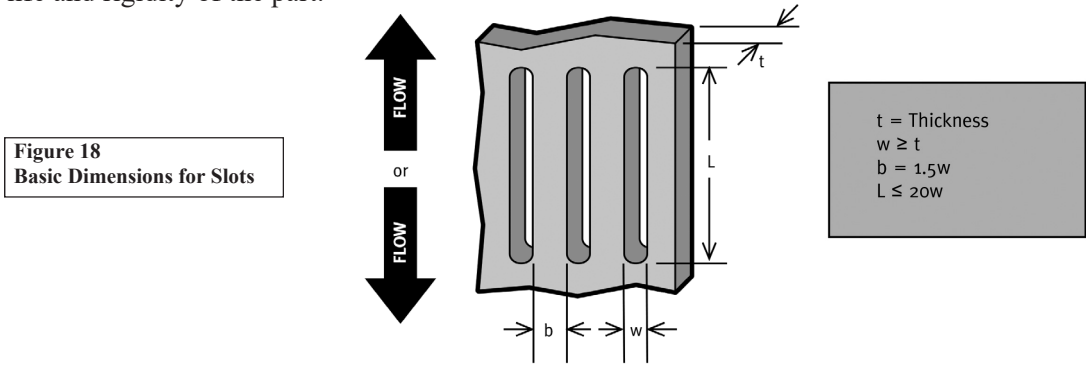


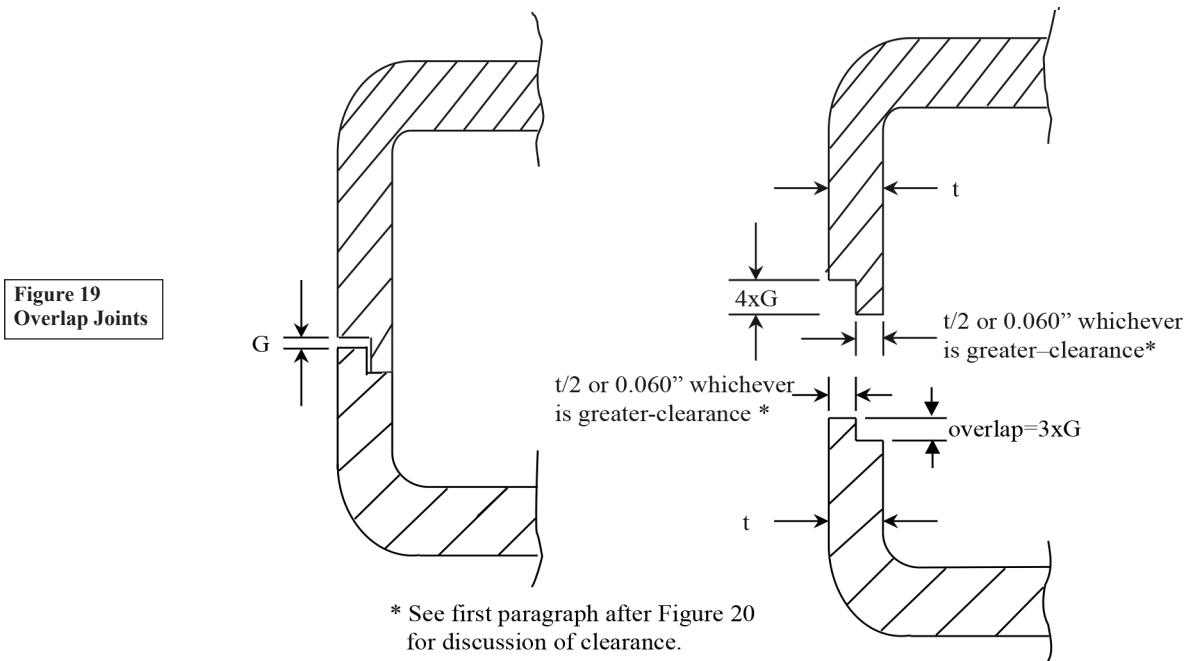
Figure 17
Orient Slots in Direction of Resin Flow

Figure 18 shows good proportions to use for slots to ensure good tool life and rigidity of the part.



Joints Between Parts:

Good design practices recommend that one part in an assembly takes its position from its mating part. This is also true for plastic parts. You will also be more successful with RIM parts if you follow this practice. The molding process offers many options for locating parts relative to one another. Industrial designers often want to incorporate reliefs into the joints between the parts. Two common methods of achieving both are outlined in Figures 19 and 20.



These are general guidelines to be used for overlap joints in most parts. Consult with Premold Corp for variations from these guidelines. For thin walled parts the side walls may have to be thicker than the rest of the walls to make $t/2$ thick enough. The $t/2$ dimension gets thinner when draft is applied. Each corner radius should be as large as possible. The minimum radius is $t/6$.

Guidelines for designing overlap joints with reveal gaps:

<u>Size of Part (length of part's perimeter)</u>	<u>Reveal Gap "G" (inches)</u>
<10"	.025
10 - 20"	.040
20 - 60"	.060
>60"	.080

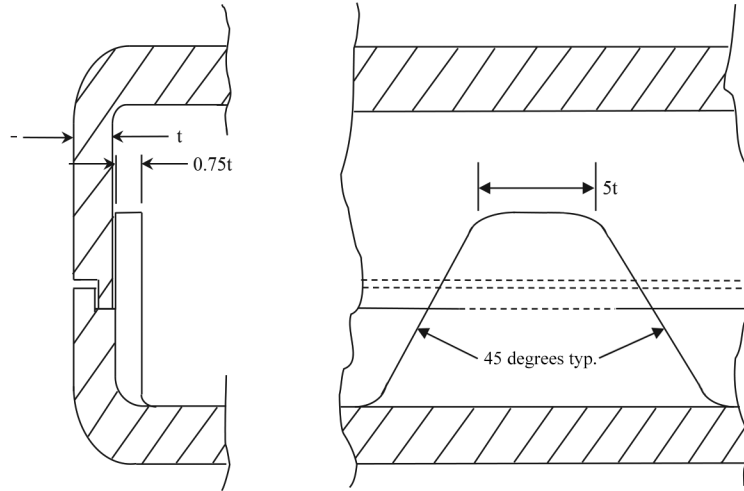


Figure 20
Tongue and Groove Joints

Tongue and groove joints can be used to fully locate one plastic part relative to another. The inside portion of the groove can be localized as shown in Figure 20 or it can be continuous around the entire perimeter of the part. Use the guidelines shown in Figures 19 and 20. Allow clearances between the tongue and groove for tolerances and paint thicknesses. The typical tolerances listed in Section V can give you some ideas of how much clearance to allow. Allow more clearances if the tongue and groove feature extends around most of the part's perimeters.

These joint designs help control the horizontal or X and Y direction locations of mating parts. Fasteners or other clamping methods should be used to control the vertical or Z direction locations. The number of fasteners and their spacing depends on the size of the part and your design goals. Tall, deep section parts usually need fewer fasteners. Shallow parts may need more fasteners. Premold Corp can help you with the details.

Molding Small Details:

Small, intricate details can be molded into parts. In general, it is easier to create them by coring out plastic (negative features) than it is to mold the details in plastic (positive features). Thin ribs and small diameter bosses can be molded in as long as good flow is provided for the resin to get into the mold and for the air to get out of the mold (see Figure 21).

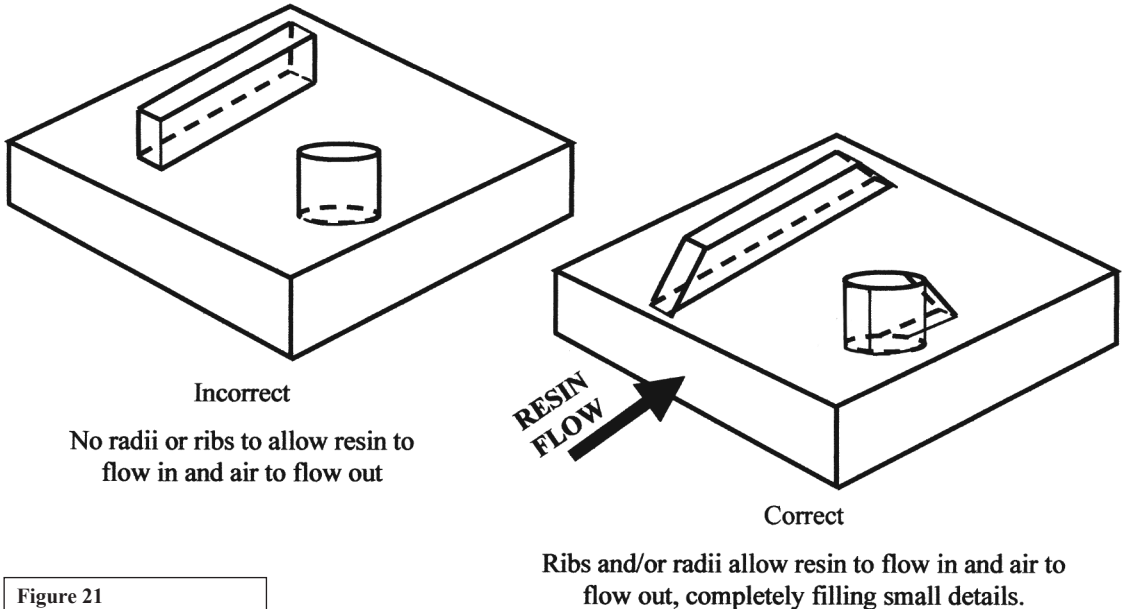


Figure 21
Molded In Details

Letters and Logos:

Both raised and recessed letters and logos can be molded into RIM parts. The main thing to keep in mind to minimize molding flaws, and therefore part cost, is that RIM molding is a flow process. It does not use high pressure to fill out fine details in these features. The resin must have a path to flow in and the air a path to flow out in order to fill the feature without leaving voids. The key factors are: height or depth of the feature, width of the feature, radii on the feature and space between features (S). See figures 22A and 22B. These four factors also affect mold cost and lead time as discussed in Minimizing Mold Costs.

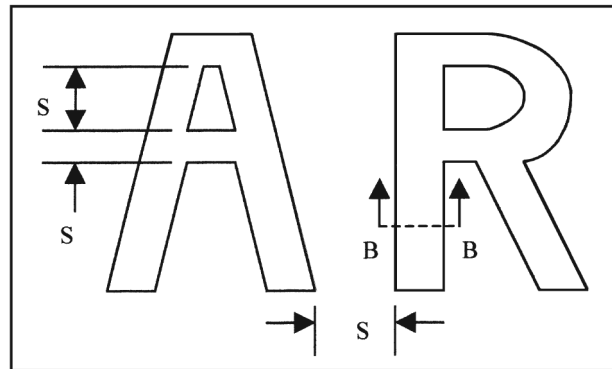


Figure 22A
Molded in Letters and Logos

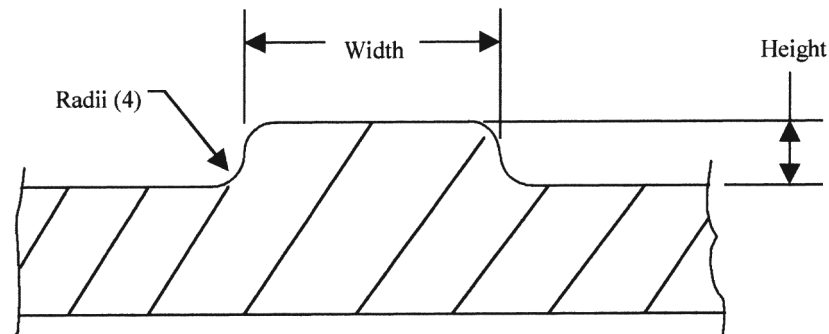


Figure 22B
Section B-B of Raised Letter

We recommend S to be a minimum of .050" typical. We recommend width to height ratios of at least 2. The radii should be at least equal to half the height. Larger radii are better. Chamfers can be used if they are at least 30 degrees off vertical.

We recommend the width to be at least .060" and the radii to be at least .031" to minimize machining costs.

The inside or outside corners of the letters and logo in Figure 22A should have radii to minimize machining costs and part costs. Whether it's the inside or the outside corners depends on if you use raised or recessed characters. Premold Corp can help you with the details to ensure the most cost effective design.

Undercuts:

We all try to avoid undercuts in plastic part design. However, sometimes it is very cost effective for the part to feature an undercut. Undercuts are easier to tool and mold in the RIM process. If by-pass cores cannot be designed into the part, loose piece cores can be set into the mold and ejected with the part (see Fig. 23).

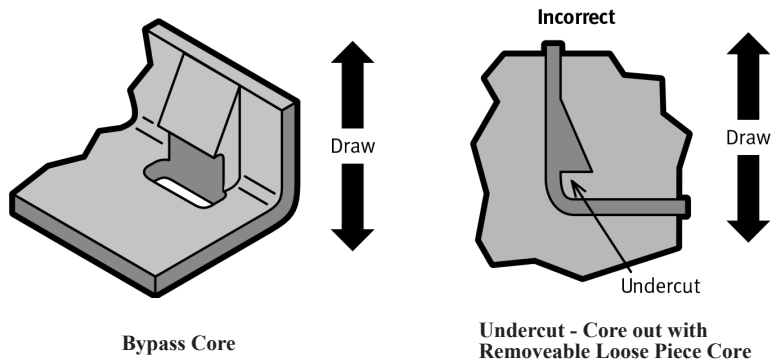


Figure 23
Mold Configurations Showing Undercuts

Snap Fits and Molded in Hooks:

Snap fits can be used even in rigid polyurethane RIM parts (see Fig. 24). Follow the same design practice used for thermoplastic resins. Premold personnel can help with your specific applications.

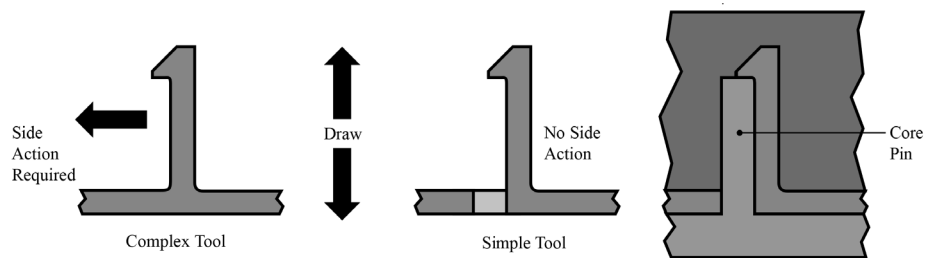


Figure 24
Snap-Fit Undercut

Molded in hooks can speed assembly time and save the cost of hardware (see Fig. 25). They can be used to attach component parts, PC boards, tubing, electrical wires, etc. They can often be molded in with by-pass cores.

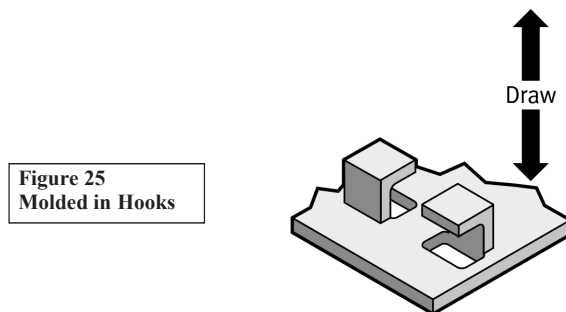


Figure 25
Molded in Hooks

Threaded Inserts and Self Tapping Screws:

Premold's tests have shown that Yardley Trisert style inserts give the best performance in polyurethane parts. They are available in many different english and metric sizes. They are also available in short and regular lengths. Premold personnel can help with your application needs.

We often use the following cored holes and boss outer diameters:

<u>Insert Size</u>	<u>Insert Length (in.)</u>	<u>Hole Dia. (in.)</u>	<u>Preferred Boss OD (in.)</u>
4-40	.172 or .234	.156	.360
6-32	.218 or .281	.198	.430
8-32	.250 or .328	.230	.490
10-24	.296 or .375	.270	.560
10-32	.296 or .375	.270	.560
1/4-20	.375 or .484	.343	.650
M3.0 x 0.5	.172 or .234	.156	.360
M3.5 x 0.6	.218 or .281	.198	.430
M4.0 x 0.7	.250 or .328	.230	.490
M5.0 x 0.8	.296 or .375	.270	.560
M6.0 x 1.0	.375 or 0.484	.343	.650

These hole diameters are minimums. Draft of 0.25 degrees per side should be added to them. Hole depths should be at least 0.050" deeper than the length of the insert. Wall thicknesses at the bottoms of cored bosses should be at least 0.100" thick (see Figure 13).

Do not use Loctite or nylon patch thread locking screws with threaded inserts. These will cause the inserts to turn out if you try to remove the screws.

Do not allow rotation of the part being fastened against the threaded inserts. This will allow the insert to be turned into or out of the plastic part.

Self-tapping screws can be used in rigid polyurethane parts. Thread cutting style screws must be used. If the screws will be removed and reinstalled more than 5 times over the life of the part, it is best to use threaded inserts. A good rule of thumb is to use a hole diameter equal to the average of the screws' major and minor diameters. This diameter should be held at the mid point of the screw engagement length. The hole diameter should have 0.25 degree of draft per side. Therefore, the radial thread engagement will be a little more than 50% below the mid point of the screw engagement length and a little less than 50% above it. Thread engagement length should be at least two times the diameter of the screw.

When using threaded inserts or self-tapping screws, provide radial clearance around screw heads and shanks to allow for manufacturing tolerances. See Figure 26.

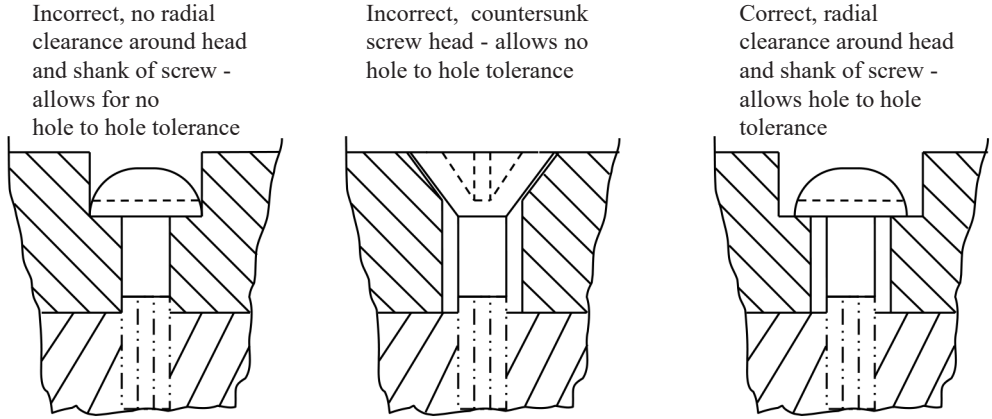


Figure 26
Location Tolerance for Screw Holes

It is important that mating parts bear against the ends of the threaded inserts installed in RIM molded plastic parts. If the mating part's hole diameter is larger than the OD of the threaded insert, the machine screw will pull the threaded insert out of the plastic part. The plastic cannot overcome the mechanical advantage of the screw thread as the screw is tightened. See Fig. 27.

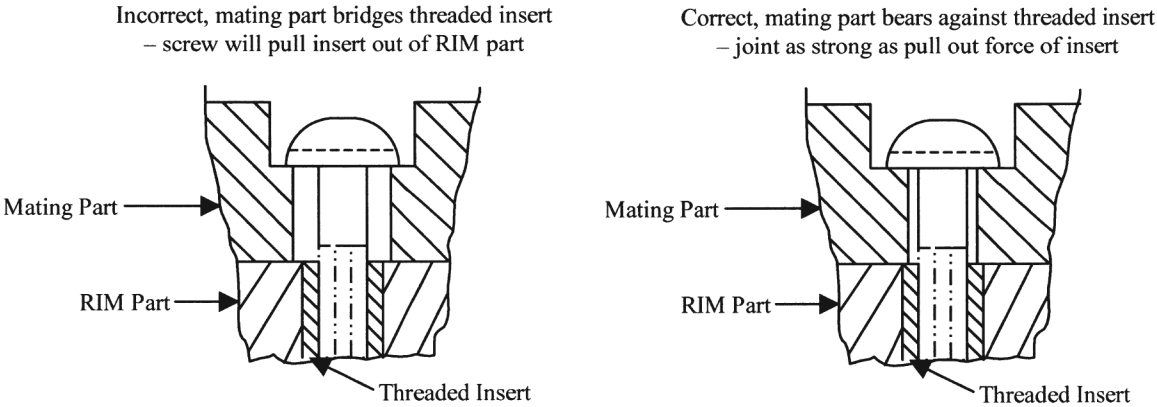


Figure 27
Threaded Insert Joint Design

Insert Molding:

The low pressures, temperatures and viscosities of our RIM resins make it easy to insert mold or encapsulate components in RIM parts. The main criteria for the insert are:

- able to withstand 25 to 50 psi
- able to withstand 250 degrees F for short period of time during chemical reaction of resin
- will not be damaged by low viscosity resin flowing around it

Another important consideration when designing for insert molding is the shrink rate of the polyurethane resin. Most insert materials will resist shrink during molding. This can cause excessive internal stress or warp in some parts. Premold Corp has the experience to help you avoid these problems.

SECTION III - PAINTING , COATINGS & DECORATING

Specifying Surface Finish:

To control quality and costs we use three classifications of surface finishes: primary, secondary and interior. These classifications communicate important information to the people who mold, finish, paint and inspect your parts. They are also important cost drivers when we quote a part.

The most important cosmetic surfaces of your part, those that are readily visible to your customers, are classified as “primary”. Surfaces that are not seen by your customer are classified as “interior”. Surfaces that are visible but with less critical cosmetics are classified as “secondary”.

These classifications can be specified on the part drawing and a detailed definition of the three classifications can be provided. This helps ensure that both your inspectors and Premold Corp’s inspectors can evaluate parts the same way.

Part Color:

While RIM parts can have molded-in color and texture, most parts are painted to achieve the color, gloss, texture and uniform appearance desired. Painting eliminates parting lines, witness lines and differences in shade that can occur due to changing wall thicknesses. Consult with Premold Corp to review the details of your parts.

Painting is a manufacturing process like any other. Your best cost and quality are achieved if the parts are designed for painting manufacturability. Be cautious selecting high gloss and/or minimal texture finishes. These can approach automotive finishes and are more expensive to produce in lower quantities. Premold’s engineers will be happy to help you with the details.

Texture Painting:

Texture painting is done by spraying small drops of paint onto the part after a basecoat of paint has been applied to completely cover the part. The size, height and population density of the small drops of paint must be specified. This is usually done by the customer providing a sample of a texture they want Premold Corp to match. Texture standards used in the mold making industry can also be used to specify texture. In general, the smaller the paint drop and the higher their population density on the surface of the part, the more it costs to texture the part. The smallest practical paint spray texture is MT11030. Sample panels called “Q” panels are commonly used as inspection standards to check paint texture.

Color Matching:

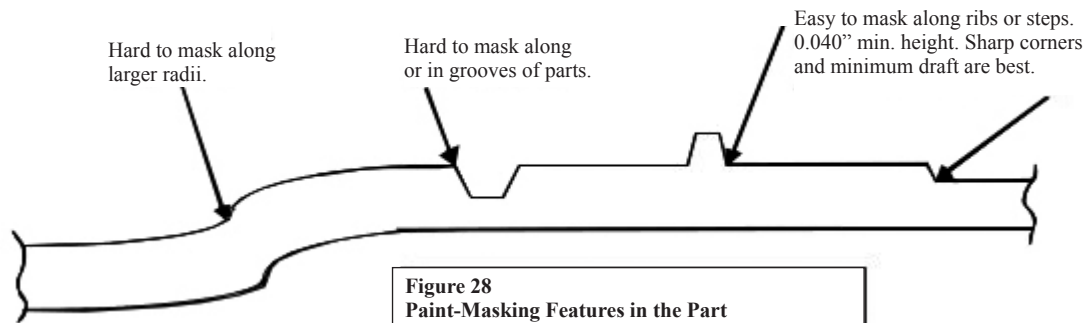
Paint color is best established by providing Premold Corp a sample of the color you want to match with your painted part. We have our paint supplier color scan the sample to determine the exact blend of paint required to match it.

Pantone numbers can be used for color matching but are not always accurate. The Pantone color system was developed for, and is used, in the printing industry for inks on paper substrates. It can give different results when using paints on plastic.

Metallic paint colors and specifications can range from relatively basic to extremely complex. The more metal flake and other ingredients in the metallic paint the more the painted part's appearance varies with viewing angle and lighting conditions. This makes it more difficult to establish specifications and to evaluate paint appearance. Most metallic paints require a primer before applying the basecoat of metallic paint. These factors tend to make metallic painted parts more expensive than non-metallic parts.

Multi-Colored Parts:

If your part requires more than one color of paint, you can minimize masking and painting costs by designing a step in the part. The step serves as a guide for the operator to apply the masking tape and it provides a visual break in the surface of the part. This allows for manufacturing tolerances in the masking and painting process. The step should be at least 0.040 inches high with 3 degrees or less draft. See Figure 28.



Specifying Paint:

You have your choice. You can simply say “color and texture to match approved Q panel” or Premold’s engineers can help you write a detailed paint specification. If you want a detailed specification, the important performance criteria to specify are color, gloss, texture, hardness, scuff and wear resistance, chemical resistance and UV resistance. We are familiar with the proper ways to quantify and measure each of these parameters.

Our paints have proven performance for medical and laboratory instruments. You automatically get superior performance even with a simple color and texture specification.

Paint Adhesion:

Surface preparation is crucial to obtaining good paint adhesion. The part’s surface must not only be clean it should not be too smooth. Premold etches all part surfaces prior to painting. We use catalyzed urethane based paints for superior performance. Our manufacturing standards for adhesion are ASTM D3359-02 Classification 4B or 5B.

Decorating:

In addition to multi-color painting, RIM parts can be silk screened or pad printed. Hot stamping is not used because RIM urethane resins are thermoset materials.

A full spectrum of colors are available to silk screen onto RIM plastic parts. Pad printing is typically more expensive than silk screening. Pad printing may be required if part contours are too extreme for silk screening or if the surface to be printed is too concave.

Ink colors are normally specified using Pantone numbers. Premold Corp uses only chemical resistant, catalyzed inks for the most durable printed images.

EMI Protection:

Premold has UL recognition to supply you with molded plastic parts with EMI paint applied. This protects you and reduces the work you have to do to get your products UL recognized.

EMI stands for electromagnetic interference. It can be generated by electronics or power supplies in your machine or other devices can generate it and cause interference with your device.

We apply a conductive paint to the inside surfaces that you specify on your part. This is the most cost effective method for providing EMI protection. Over spray of the exterior paint on top of the EMI will not diminish its effectiveness. However, if you need an electrical grounding location, let us know and we will mask the EMI surface to prevent over spray. You can minimize masking costs by being liberal with locations and tolerances.

We do not recommend applying a cosmetic coat of paint over EMI paint. EMI paint is not a durable paint and the cosmetic paint will crack or chip easily.

Soft-Touch Paints:

Premold Corp can coat your custom molded plastic parts with durable soft-touch paints color-matched to your needs. Premold's engineers can help you with application details.

Anti-Microbial Paints:

Custom colored anti-microbial paints can also be applied to your molded plastic parts. Consult with Premold's engineers for specifications and details.

R-IMPact+™ Coating:

Premold Corp developed R-IMPact+™, a composite material with greatly enhanced impact strength and extreme scuff resistance. This coating can be applied by Premold during normal processing of your parts. Custom colors are available. Premold can also paint the coating to give you more finish options. The coating can be applied to selected areas of your parts or to entire surfaces. Contact Premold Corp engineers for more information and application details.

SECTION IV - DESIGN FOR QUALITY ASSEMBLY

Design for Quality Assembly:

RIM parts can be designed to make it easier for you to build machines with quality fits and finishes. Premold Corp calls this process Design for Quality Assembly or DQA. The larger the plastic parts and the more complex the assembly, the more important it is to use DQA techniques. DQA often results in molded-in features (bosses, ribs, tabs, etc.) to help locate parts in an assembly. Plastic molding, especially the RIM process, offers you tremendous design flexibility to take advantage of these DQA features. Premold Corp's engineers can help you choose from many different design features to accomplish good design-for-quality assembly. By planning and designing quality into the parts during the design phase, you will save considerable time and money during both production start-up and during on-going production.

The DQA process analyzes the critical fits and tolerances in your assemblies. Some common DQA design techniques are:

- Use locators to control important dimensions in an assembly. The locators should be as close as possible to the features to be controlled.
- Use features to support plastic walls to limit their deflection from outside loads. These will also help prevent creep.

Good plastic part design and DQA accounts for four key factors:

- part shrinkage during molding.
- material properties of the resin.
- outside forces on your plastic part.
- assembly tolerances.

Plastic resins shrink during the molding process. Thicker cross sections of plastic tend to shrink more than thinner cross sections. RIM materials are generally unaffected by variations in wall thickness. However, if the thickness variations are significant (and depending on part geometry) unequal shrink can cause the part to distort or warp. Premold engineers can guide you in part design to minimize the risk of warp.

The most commonly overlooked plastic material property is creep. The resins we use at Premold Corp are very structural but plastics in general creep at lower temperatures and pressures than the metals to which designers are accustomed. RIM offers the capability to mold very large parts (over 24 inches long). This makes it more important to account for creep in your design.

Creep is a slow dimensional change over time. It is a function of time, temperature and pressure (i.e. a force generating a stress on the part). The rate and amount of creep will increase if one or more of these factors increase. All materials creep, however creep accelerates in most plastics at lower temperatures and pressures than for metals. Premold engineers can help you determine whether creep could be a factor in your design and offer proven methods to minimize its effects.

Most plastic resins are not as strong or as stiff as metals. Your plastic part may deflect when an outside force or load is applied, especially if is large (over 24 inches). Premold engineers will help you design parts that will meet your load requirements.

These factors, along with the stack-up of your assembly's tolerances, can be addressed using proven DQA techniques. Premold Corp's applications engineers will work with you to understand your product requirements and help you design parts that meet them. DQA will help you achieve well-designed assemblies that improve your production efficiency and product quality.

SECTION V - ADDITIONAL INFORMATION

Tolerances:

During processing, plastic resins are heated so they can be molded or formed into parts. As the parts cool they shrink. Part geometries like unequal wall thickness, thick ribs, large bosses, and open sections tend to cause uneven shrinkage. This material characteristic is called warp. Tolerances from warp can be addressed by designing locating features into the part.

Molded plastic parts, especially RIM parts, lend themselves very well to molding in locating features to help control these tolerances. In fact, Premold Corp has developed Design for Quality Assembly (DQA) methods to help make your multi part assemblies look good every time. For more information about how to design in locating features, please refer to the topics “Joints Between Parts” and “Design for Quality Assembly” in this design guide or contact a Premold Corp engineer.

Typical tolerances are:

molded dimensions:	
for basic part geometry:	+/- 0.001 in./in. or +/- 0.005 in., whichever is greater
for complex part geometry:	+/- 0.002 in./in. or +/- 0.005 in., whichever is greater
flatness:	
restrained:	+/- 0.0010 in./in
unrestrained:	+/- 0.0015 in./in
post machined dimensions:	+/- 0.005 in.

Consult Premold Corp if you need smaller tolerances than these and to verify that your part design does not require larger tolerances.

Shrink Rate:

Premold Corp’s rigid urethane resins shrink 0.008 in./in. during the molding process. We compensate 0.001 in/in for the thermal expansion of aluminum molds. You do not need to include these factors in your design. They are factored in during the CNC programming to make the mold.

Adhesive Bonding:

Our urethane resins can easily be bonded with epoxy, cyanoacrylate or hot melt adhesives. Stronger adhesive joints are achieved when double shear joints are used. Application of the adhesive and assembly of the parts is faster and easier if a tongue and groove joint is used. Attention to the joint design details helps achieve a strong, aesthetic joint that makes it easier to achieve repeatable, quality results. Premold Corp can help you by bonding your RIM parts together or bonding your RIM parts to parts made from other manufacturing processes. Contact a Premold Corp engineer for details.

Figures 29 and 30 show two types of tongue and groove joint designs.

Figure 29 shows a version that allows excess adhesive to squeeze into a non-cosmetic area of the assembly. This design controls some of the thickness of the adhesive joint, the position of the parts and the size of the reveal gap. The tongue and groove joint should be designed so assembly technicians can apply an adhesive bead that fills 50% to 80% of the adhesive joint cross-sectional area. Sizes should be designed so the adhesive application process will be capable of controlling the size of the adhesive bead within this tolerance range. This prevents excess adhesive from squeezing out of the adhesive joint and causing cosmetic and clean-up problems.

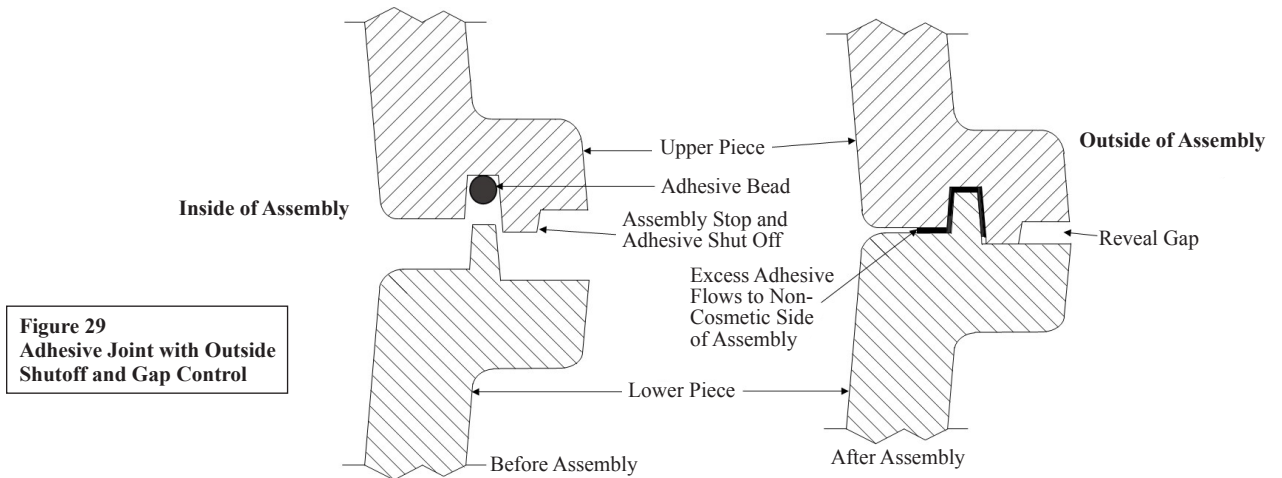


Figure 30 shows a version where the assembly stop is molded on the interior of the part. This controls some of the thickness of the adhesive joint, the position of the parts and the size of the reveal gap. The tongue and groove joint should be designed so assembly technicians can apply an adhesive bead that fills 50% to 80% of the adhesive joint cross-sectional area. Sizes should be designed so the adhesive application process will be capable of controlling the size of the adhesive bead within this tolerance range. This prevents excess adhesive from squeezing out of the adhesive joint and causing cosmetic and clean-up problems.

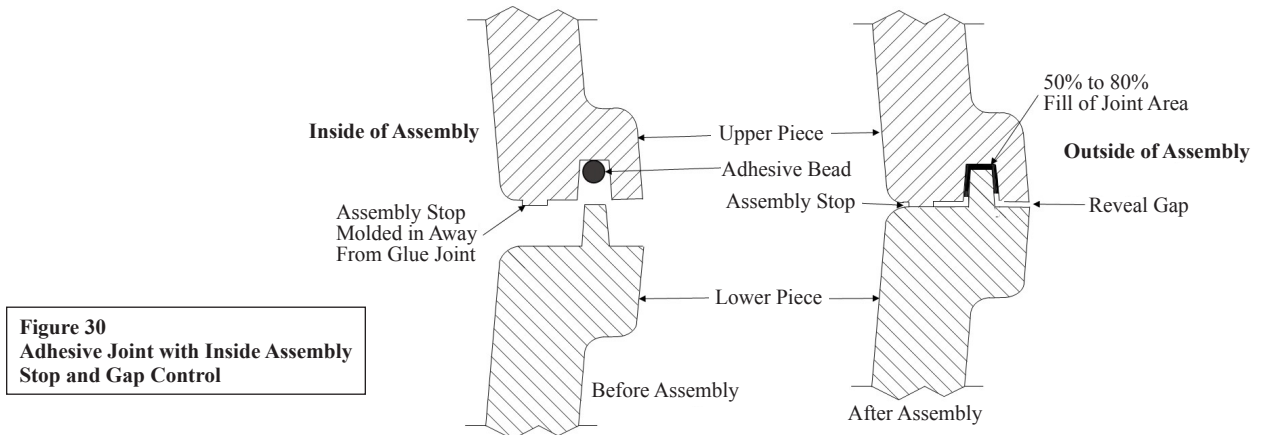


Figure 30
Adhesive Joint with Inside Assembly Stop and Gap Control

All these designs, and any others used, need to have details important to controlling costs and quality.

The details are:

- A groove to apply the adhesive into. The groove is large enough to allow the use of easy-to-use application equipment. It is also sized to achieve the structural strength required from the adhesive joint.
- The groove is sized for manufacturability and to allow application of a practical and easy-to-apply size of continuous adhesive bead. It allows for acceptable manufacturing tolerances in the size of the adhesive bead. Consult with Premold Corp engineers regarding these sizes. Like all manufacturing processes, the adhesive dispensing equipment and the entire application process have capabilities and tolerances associated with them. In general, the larger the tolerance that can be allowed, the faster (lower cost) and easier (higher quality) the adhesive can be applied.
- The tongue is sized for manufacturability and to allow for manufacturing tolerances of the two parts being bonded together. These tolerances depend on the sizes and shapes of the parts. The tongue is also sized to ensure that enough of the adhesive is squeezed between the tongue and the groove to achieve a double shear joint of adequate strength. This must be achieved even when accounting for part tolerances and adhesive application tolerances.
- Assembly stops molded into the mating parts to control how far the parts telescope together when assembled. This maintains the proper thickness of adhesive for the double shear joint. It also allows the parts to be clamped together until the adhesive cures.
- Reveal gaps essential to high cosmetic assemblies of the parts.

SECTION VI: PROTOTYPES AND ULTRA-LOW VOLUME PRODUCTION PARTS

Premold Corp has the craftsmen and equipment in-house to make inexpensive, short-life molds to make prototypes of your parts. These cast silicone molds are so precise we can even mold color and texture into the parts. The use of longer cure urethane casting resins and mold pressure chambers help ensure high cosmetics for your parts. Tight tolerances and a wide range of material property choices allow you to use Premold's prototype parts for fit, form and functional tests. Our prototype parts can also be painted and decorated using our in-house painting, silk screen or pad print processes.

Silicone molds can be made in short lead times. Their lives are typically 25 pieces before the mold is worn out. Replacement silicone molds can be made at a fraction of the cost and lead time of the original mold. This enables customers to order more than 25 prototype parts or even use silicone molds for their ultra-low volume production needs.

Cast urethane prototype parts can be designed using the recommendations in this Design Guide. All the features you design into your production parts can be cast into your prototype parts

Premold not only saves you time and money, we also help you ensure higher quality when we provide your prototype and production parts. You communicate all your needs and specifications to just one supplier. Premold uses insights gained from providing your prototype mold and parts to reduce your costs and lead times for providing your production mold and parts. Contact Premold Corp to learn more about how your company can benefit from cast urethane parts.

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Gallery of Sample Parts

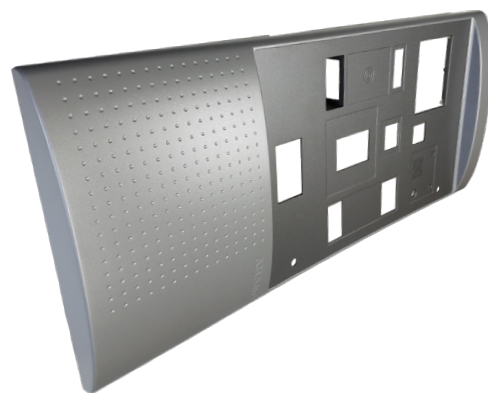
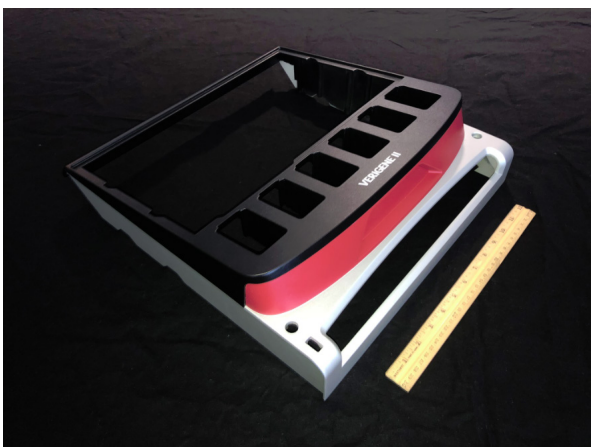
Capabilities of RIM Design Generosity...



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Gallery of Sample Parts

Capabilities of RIM Design Generosity...



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Premold Corp has advanced Reaction Injection Molding to a state-of-the-art process and we provide exceptional customer service. These advances have made it possible for us to expand our capabilities in our modern 68,000 square foot manufacturing facility. Our factory is equipped with computer controlled RIM molding equipment to ensure precise, high-quality parts.

We invite you to visit our facility to meet our RIM and customer service experts. Let us explain how you can benefit by innovative, low cost tooling solutions for your molded plastic parts.



Premold Corp has added a manufacturing location in Monterrey, Mexico. Already North America's leading RIM molder for specialty equipment, this greatly expands Premold's logistic and price advantages. Contact us to learn how you can benefit.

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