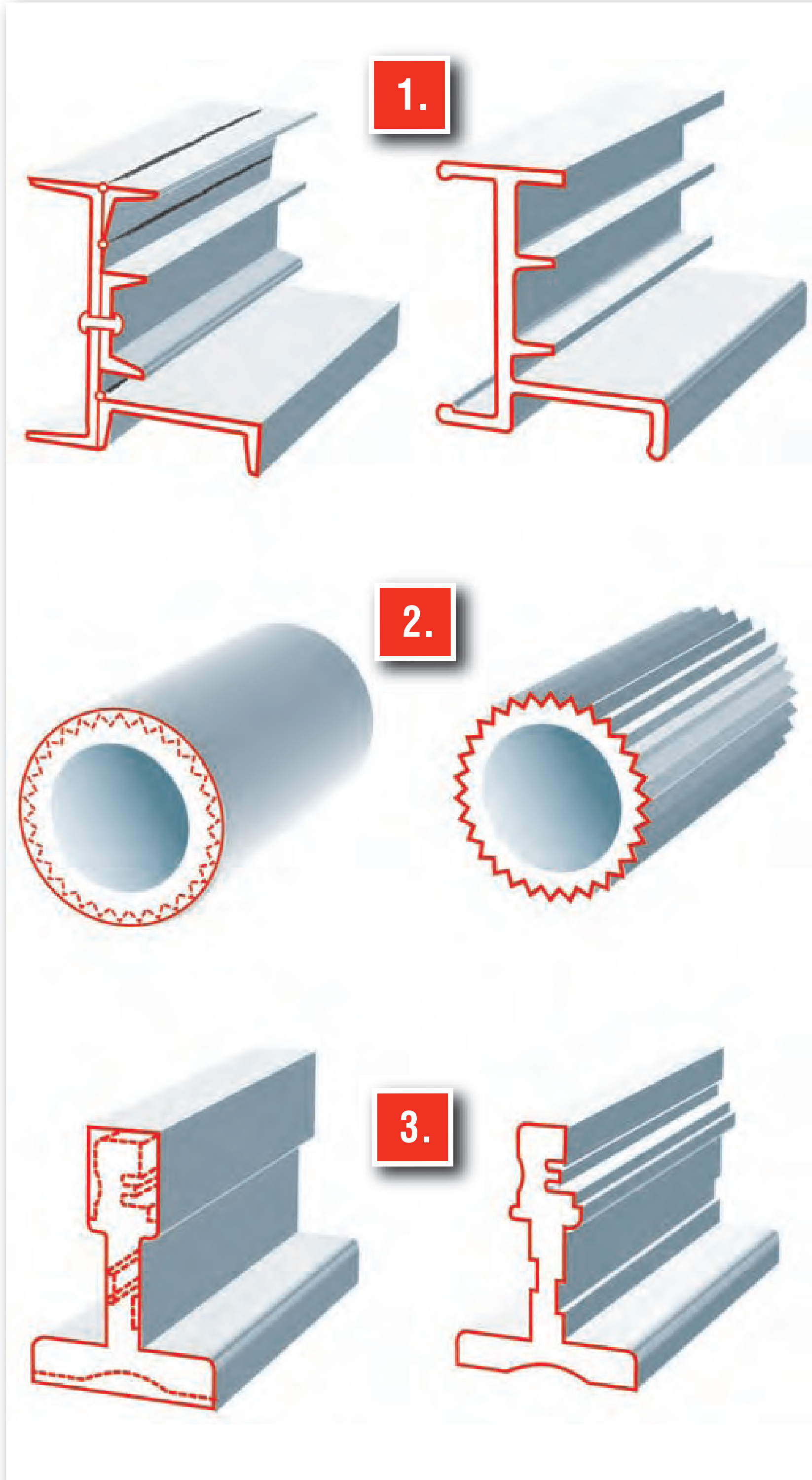
Design Decision – Advantages with Aluminum Extrusions

There are any number of ways in which extruded aluminum can be applied to meet design challenges more effectively, more efficiently, or more economically than alternative methods of manufacture. The following illustrations offer just a few common examples.

1. As shown, several rolled shapes, riveted together, can be replaced by a single extruded profile, resulting in higher strength while eliminating joining costs.

2. Machining costs often can be reduced by extruding the desired component to exact (or near net) size and shape requirements.

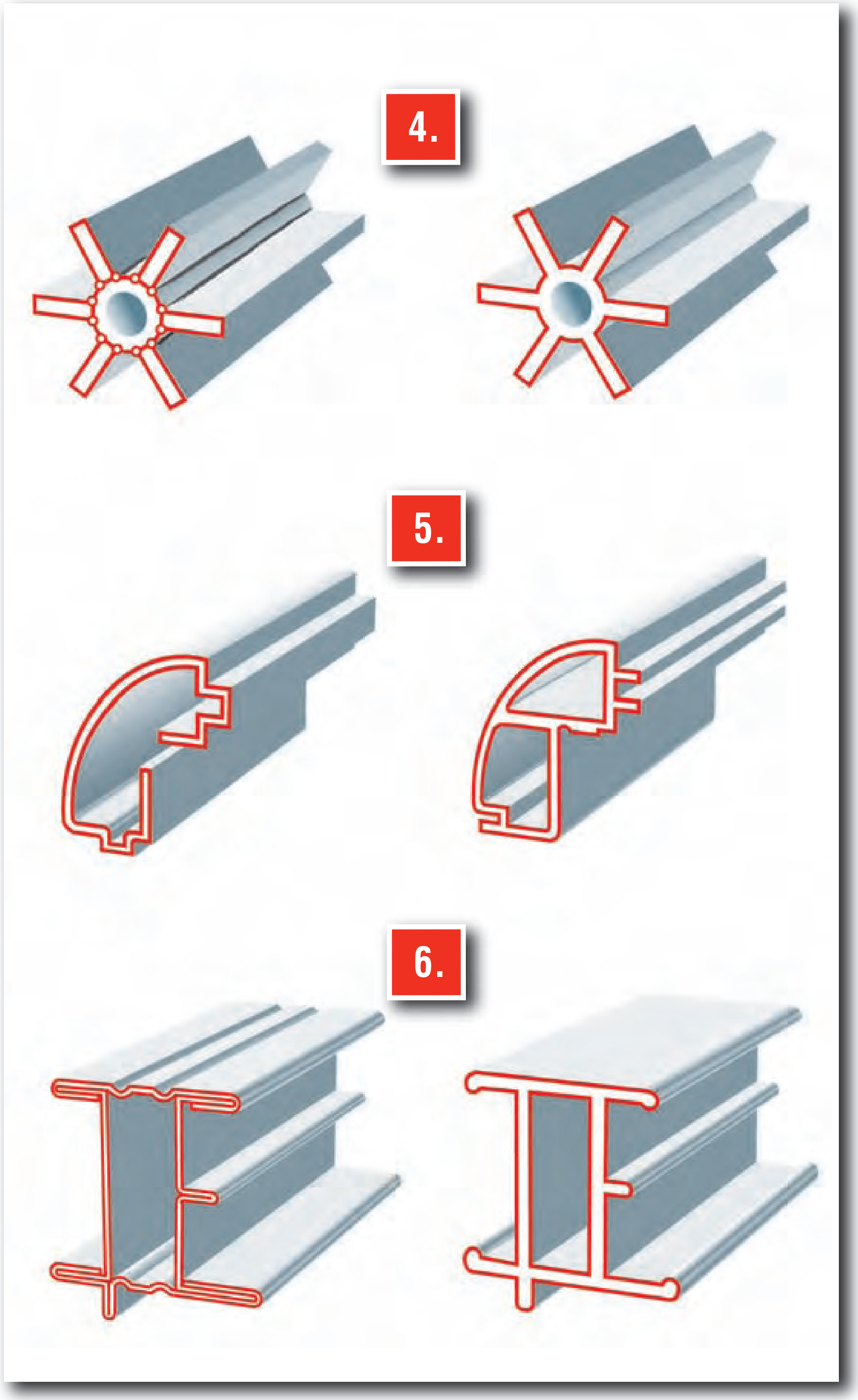
3. Weight can be greatly decreased by putting the metal only where needed. The extrusion process can put the metal exactly where needed.



4. Welded assemblies frequently can be eliminated by designing an appropriate extrusion. In this way, costs can be reduced while both strength and accuracy are increased.

5. Sturdy multi-void hollow profiles are available to replace roll-formed alternatives, often at reduced set-up costs and shortened lead times.

6. Improved stiffness and strength can be achieved through extrusion. Here, a detailed hollow profile replaces a crimped tubular section, at a reduced manufacturing cost.



Circumscribing Circle Size

One common measurement of the size of an extrusion is the diameter of the smallest circle that will entirely enclose its cross-section—its circumscribing circle.

This dimension is one factor in the economics of an extrusion. In general, extrusions are most economical when they fit within a medium-sized circumscribing circle: that is, one with a diameter between one and ten inches.

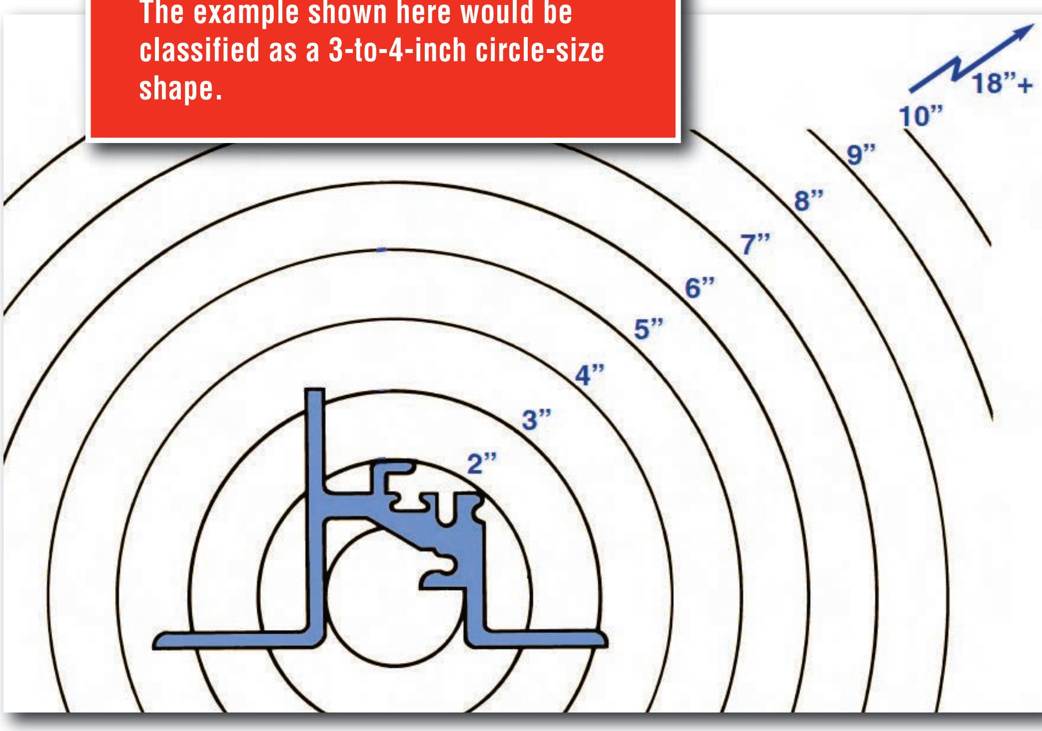
Most common profiles are less than 18 inches in diameter, but a few extruders are capable of producing extrusions with a much larger circumscribing circle diameter (CCD), some as large as 32 inches.

Cross Section Area in sq inches	Circumscribed Circle Size in inches: <1	1 to 7	7 to 10	10 to 14	>14	Corresponding Profile weight (lbs/ft)
<.050	L	x	x	x	x	<.06
.050 to .100	G	G	L	x	x	0.06 to 0.12
.100 to 1.0	W	W	L	x	x	0.12 to 1.18
1.0 to 2.5	x	W	W	L	x	1.18 to 2.94
2.5 to 10	x	W	W	G	L	2.94 to 11.76
>10	x	x	W	G	L	>11.76

x	Not available
L	Limited Availability
G	Generally Available
W	**Widely Available**

NOTE:
There are many presses available with up to 7" diameter containers
There are fewer presses available with 7" to 10" diameter containers
There are even fewer presses available with 10" to 14" diameter containers
There are very few presses available with greater than 14" diameter containers

The example shown here would be classified as a 3-to-4-inch circle-size shape.



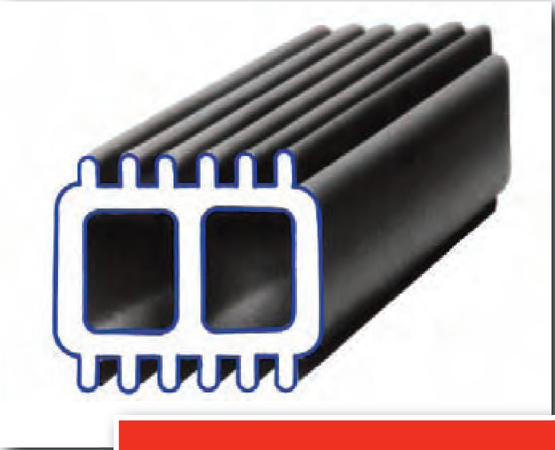
Design Decision - Practices

To develop a good extrusion design, the following key characteristics should be addressed:

- Specify the appropriate metal thickness
- Keep metal thickness as uniform as possible
- Use metal dimensions for tolerances
- Design with surface finish in mind
- Smooth transitions
- Use webs where possible
- Use ribs to straighten
- Round corners wherever possible, avoiding sharp edges
- Incorporate indexing marks.

Specify the Most Appropriate Metal Thicknesses

Specify metal thicknesses that are just heavy enough to meet your structural requirements. Even in low stress areas, however, keep sufficient thickness to avoid risking distortion or damage. Some shapes tend to invite distortion during the extrusion process (such as an assymetrical profile or thin details at the end of a long flange); such tendencies exert more influence on thin-walled shapes than on those with typical metal thickness.



Metal thicknesses should be appropriate.

Rounded corners ease the flow of metal.

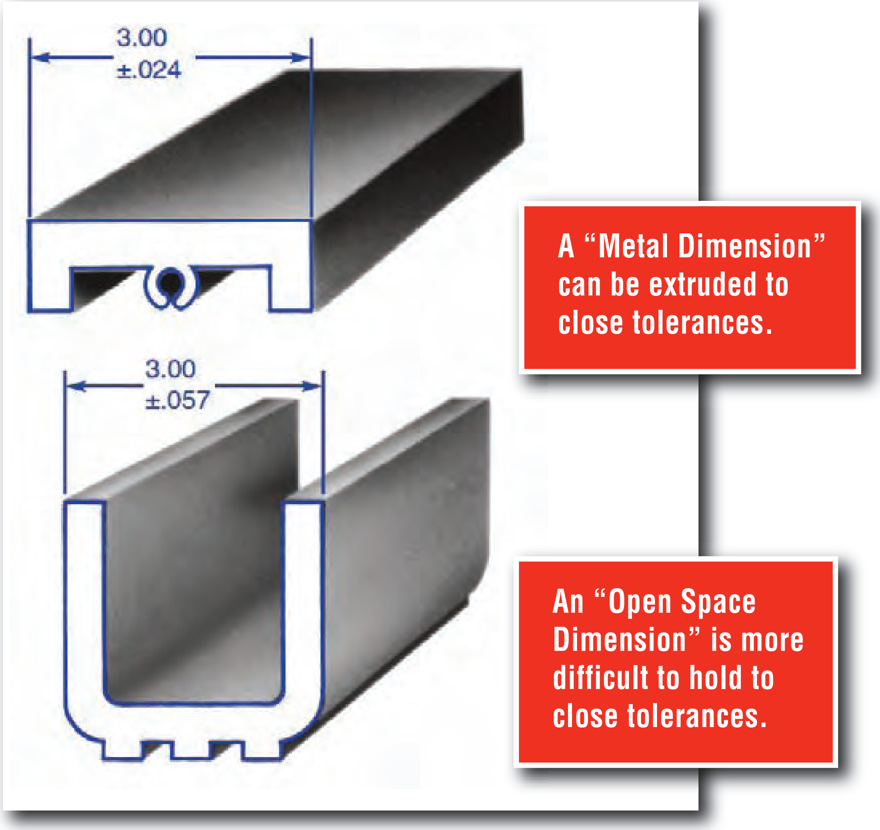
Keep Metal Thickness As Uniform As Possible

Extrusion allows you to put extra metal where it is needed—in high-stress areas, for example—and still save material by using normal dimensions elsewhere in the same piece. Adjacent-wall thickness ratios of less than two-to-one are extruded without difficulty, but large differences between thick and thin areas may create dimensional control problems during extrusion. It is best to maintain near uniform metal thickness throughout a shape if possible. When a design combines thick and thin dimensions, streamline the transitions with a radius (a curve, rather than a sharp angle) at junctions where the thickness changes sharply.

Practices

Use Metal Dimensions for Best Tolerance

Dimensions measured across solid metal are easier to produce to close tolerances than those measured across a gap or angle. So rely on so-called metal dimensions as much as possible when designing close-fitted mating parts or other shapes requiring closer tolerances. Standard industry dimensional tolerances are entirely adequate for many applications, but special tolerances can be specified if necessary.

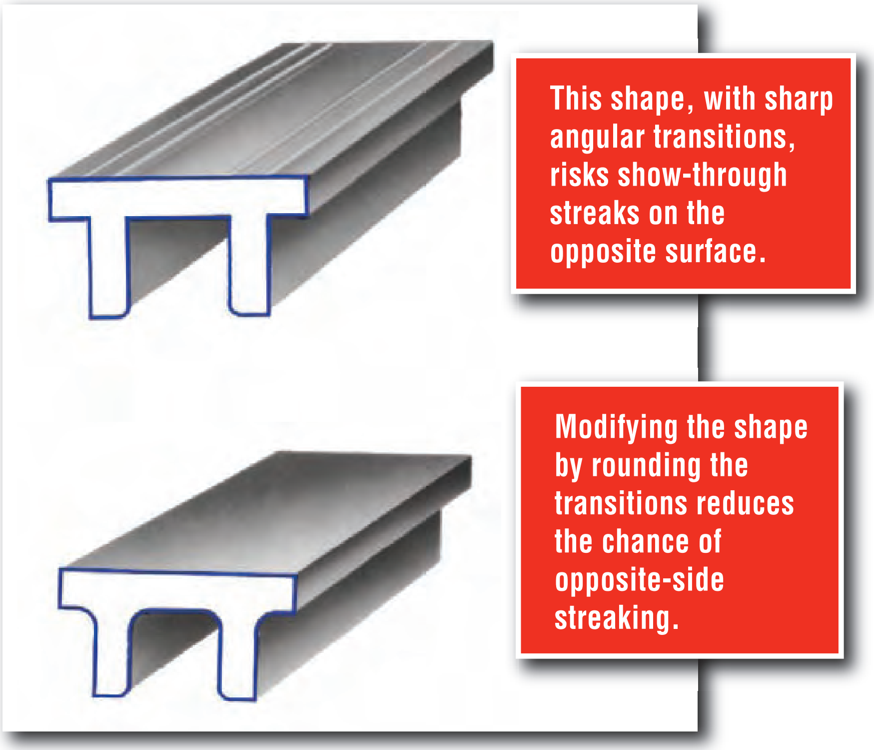


Design with Surface Finish in Mind

Always indicate "exposed surfaces" on your design drawing so the extruder can give them special attention and protect their finish during both extrusion and post-extrusion handling.

As a general rule, the narrower the exposed surface, the more uniform its finish.

Webs, flanges, and abrupt changes in metal thickness may show up as marks on the opposite surface of an extrusion, particularly on thin sections. The marking of exposed surfaces can be minimized by thoughtful design.



Smooth All Transitions in Thickness

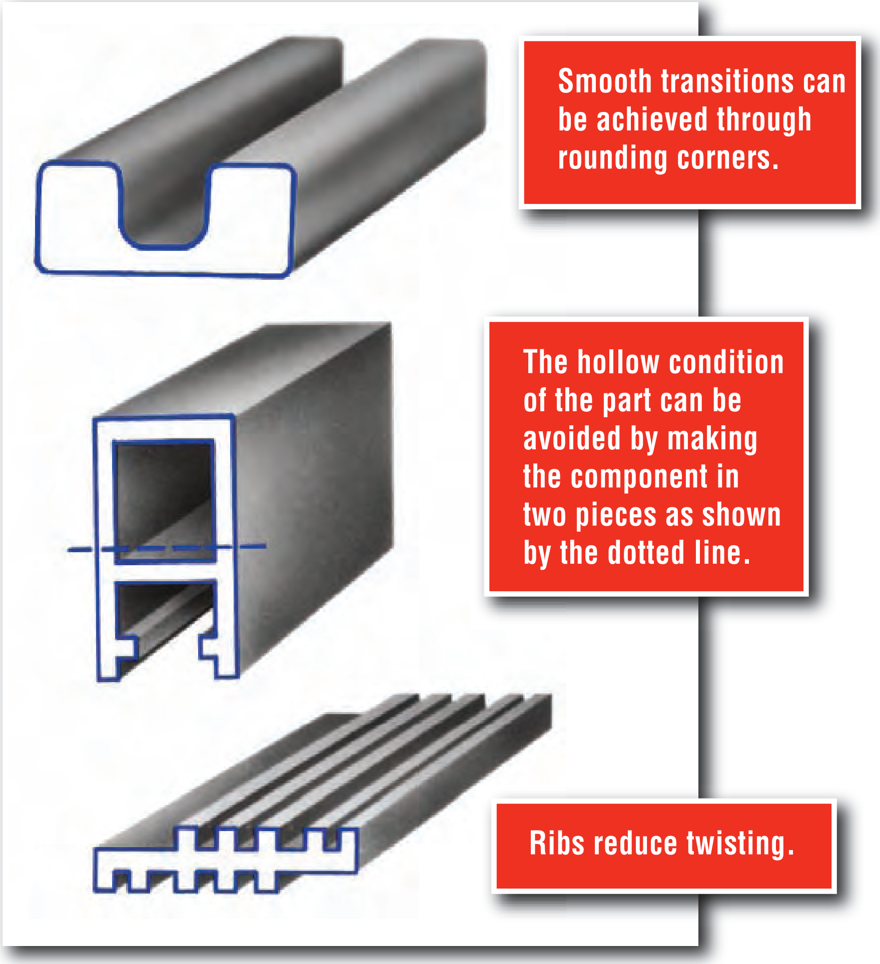
Transitions should be streamlined by a generous radius at any thick-thin junction.

Web Gives Better Dimensional Control

Metal dimensions are more easily held than gap or angle dimensions. The web also allows thinner wall sections in this example.

Ribs Help Straightening Operation

Wide, thin sections can be hard to straighten after extrusion. Ribs help to reduce twisting, and to improve flatness.

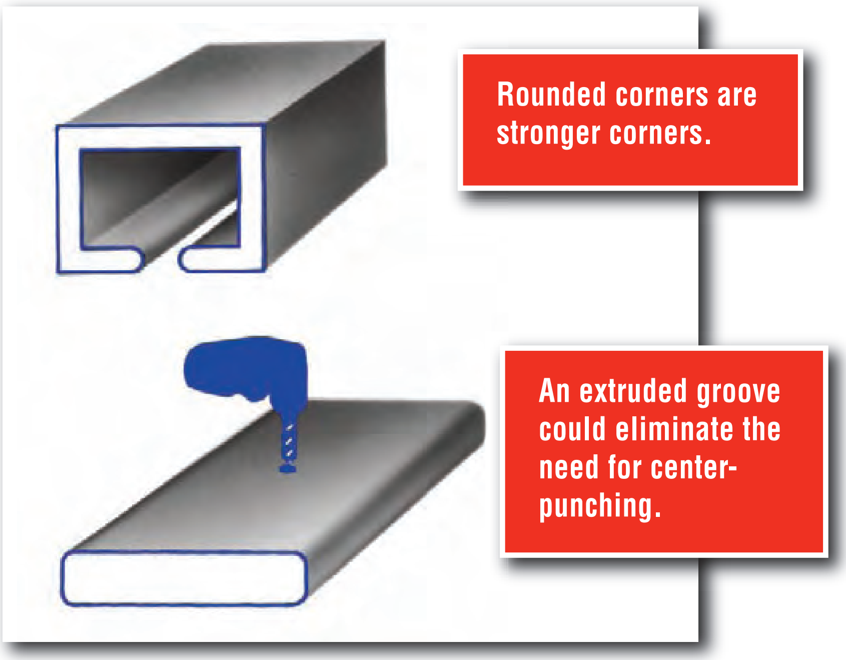


Rounded Corner Strengthens Tongue

The die tongue is less likely to snap off when the corners of the profile are rounded at the narrowest area of the void.

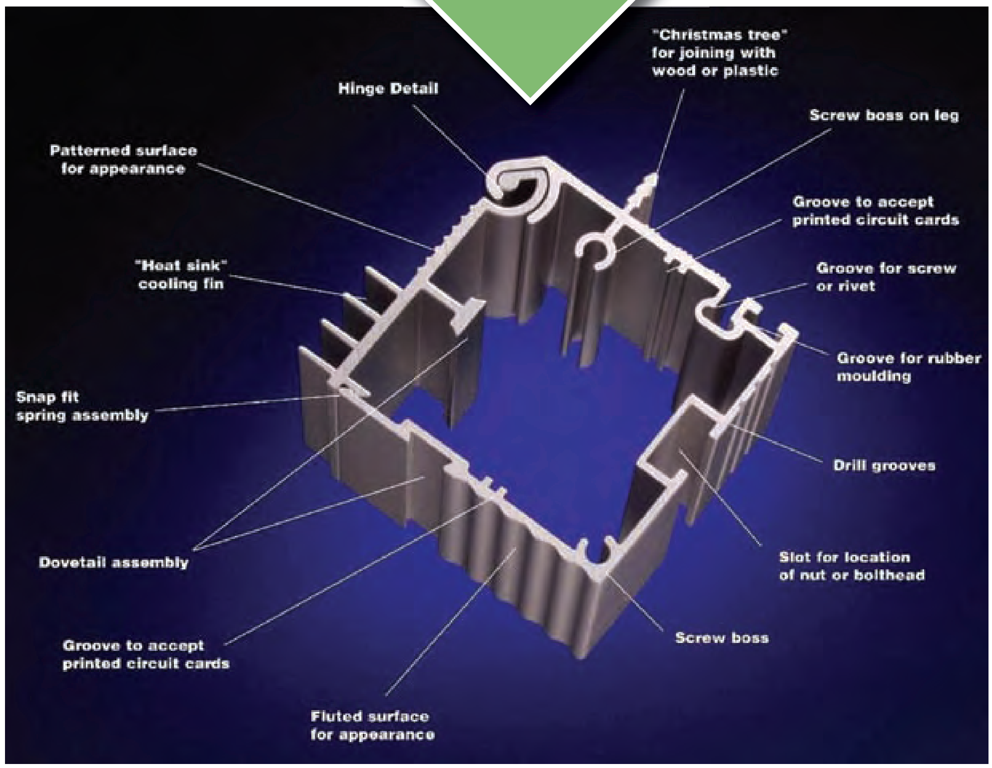
Built-In Indexing Mark

Shallow extruded grooves make drilling, punching, and assembly easier by eliminating the need for center-punching. An index groove can also be used to help identify pieces that are similar in appearance, or to distinguish an inside (rather than an outside) surface.



Design Decision - Assembly

Extruded shapes can incorporate essential design features such as screw bosses, card slots, or drill guides. Thus, aluminum profiles enhance the usefulness of the part produced.

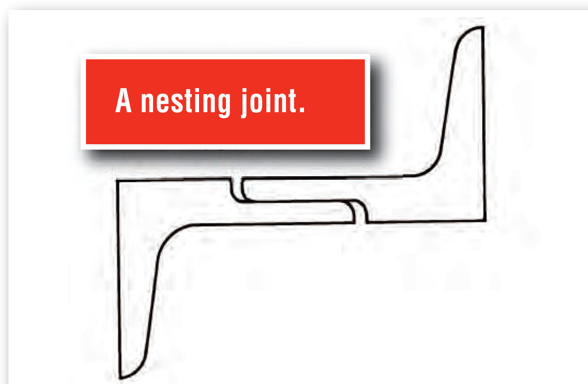


The joining of aluminum extrusions can be accomplished by way of nine distinct methods that can be designed into the profiles themselves:

1. Nesting
2. Interlocking
3. Snap-fit
4. Three-piece interlock
5. Combination
6. Slip-fit
7. Hinge joint
8. Key-lock joint
9. Screw slot

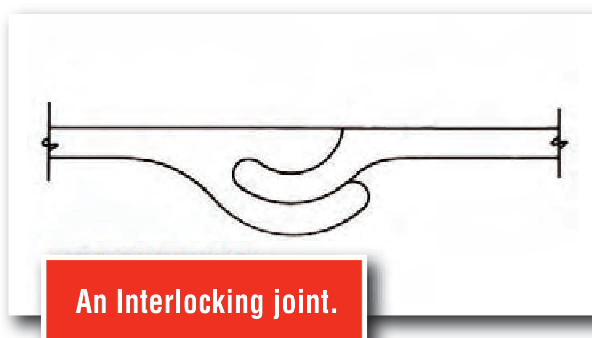
Nesting Joints

Nesting joints which include lap joints and tongue-and-groove joints, have mating elements that are shaped to be assembled with little or no self-locking action.


A nesting joint.

Interlocking Joints

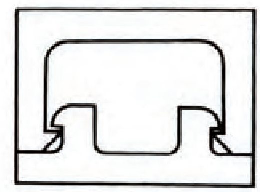
The interlocking joint is, in effect, a modified tongue-and-groove. But instead of being straight, the two mating elements are curved, therefore, they cannot be assembled or (more to the point) disassembled by simple straight-line motion. They are assembled by a rotating motion and will not separate without a corresponding counter-rotation. As long as the parts are held in their assembled position, they strongly resist separation and misalignment in both the horizontal and the vertical directions.


An Interlocking joint.

Snap-Fit Joints

A “snap-fit” or “snap-lock” joint is one which is self-locking and requires no additional fasteners to hold the joint together.

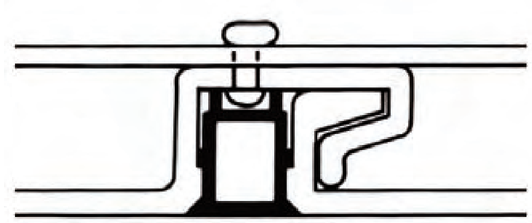
The mating parts of a snap-fit joint exert a cam action on each other, flexing until one part slips past a raised lip on the other part. Once past this lip, the flexed parts snap back to their normal shape and the lip prevents them from separating. After it is snapped together, this joint cannot be disassembled unintentionally.



A snap-fit joint.

A Three-Piece Interlocking Joint

A three-piece joint can be designed with a blind (hidden) fastener interlocking the two principal extrusions. Such a design presents one side with a smooth appearance and no visible mounting hardware.



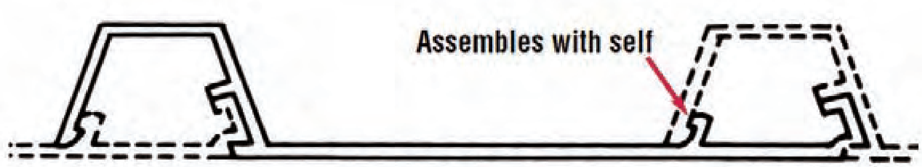
A three-piece interlocking joint.

Combination Joints

Nesting, interlocking and snap-fit joints can be combined in the same extruded assembly.

For example, snap-fit elements can easily be combined with rotating elements.

Assembly

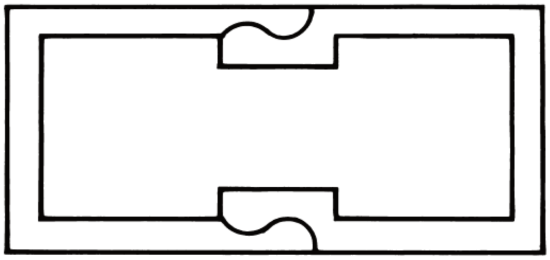


In example at above, a single extruded shape is designed for mating with identical parts that are rotated into assembly and then snap-locked rigidly into position without auxiliary fastening. The tight surface-to-surface contact in this design also provides resistance to sliding between the parts.

Slip-Fit Joints

Slip-fit joints are assembled by sliding two extruded mating parts together in the direction of their length. They are generally classified either as close-fitting, rigid dovetail joints or as loose, freely-rotating hinge joints.

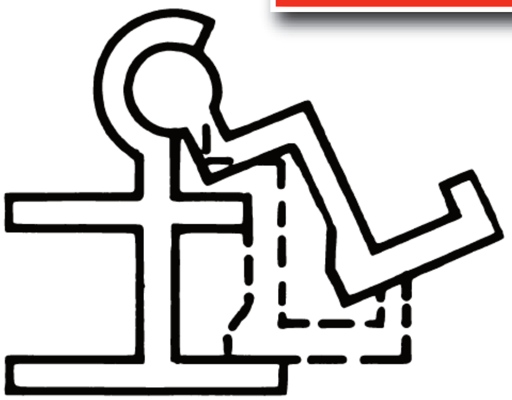
Dovetail joints are useful in many products where a simple, strong, permanent connection is required.



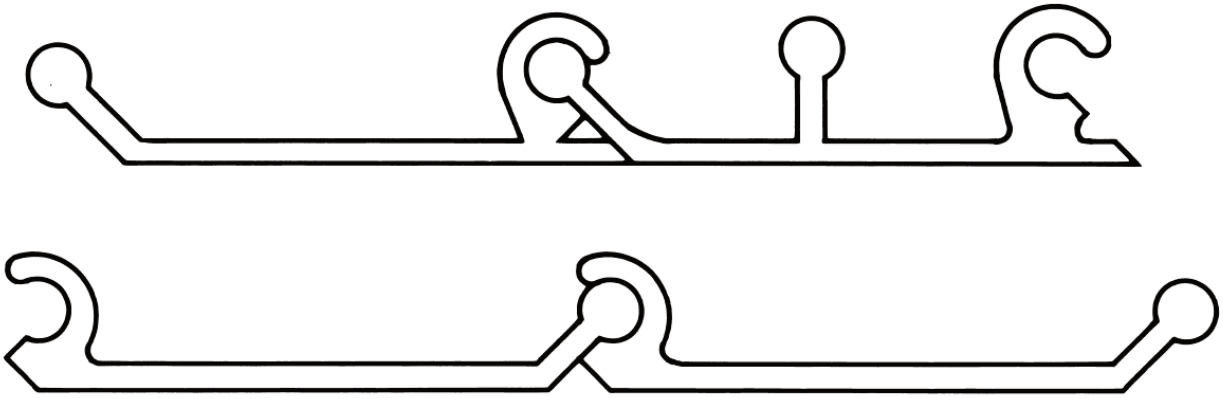
This dovetail joint is a type of slip-fit joint.

Hinge Joints

The cross-section of the components of a hinge joint have ball-and-socket shapes that allow them to rotate without separating. Hinge action through 60 to 90 degrees is easy to obtain; incorporating adequate reinforcement, hinge joints may be designed to rotate beyond 90 degrees. Since the hinge joint is relatively "loose," provisions should be made to prevent lateral (side-to side) slippage.



A pair of extruded components make up this hinge joint.



A number of profiles could be assembled in series for this type of hinge joint.

Key-Locked Joints

These unusual joints have two or more primary elements which are locked together only when an additional specialized part, the key, is slid into position.

The joint shown here is used to connect two or more panels. In the illustration, two panels and their extruded joining elements are seen edge-on from the top or bottom. The three hook-profiled extrusions nest together, but are not in fact joined until an extruded pin with a special profile is inserted into the space at the center, locking them in place.

Keyed interlocks of this type permit rapid, easy assembly and disassembly, making them particularly adaptable to temporary and portable installations, as well as relatively permanent structures.

This unique key-locked joint won an award in an international extrusion design competition cosponsored by the Aluminum Association and the Aluminum Extruders Council.