A Simple Guide to Extrusion Designs

The manufacturing and production process starts with the die design. It is here that the extrusion takes shape and features are built in to reduce weight, simplify assembly, add functionality and minimize finishing costs. Here we take advantage of the unique benefits of aluminum, in combination with the extrusion process, to make a cost-effective product with optimal functionality and an attractive appearance.

The Georgia Extrusion Division has a staff with over 140 years of experience in Die Design and Die correction/repair. Our talented Engineering Department is available to assist your design engineers with the specifics in extrusion design.

Extrusion design tips:

- Wall/material thickness
- Uniform wall thickness
- Wall/material Variance
- Radius v/s Square corners
- Solid profiles if possible
- Fewer cavities in hollow profiles
- Profiles with deep channels and ratios
- Heat sinks
- Decorative Surfaces
- Run out surface

Wall thickness:

When deciding how thick the walls of a profile should be, strength and optimum cost-efficiency are two of the main considerations.

Profiles with a uniform wall thickness are the simplest to produce. However, where necessary, wall thickness within a profile can easily be varied. For example, a profile's bending strength can be increased by concentrating weight/thickness away from the centre of gravity.

Cost-efficient production

To optimize cost-efficiency, a profile's design should always be as production-friendly as possible. To achieve this, the profile should:

- have a uniform wall thickness
- have simple, radius corners
- be symmetrical
- have a small circumscribing circle
- not have deep, narrow channels, try to keep channels to a 3 to 1 ratio
- have as few channels, screw bosses as possible

Recommended wall thickness - guidelines

Amongst the factors having an effect on wall thickness are extrusion force and speed, the choice of alloy, the shape of the profile, desired surface finish and tolerance specifications.

Even with these noted walls thickness due to the complexity and the press' that are available some profiles may need more material thickness.

<table>
<thead>
<tr>
<th>Aluminum minimum wall thickness</th>
<th>6063 / 6463</th>
</tr>
</thead>
<tbody>
<tr>
<td>circle size .500 [12.7mm] to 2.000 [50.8mm]</td>
<td>.045 [1.143mm]</td>
</tr>
<tr>
<td>circle size 3.000 [76.2mm] to 4.000 [101.6mm]</td>
<td>.050 [1.27mm]</td>
</tr>
<tr>
<td>circle size 4.000 [101.6mm] to 5.000 [127mm]</td>
<td>.062 [1.574mm]</td>
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And the trend continues.

**Uniform wall thickness**
In the drawing below you can see in the left hand profile that the internal and external walls have a different thickness. It is an advantage if the internal and external walls are of the same thickness (below right). This decreases die stress and improves productivity.

**Wall/material Variance**

It is of course perfectly acceptable for a profile to have walls of different thicknesses. For example, for strength reasons, it may be best to concentrate weight/thickness away from the centre of gravity.

**Radius corners**

The extrusion process cannot achieve razor­sharp corners without additional fabrication. Corners should be rounded. A radius of \(0.020r - 0.040r\) \((0.5 - 1\text{mm})\) is often sufficient.

A design may demand sharp internal angles, a profile that may enclose a box shape. This is easily solved by incorporating a recessed corner.
As far as possible sharp tips should be avoided. The tip can easily become wavy and uneven or possible having a tearing result when extruded. Tips should therefore also be **rounded**.

And for accurate measurements dimensioned to a tangent instead of an intersection.

This extrusion on the left showing the square corners, with large variations in wall thickness cools unevenly. This causes visible structural unevenness that is particularly noticed after anodizing. Always use **radii to blend corners**.

**Solid profiles if possible**

The part on the left is a double void hollow if you can eliminate the voids it will be best. Solid profiles reduce die costs and are often easier to produce.
Fewer cavities in hollow profiles

This hollow profile is extremely complex to produce. Notice it has (9) hollow voids. By replacing the hollow profile above with these two telescoping profiles, the product is considerably easier to produce. And you will also need to consider extrusion tolerances when designing mating parts.

It's best to have as few of voids as possible, reducing the number of cavities in a hollow profile makes it easier to extrude. This also increase dies stability. While reducing the number of cavities also consider keeping the internal walls as short as possible.

Deep channels and ratios

For profiles with channels (tongues), there is a basic rule that the height to width ratio should be approximately 3:1. This is best for an extrusion die and ensures that the strength of the die is not jeopardized. (example height .300 [7.62]x width .100 [2.54])

By using large radii at the opening of the channel, and a full radius at the bottom, the ratio can be increased to 4:1 but again the ratio is higher so expect more breakage.
Where channel width is under .079 [2 mm], or where a profile’s design is complex, permissible channel depth must be determined on a case-by-case basis. It may be possible to increase radii and opening dimensions without compromising functionality. Here, a holder has to enclose a slide. After redesigning the holder on the (left) gives a more extrusion-friendly profile and improved functionality.

A profile can be extruded “open” and then rolled into shape. This also reduces the tongue ratio and it will take a second process to close the shape up which usually calls for a brake press. The solution below shows a narrow, deep channel and an extrusion-friendly profile. The designer will need to think about tongue depth and ratios.

Reduced channel depth using a step. Adding a wall in this case makes the gap opening easier to control.
Heat sinks

The use of cooling fins on profiles greatly increases the heat dissipating area. This can be further increased by giving the fins a wavy surface. Where there is forced air-cooling longitudinally along the profile, it is better to leave the fins smooth. An undulating surface increases the heat dissipation area of fins, as shown in the close-up image below.

The profile below exemplifies technical development. Large profiles with deep channels yet tight tolerances are respected and there is a high quality surface finish. It's best to keep this type of design as symmetrical as possible. This type of die is more acceptable for die breakage and tongue shift and very hard to produce in some cases due to the variance in wall thickness and high tongue ratios.

Decorative Surfaces

Decorations have several advantages:
- Design
- Masking of imperfections
- Protection against damage during handling and machining
A decorative pattern can make a plain aluminum surface more attractive. The consistent use of a pattern on all a product's component profiles can help make it uniquely identifiable. There are endless possibilities for creating unique designs.

For mating parts a joint can be hidden by making it part of a fluted design.

Masking of imperfections

Where a profile has, for example, arms and screw ports, there may be process induced shadowing (heat zones) opposite such features. Using decoration the heat zones can be completely masked.

Protection against damage

Well designed decoration can also protect profiles from handling and machining damage.

Run out surface:

All extrusions have a run out surface.

What is a run out surface? Run out surface is the part of the extrusion that will be on the extrusion press table. This area of the shape will have some marks scratched, carbon, and possible dents. To explain why: The aluminum profile is at roughly 1000 degrees when it comes out of the press which the material is very soft.
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**Metal manufacturing services:** CNC Manufacturing, Laser Cutting, Water Jet Cutting, CNC Breaking, CNC Punching, Aluminum Extrusion, Extrusion Fabrication

**A glimpse of a few of our products:** Entrance Doors, Steel & Aluminum Window Guards, Door Hardware, Putty Tapes, Sealants, Cargo Trailer Doors, Aluminum Siding, Roll Roofing, Steel Framing, Sports Equipment

**Some of the industries we serve are:** Recreational Vehicles, Factory Built Homes, Cargo Trailers, Lighting, Academic and Community Athletic Programs.