DESIGN GUIDE

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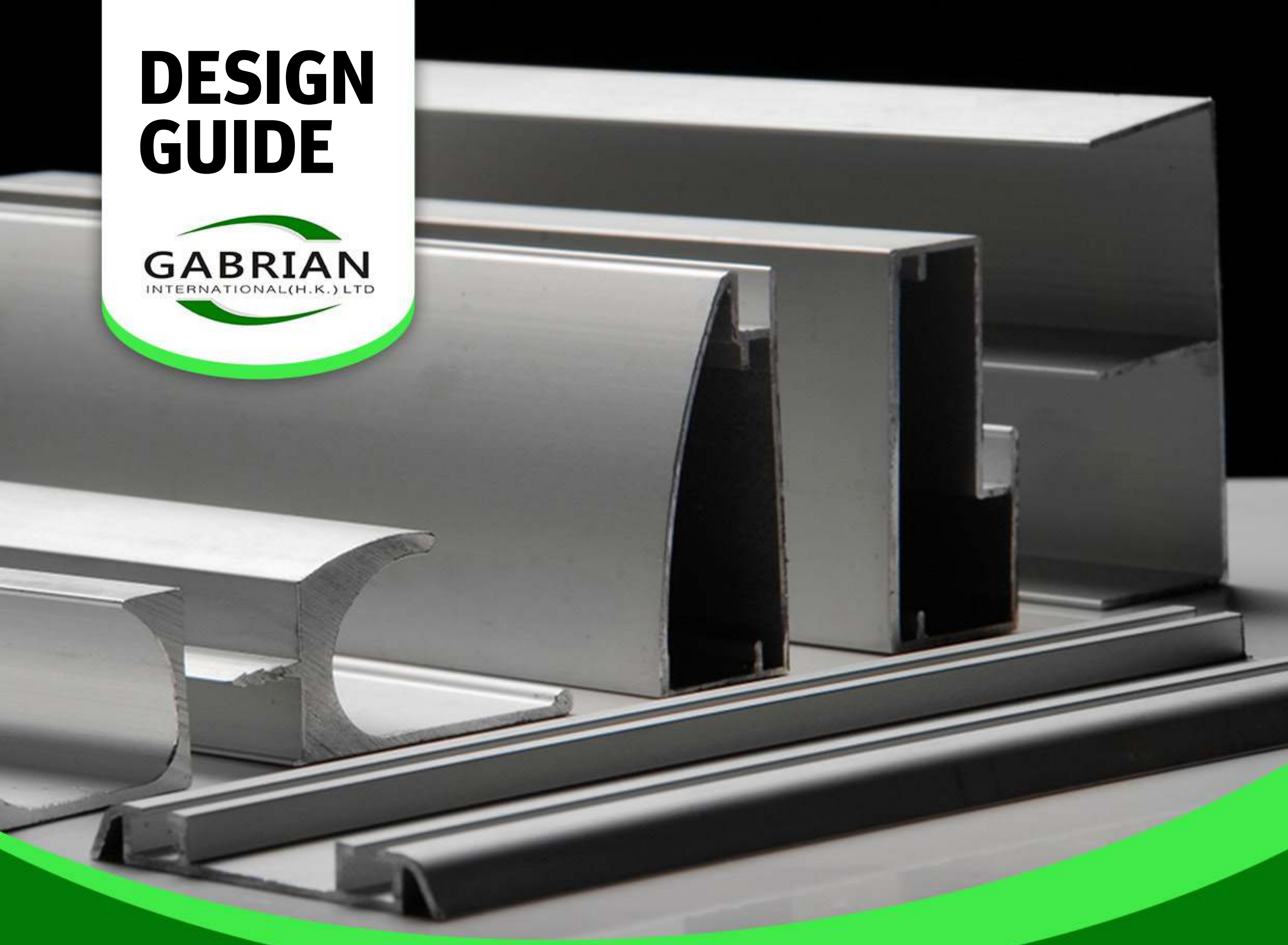


ALUMINUM EXTRUSION

11 Tips to Help You Reduce Manufacturing Costs and Maximize Quality

CONTENTS

1. Choose an Alloy With Suitable Material Properties and Characteristics

There are many aluminum alloys to choose from when working with aluminum extrusions. It is best to pick an alloy that satisfies the intended performance requirements.

However, bear in mind that alloys having a higher content of alloying elements are generally more expensive and difficult to manufacture than those with a lesser percentage of alloying elements.

Common alloying elements include: Magnesium (Mg), Silicon (Si), Manganese (Mn), Copper (Cu), and Zinc (Zn). These elements may make up as small as 0.2% and as large as 15% of the alloy by weight. Some of the most common aluminum alloys used in aluminum extrusion design include:

Alloy series 1000 – These alloys are made up of 99% aluminum (Al) with no major alloying element additions. These alloys are characterized by excellent corrosion resistance, high thermal and electrical conductivity, and excellent workability. While the alloys in this series are easy to extrude, they have less desirable mechanical properties compared to other alloy series and are non-heat-treatable. They are suitable for food packing trays and electrical applications.

Alloy series 6000 (Al + Si + Mg) – These alloys have excellent corrosion resistance, moderate to high mechanical properties, desirable machinability, and weldability. They are heat treatable but more difficult to extrude compared to the 1000 series alloys. A typical example is the alloy Al 6061, which is one of the most used alloys in the design of extrusion profiles for industrial applications.

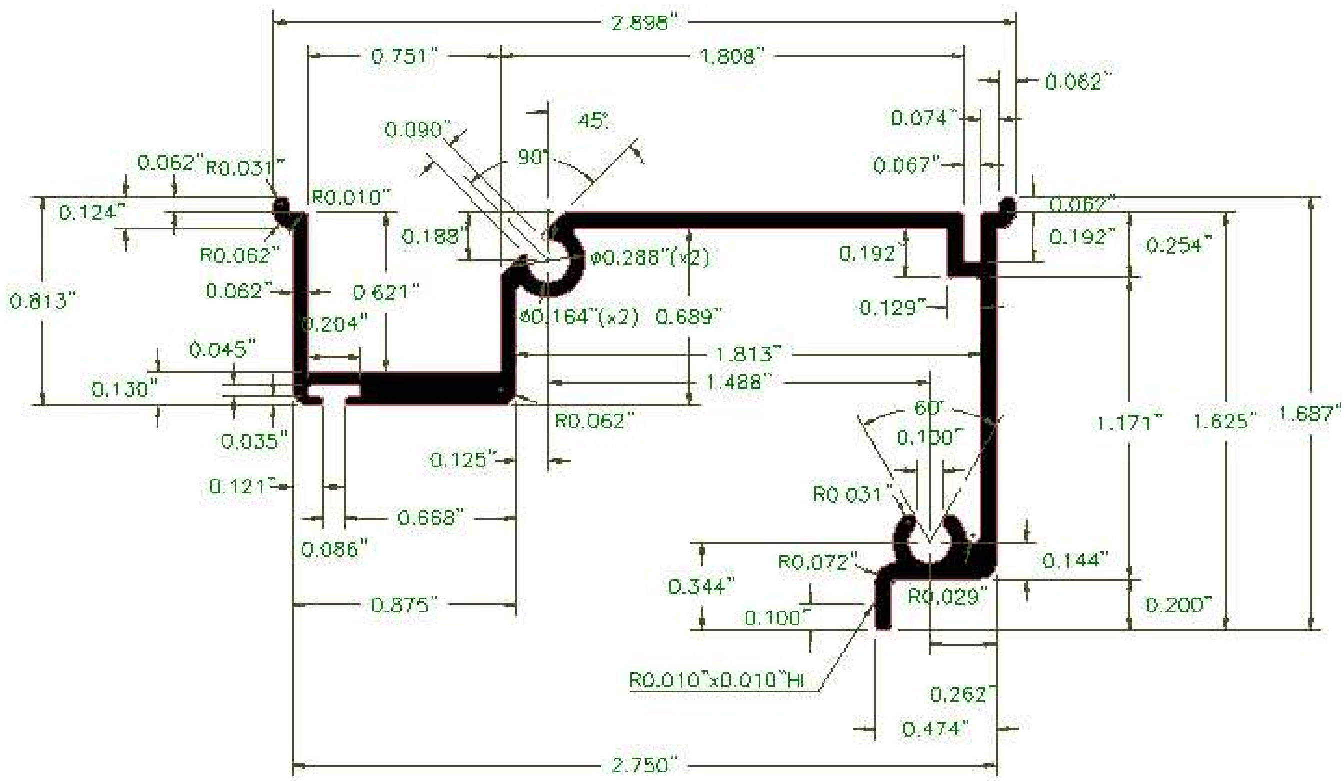
Alloy series 7000 (Al + Mg + Zn) – These alloys have the most desirable mechanical properties and are weldable. However, they have poor corrosion resistance, poor surface finish, and are very difficult to extrude. These alloys are typically used in the automotive, aerospace, and shipping industries, where high mechanical properties are important requirements.

2. Identify the Critical Dimensions and Tolerances Early

Dimensions in modern manufacturing processes are almost never exact. There is always a variance between the intended dimensions and the delivered parts. As such, critical dimensions with tolerances must be identified before the extrusion stage.

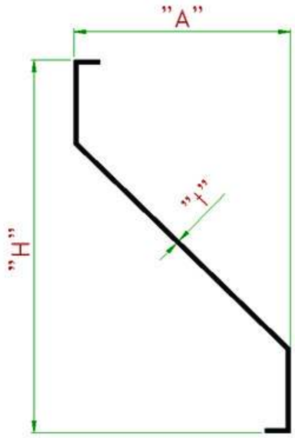
It is a good practice to discuss the important and critical dimensions of your design with manufacturers or aluminum extrusion experts. After defining your critical dimensions, you may proceed to understand the tolerance requirements using the ANSI H35:2 standard.

ANSI H35:2 is a highly technical document developed and published by the Aluminum Association. It features dimensions and standard tolerances for aluminum products. You should use this document to understand which tolerances are achievable based on the extrusion process. This will help you to reduce production costs and ensure your product performs efficiently and as intended.

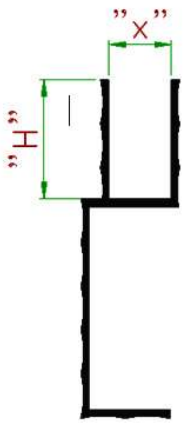


Critical dimensions of an aluminum extrusion profile.

Find below some tolerance guidelines for metal thickness dimensions and open space dimensions.



Nominal Dimensions for "A", "H", and "t" (mm)		Tolerances for Dimensions "A" and "H" (± mm)	Tolerances for Metal thickness "t" (± mm)					
			Dimensions "A" and "H"					
From	To		0-30	30-60	60-100	100-150	150-200	>200
0	1.5		0.15	0.15	0.20			
1.5	3	0.15	0.15	0.20	0.25	0.30	0.35	0.40
3	6	0.15	0.20	0.25	0.30	0.35	0.40	0.45
6	10	0.20	0.25	0.30	0.35	0.40	0.45	0.50
10	15	0.20	0.30	0.35	0.40	0.45	0.50	0.55
15	30	0.25	0.35	0.40	0.45	0.50	0.55	0.60
30	40	0.30	0.40	0.45	0.50	0.55	0.60	0.65



Nominal Dimension for Open Space "x" (mm)		Tolerances for Open space "x" (± mm)				
		Dimension "H"				
From	To	15-May	15-30	30-60	60-100	>100
0	6	0.30				
6	15	0.35	0.50			
15	30	0.40	0.55	0.95		
30	40	0.45	0.60	1.00	1.70	
40	50	0.50	0.65	1.05	1.75	
50	60	0.55	0.70	1.10	1.80	2.60
60	80	0.60	0.75	1.20	1.90	2.70
80	100	0.70	0.90	1.30	2.00	2.80
>100		0.80-1.60	1.00-1.80	1.40-2.20	2.10-2.90	2.90-3.70

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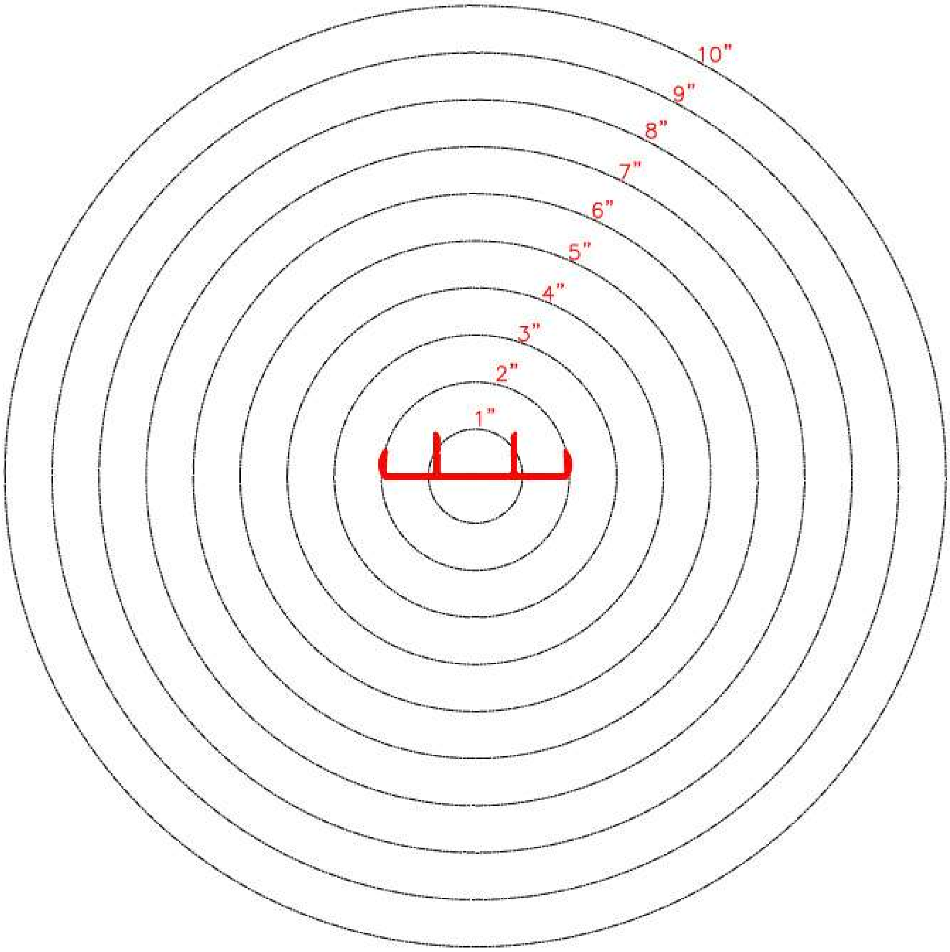
3. Understand the Circumscribing Circle Size Factor

The circumscribing circle is the smallest circle that will entirely enclose the extrusion profile cross-section. This common dimension is an important factor when considering the cost of an extrusion.

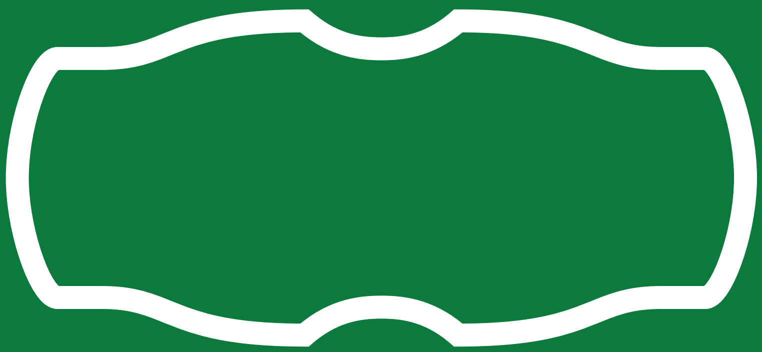
Profiles with a circumscribing circle diameter (CCD) between one and ten inches are less expensive to produce, while dimensions greater than ten inches are often more expensive to produce. Although most manufacturing facilities produce extrusion profiles with diameters less than 18 inches, some facilities can produce profiles with dimensions up to 32 inches.

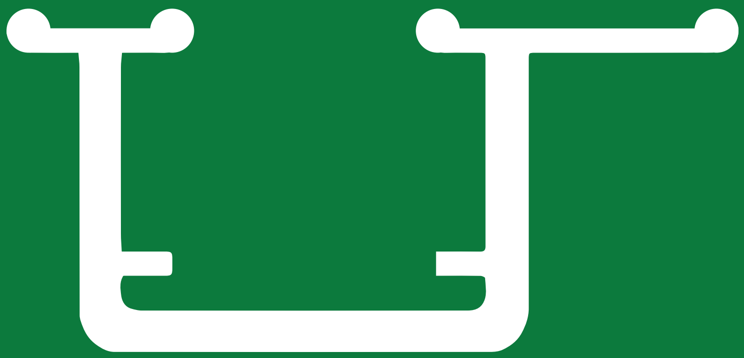


A profile with a circumscribing circle diameter of approximately 2 inches.

4. Implement Round Corners and Simple Shapes

While it is possible to extrude a wide variety of shapes, extruding simple shapes is more cost-effective. As a rule of thumb, you should implement round corners and avoid sharp projections in the design of the profile.





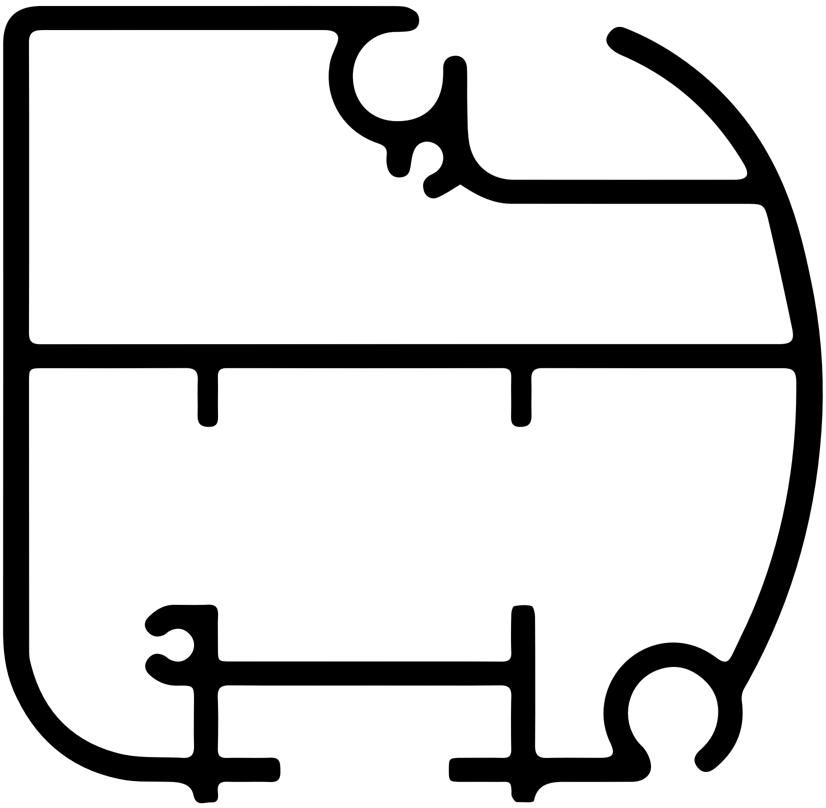
Unlike round corners, sharp corners and projections are especially difficult to produce through extrusion. Rounded corners not only help to strengthen the die tongue but also allow you to obtain smooth transitions.

Profiles with round corners are easier to produce through extrusion.

5. Profiles With Uniform Wall Thickness are Best

Profiles with uniform wall thickness are the easiest to extrude and manufacture. Unlike profiles with varying wall thickness, they are more likely to hold the correct dimensions throughout the extrusion process.

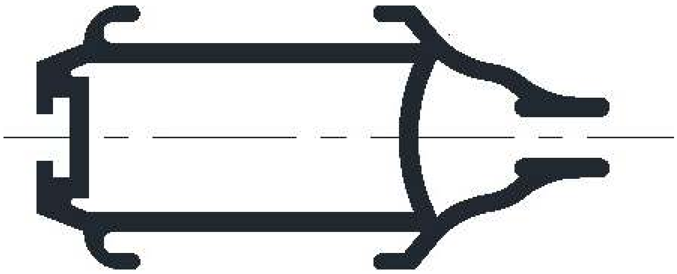
This is due to the fact that uniformly thick walls allow the aluminum to flow at a more even rate. If reduced production cost is a priority, then you should design the profile with minimum metal thickness and uniform wall thickness while satisfying the intended performance requirements.



An extrusion profile having a uniform wall thickness.

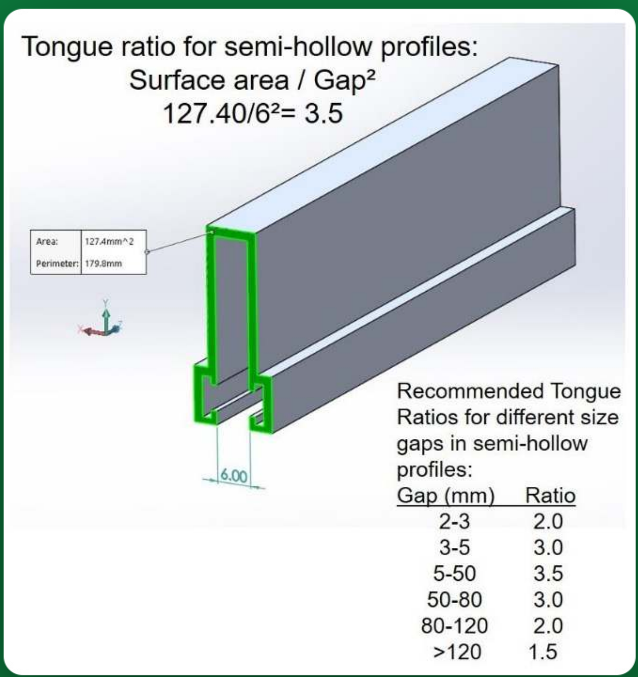
6. Symmetrical Extrusion Profiles are Best

Symmetry is another factor to consider during aluminum extrusion design. Symmetrical extrusion profiles are easier to manufacture and more cost-effective than complex profiles. With this design, a uniform flow of the material passes through the die, distributing the load evenly and preventing die fractures.



Symmetrical extrusion profiles are easier to produce through extrusion.

7. A Higher Tongue Ratio Factor Means More Complexity



Tongue ratio plays an important part in the performance and cost of extruding a profile. The higher the tongue ratio, the more difficult it is to extrude a shape since higher levels of force will need to be applied to the die. As a result, the void/tongue area becomes prone to breakage. Semi-hollow dies have a higher tongue ratio than solid dies; hence, they create more complexity during manufacturing. You should also try as much as possible to avoid narrow and deep channels in the extrusion design. This helps to reduce production costs and allows an easier extrusion process.

Profiles with higher tongue ratio are more difficult to produce.

8. Surface Finish and Decoration Options

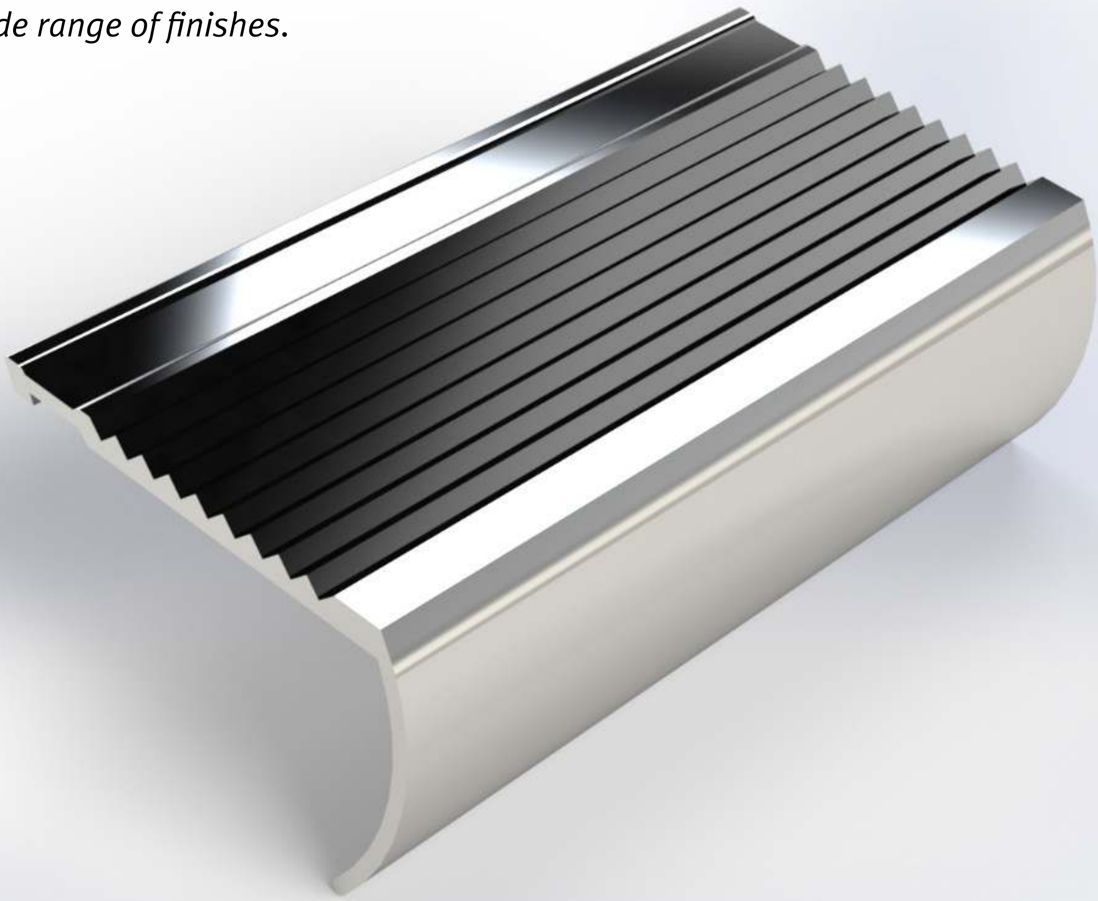
Aluminum offers a number of options for surface finish and decoration. These post-extrusion operations include polishing, powder/liquid coat painting, anodizing and others.

These special treatments help to:

1. Improve aesthetic
2. Provide the surface with improved properties and characteristics, such as increased corrosion resistance, improved surface structure, hardness, wear, and a better electric insulating property.

Decoration is used to lower manufacturing costs while maintaining good design. It also helps to hide imperfections and prevent damage during material handling in the manufacturing and transportation flow process.

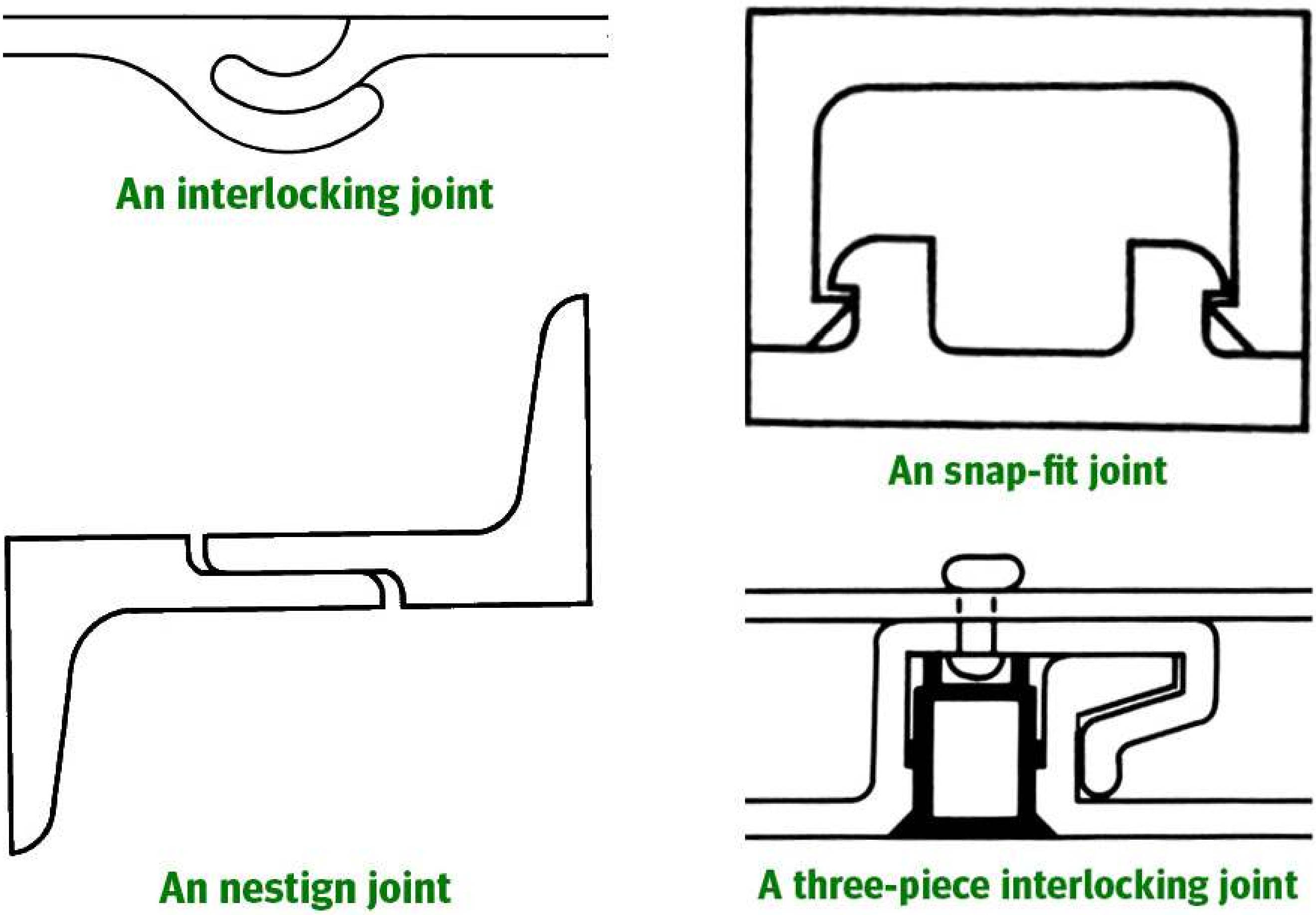
Aluminum profiles can be treated with a wide range of finishes.



9. Implement Efficient Joining Methods

Joining methods play a significant role in reducing production costs in aluminum extrusion design. A good practice is to assemble two or more simple extrusion profiles to make a complex one rather than directly extruding the complex profile.

There are several efficient ways of assembling two or three extrusion profiles. The Aluminum Extrusion Manual by the Aluminum Extruders Council (AEC) contains several examples. Click here to download it.



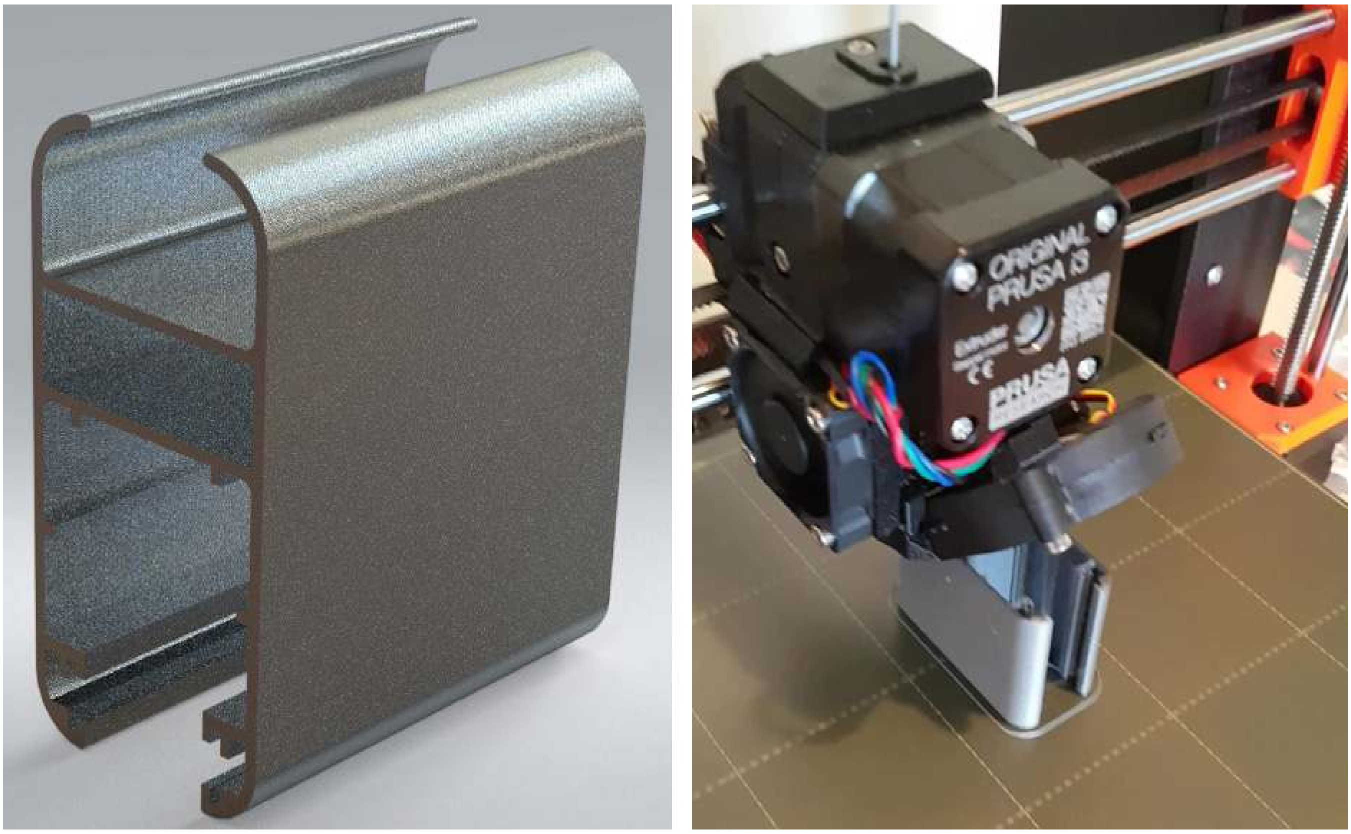
Efficient joining methods for aluminum extrusion design.

10. You Can Achieve Smart Design with CAD Software and 3D Printing

Using CAD software technology, product designers can create extrusion profile designs in a virtual space and check for fit and tolerances. There exist several CAD applications that can be used for quick routine designs and process automation.

These applications allow product designers to communicate early with manufacturers via CAD networking. This communication is usually during the design stage, and it eliminates potential design flaws.

3D printing also allows you to visualize the details of the intended extrusion design. Hence, you are able to communicate with manufacturers and modify your extrusion design to simplify the production process and reduce production costs.



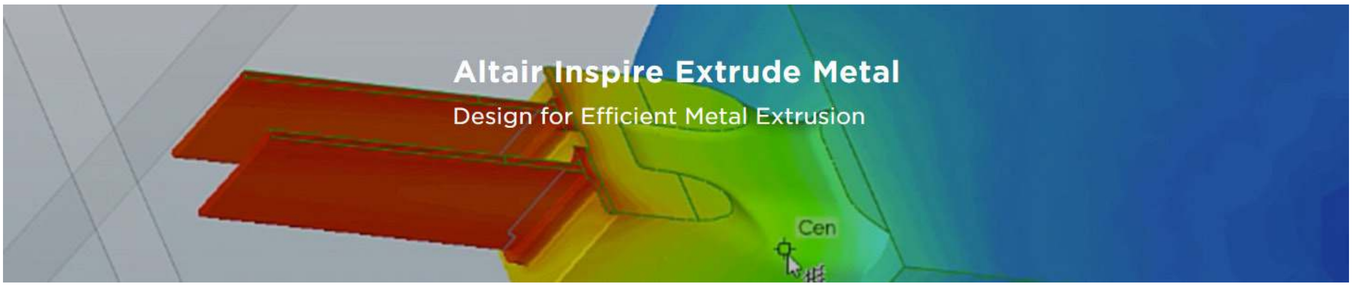
3D printing technology allows you to visualize intended extrusion design.

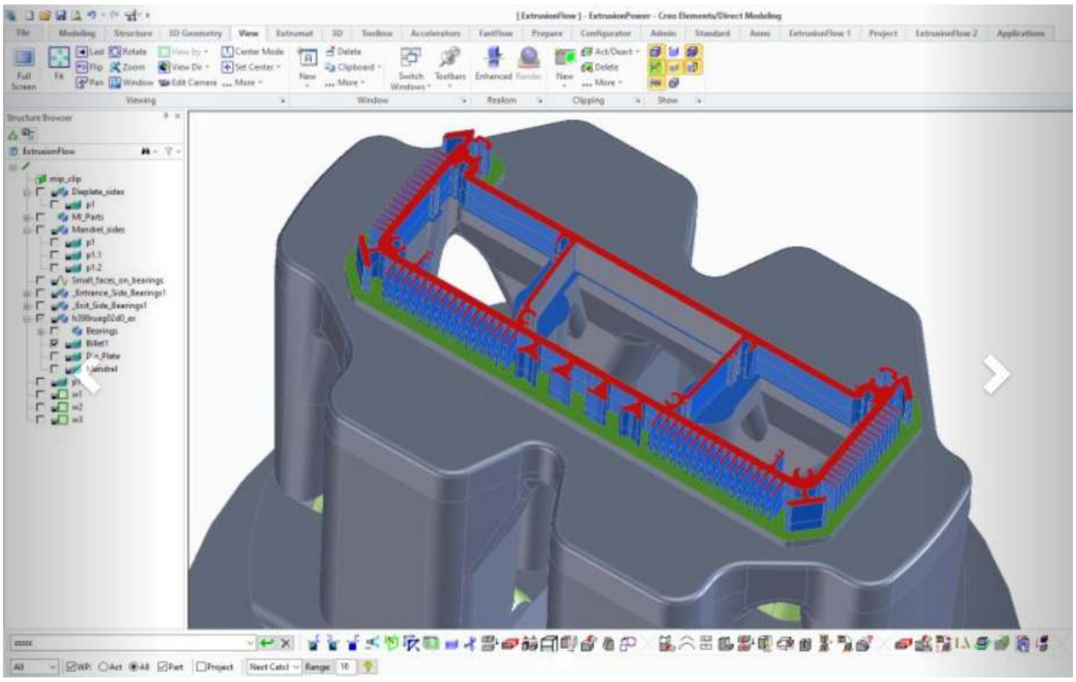
11. Modeling and Process Simulation Applications are Essential

Modern computer applications allow product designers to model and predict the extrusion of profiles. This process saves time as it eliminates the need for trial and error during first production runs.

Manufacturers utilize these software applications to simulate their process with the data from the extrusion design. Hence, product designers can carry out process simulation in conjunction with the manufacturer. By doing so, they are able to reduce production costs and make better designs.

Two popular modeling and simulation software applications are shown below:





CONCLUSION

Not only does extrusion profile complexity increase manufacturing costs, but it is also a major cause of complications, such as die fracture and failure. However, this does not mean you should avoid designing complex profiles; there are just certain considerations to make before commencing the manufacturing process. It is best to discuss your product design early with extrusion experts and manufacturers.

Gabrian International (H.K.) Ltd. is a leading provider of aluminum extrusion solutions across the globe. We have been serving OEMs and other manufacturers since 1995.

By contacting us today about your project, we can help you reduce manufacturing costs and maximize quality while ensuring on-time delivery.

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