FORMERO

Design Guide.

METAL STAMPING

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Overview

Formero specialises in quick-turn, low quantity prototype through production metal stamping parts and weldments. Our goal is to make you the best parts with the quickest lead times at the lowest price possible.

It is estimated that manufacturers can spend as much as 50% of our time addressing design errors that affect manufacturability. The reason for this is often due to the wide gap between how metal stamping parts are designed in CAD and how they are actually fabricated on the shop floor. Also specifics on material type, thicknesses, possible tolerances and shop-specific cutting and fabrication techniques may be lacking.

What does that mean for you? Extra cost, longer lead time and parts that might not suit your needs. The purpose of this design guide is to help you define the specifics so that your designs are ready to go in production with us in such a way that theoretical versus actual is minimal and your features match available processes. This will help us make your parts effectively and efficiently.

Because all parts fabricated with sheet metal start out as sheet, we suggest starting with a flat pattern in CAD that can be folded in your design package. We request that you submit your CAD files in the folded form – we'll work on flattening it. Because all sheet metal stretches as it is formed, receiving your final part allows us to do some work backward to extrapolate just where to put your features in the flat pattern by allowing for our bend radii needed and the cutting and fabrication techniques we will use.

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Material Selection

When designing with sheet metal, there is a relationship between the design of the part, the use of the part and the choice of material.

While the design can guide you to specific materials, the materials themselves can often lead to functionality and cosmetic improvements based on performance characteristics of the chosen metal alloy.

Considerations for Material Selection

In choosing the best material for your design, end use and performance characteristics of the final product should be considered including:

- Strength requirements of final part
- Aesthetics
- Geometry
- Joining
- Corrosion Requirements
- Desired weight
- Formability

Material selection is not only important to cost, it is intricately tied to the design of the part and plays a pivotal role in the part's integrity.

Recommended Thicknesses	Min. (mm)	Max. (mm)
Al 5052	0.30	3.20
Brass C2680	0.20	3.98
Copper C1100	0.30	3.98
Stainless Steel	0.07	8.0
Cold Rolled Carbon Steel		
Commercial Quality (SPCC)	0.50	3.20
Electrogalvanised, Zinc Plated (SECC)	0.40	2.00
Hot Dip-Galvanised (SGCC)	0.50	3.98
Tin-Plated (SPTE)	0.15	0.78
Beryllium Copper (C1720)	0.07	0.50
Nickle Silver (C7521)	0.10	0.60
Phosphor Bronze (C5191)	0.07	2.00
Spring Steel (SK7), Untreated	0.20	6.00
Spring Steel (SK7), Heat-treated	0.60	1.60
Hot Rolled Steel (SPHC)	1.19	6.00

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Material Selection Cont.

Aluminum

Temperature resistant and weldable in most forms. It is corrosion resistant when treated and has a high strength-to-weight ratio at a moderate price point. The most common aluminum we see for sheet metal forming is AL5052, but we can also work with AL6061 for flat patterns.

Galvanized Steel

Steel coated with zinc during a zinc solution heat batch. This process protects the steel from corrosion and cracks and, like aluminum, has a good strength-to-weight ratio. Galvanized steel can have issues in adhesion of paints depending on end use. Common used are chassis for electronics printers and medical equipment.

Galvannealed Steel

Similar to galvanized steel, galvannealed steel has been taken one step further and heat treated after the initial zinc coating. Galvannealed Steel can be painted.

Stainless Steel Sheet is available in types 301, 304, 316 and 430

Type 301 is excellent for high strength and corrosion resistance. Type 304 can be easily roll-formed or bent, and its excellent corrosion resistance and weldability. Type 316 is a high corrosion resistance alloy, providing greater resistance to pitting-type corrosion. Type 430 is a ferritic stainless steel with excellent internal and external corrosion resistance. It can be formed using both mild stretch forming, bending, or drawing, however it has poor weldability due to higher carbon content and lack of stabilising elements. It requires post weld heat treatment to restore the corrosion resistance and ductility.

Copper

High thermal and electrical conductivity and is resistant to corrosion. Copper is also ductile and malleable and is both anti-bacterial and biostatic. C1100 is used for sheet metal forming.

Brass

An alloy of copper and zinc, brass is very ductile and corrosion resistant. Brass is strong and the hot versus cold working characteristics can be varied depending on the quantity of zinc in the alloy. This gives brass sheet a wider range of performance depending on the application.

Low Carbon Steel

Low carbon steel contains 0.05-0.32% carbon compared to medium, high and ultra-high carbon steel. Low carbon steel is a cost-effective choice. It is also malleable and ductile.

Other Solutions

We can also work with less common materials such as: Tinplate SPTE (thin steel coated with tin), Beryllium Copper (C1720), Nickel Silver (C7521), Phosphor Bronze (C5191), Spring Steel (SK7 and SK5), and Hot-Rolled Steel (SPHC).

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Features

Bends

The most common sheet metal form is a bend. Bends can give strength and shape to a part and are formed in a machine using bend brakes. Since sheet metal cannot be bent to a 90-degree position without breaking at sharp corners, all bends will have an acceptable bend radius. Bends in the same plane should be designed in the same direction. Our preferred bend radius is 0.030”.

Hems

Hems are folds at the edges of a part, or wall, often resembling a U or C shape. Hems can be open or closed. However, overall tolerances will depend on the radius, sheet thickness and any other features near the hem. They are more difficult to produce with prototype tooling and may require multiple bend steps. Hems improve part strength, straightness and eliminate sharp edges.

Offsets

Offsets are the creation of Z shaped bends on a part. Other offsets can be introduced, but it is important to maintain the minimum distance between features and in distance between parallel surfaces.

Holes and Slots

Holes and slots are locations where joining devices such as bolts, tabs and other features keep the part in place. Location relative to the edge is critical as holes near the edge can cause issues with deburring and within the machine during processing can cause wear on machine tooling. It is best to specify hole diameters greater than the sheets thickness. Hole diameters less than the sheet thickness results in higher punch loading, longer burnish in the holes and excessive burr. It can also lead to slug-pulling when withdrawing the punch.

In a similar vein, the spacing between holes should be at least two times the sheet thickness to ensure strength of the metal and prevent hole deformation during bending or forming. Finally, holes should be at least the sheet thickness from the edge and spaces between holes and the bend should be 1.5 times the sheet thickness plus the bend radius.

Notches, Lugs and Tabs

Taking note of the grain structure is critical to avoid cracks with lugs or tabs that are cut on three sides and bent out. For instance, lugs formed parallel to the grain direction usually tend to form cracks. The recommended practice is to for lugs perpendicular or at an angle of <45 degrees towards the grain direction.

Bend Relief

Bend relief is added to prevent cracking and tearing that can occur in complicated bends or bends with harsh radii. This provide stress relief to the part, prevents the spring-back effect, and adds stiffness to the final part.

Features Cont.

Chamfers

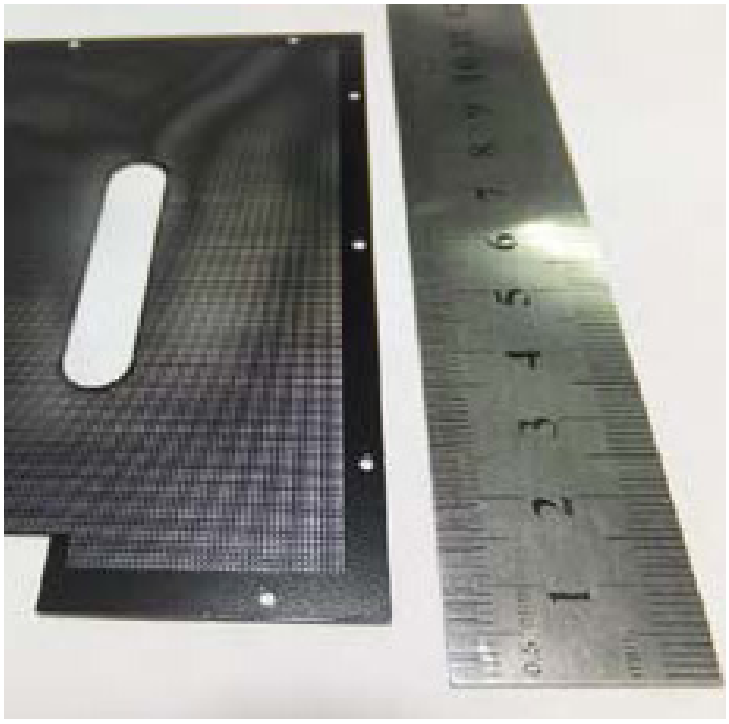
Some finished parts may have a sharp 90-degree or near 90-degree corner. Chamfering is a feature whereby the sharpest corners are rounded off to prevent catching, snagging or injury. Chamfers at corners and beads on bends increase the stiffness.

Coining and Collars

Collars increase the stiffness around pierced areas such as holes and slots. Coining and embossing around flared holes improve strength and the likelihood of maintaining flatness.

Welding

We can use welds to join parts together, finish corners, fabricate features in prototype, tack hardware in place or keep hems and bends folded. We can weld most of the materials listed but types of weld and finish on welds can affect tolerances. Because this is such a widely varying technique, tolerances do vary and we'll work to adhere to your drawings and can work with you through any questions.



Chemical Etching

In some cases on small or irregular-shaped holes, Formero may use chemical etching.

Chemical Etching is a process that produces burr-free holes of any shape. No mechanical force or heat is used, so the material properties are unaltered. This process is ideal for creating perforated metal products, such as screens, meshes, grids, filters etc.

Almost any material can be etched, including those considered hard to machine. In addition, because no hard tooling is required, design iterations are low-cost and fast.

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Tolerances & Guidelines

We follow general tolerances to ISO-2768-M and they include:

Bends

Bends are formed in a machine using bend brakes with a standard tolerance +/- 1 degree. It is also recommended that the bend radii not be less than the thickness of the sheet (T).

Hems

Minimum inside diameter on a hem should be 4x the thickness of the sheet. However, overall tolerances will depend on the radius, sheet thickness and any other features near the hem.

Offsets

Overall, all bend radii in offsets should be 0.75mm. The distance between parallel planes should be at least 2X the thickness of the sheet. A tolerance of +/- 0.30mm between features is recommended. Other offsets can be introduced, but it is important to maintain the minimum distance between features and in distance between parallel surfaces.

Holes/Slots

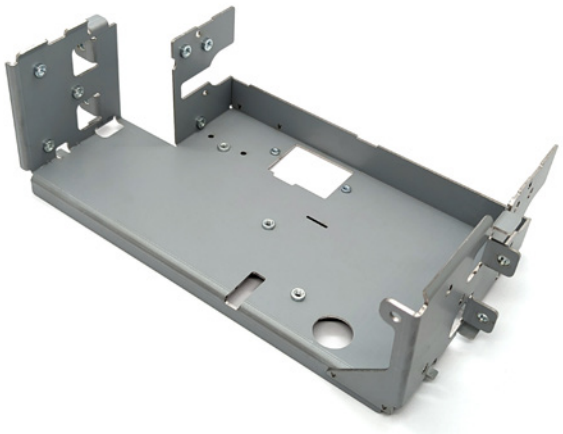
Holes and slots should be at least one material thickness in diameter (T) and preferably 4T away from the edge of the material. If using inserts, use the manufacturer's specifications to determine distance from the edge.

Notches/Tabs

Notches and tabs should be at least 1T or 1mm, whichever is greatest. They should also be no more than 5X the width.

Bend Relief

Bend relief should be no deeper than 1T plus the bend radius and should not be wider than 0.75mm.



Tolerances

General linear tolerances are +/- 0.12mm for most features on parts under 300mm.

Parts that are over 300mm in size the tolerance levels are +/-0.25mm.

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Tolerances

The difference between the theoretical world of sheet metal design and actual:

Theoretical	Actual
Hole diameters, spacing and tolerance values are exact	Cutting method has a large effect on tolerances.
	Actual designs vary after bending, which can lead to misalignments.
No need for ribs, collars or chamfers	Stiffness decreases in pierced areas or large open surface areas.
No need for coining, embossing or beads.	Strength decreases and we are unable to maintain flatness.
Lugs without understanding the grain structure of the metal is no problem.	Lugs parallel to the grain structure may lead to crack formation.

Interpreting Designs

Tolerances can be different on your actual part when compared to what is designed in CAD. Numerous factors affect tolerances such as the material type, available material thicknesses that may vary from what you've specified, feature design, possible bend radii and details such as hem type and material cutting techniques.

The above are examples of the difference between the theoretical world and actual as it pertains to sheet metal part tolerances.

At Formero we are experienced in interpreting designs and giving feedback on what is possible and we are here to help. We will work with you to achieve your goals!

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Finishing

Depending on end use of parts, a finish process may be needed. A finish can be to enhance aesthetics, further protect the part from elements that speed rust and corrosion or both.

Common finishing methods include:

Powder Coating

Powder coating can be done in both matte and glossy finish. Generally considered more durable than painting, powder coating is applied as a dry powder using an electrostatic process. The powder is then cured with heat to form a “skin” that provides a tougher finish than conventional painting.

Buff Polishing

Buff polishing uses a rotary wheel with an abrasive cloth or paper to polish the surface. Different grades of abrasive media can be used discerningly to render a smooth polished surface. It is especially effective on copper, brass and stainless steel and can be used as a finish itself or in preparation for another finish application.

Sand Blasting

Sand blasting renders a matte finish with a scored surface on metal parts. It helps remove impurities and prep the surface for additional finishing such as powder coating although it can be used as a finish surface as is. It is effectively used with metals such as stainless steel and low carbon steel sheet parts.

Brushing

Brushing uses rotary brushes to score and clean the surface and again can be used as is or as additional finish prep.

Plating

Plating is a broad term that applies to several different processes. It requires immersion into a chemical bath whereby elements within the chemical solution create a chemical reaction with the surface of the metal forming a plate or coat on the surface. Plating processes can be electrolytic or electroless, depending on the process. Examples of different plating processes include:

Tin Plating – Useful when joining dissimilar materials to the part.
Nickel Plating –Acts a substrate for other further plating when the base metal is averse to plating options.
Zinc Plating - Helps protect parts against water damage.
Anodizing – Hardens the part surface and protects softer metal parts, such as aluminum, from dings and scratches.
Chromate Coating – Provides a low friction part surface and an attractive aesthetic look.
Passivation –Application of a citric acid and predominantly a cleaning process used for stainless steel and other parts resistant to finish.

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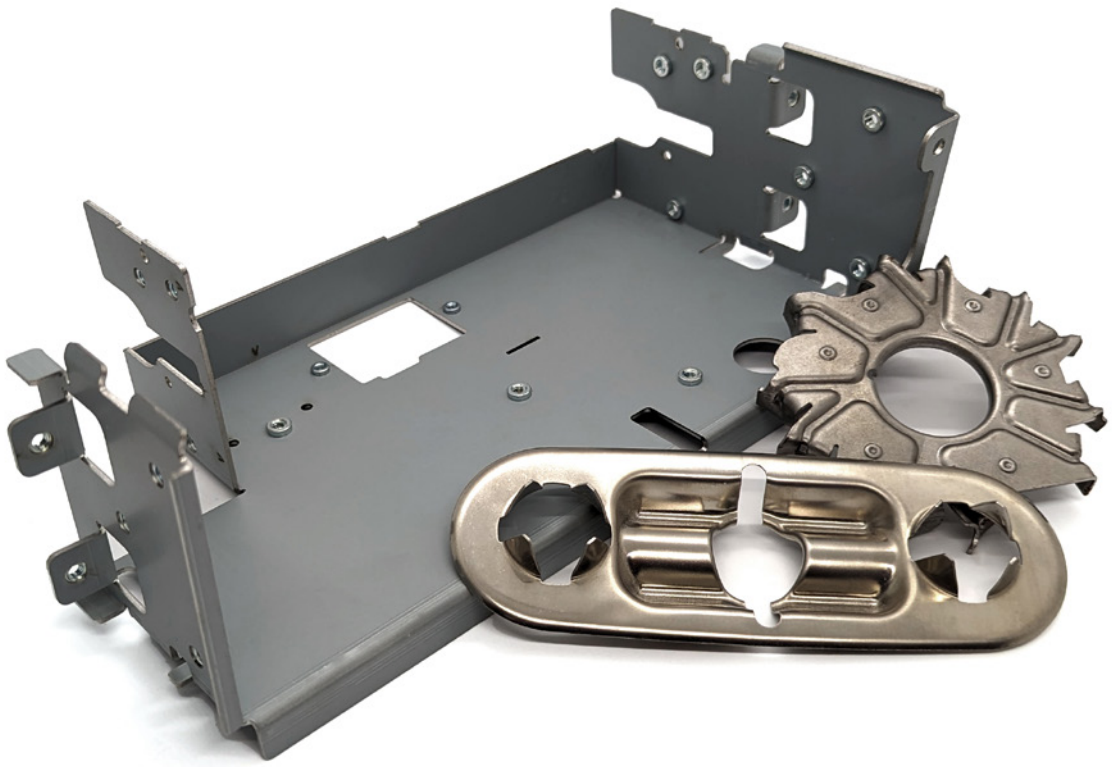
PEM & Added Hardware

PEM's and hardware are the critical final touch once your parts have been cut, bent, welded and finished. This hardware allows components to be assembled to your sheet metal parts or weldments.

Formero uses PEM hardware from PENN Engineering or equivalent for some examples below:

- Standoffs
- Threaded inserts
- Threaded nuts
- Captive screws
- Pins

Occasionally PEM requires minimum order quantities that are too high for the project or too long to meet lead time. Sometimes they also don't offer what you need. In these cases we will usually machine our own per spec.



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