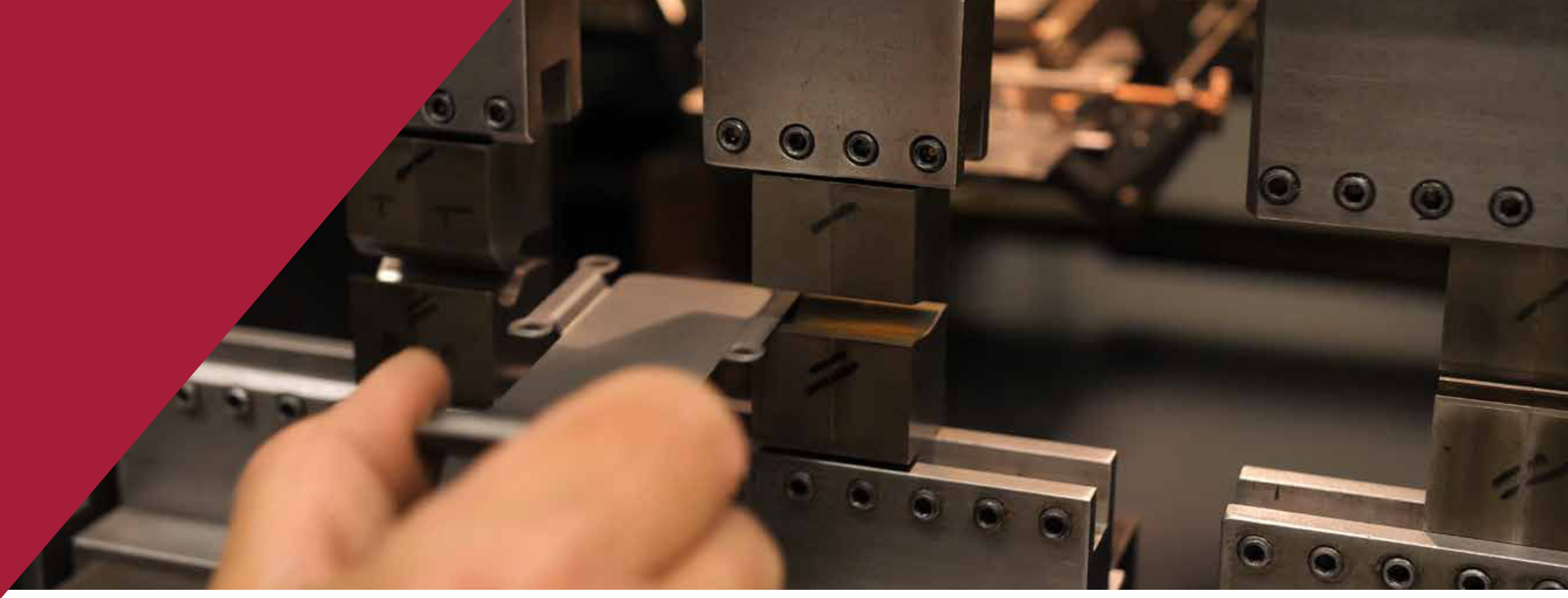

DESIGNING SHEET METAL PARTS: BEST PRACTICES

TIPS AND TRICKS FROM THE SHOP FLOOR

INCODEMA
SHAPING THE FUTURE

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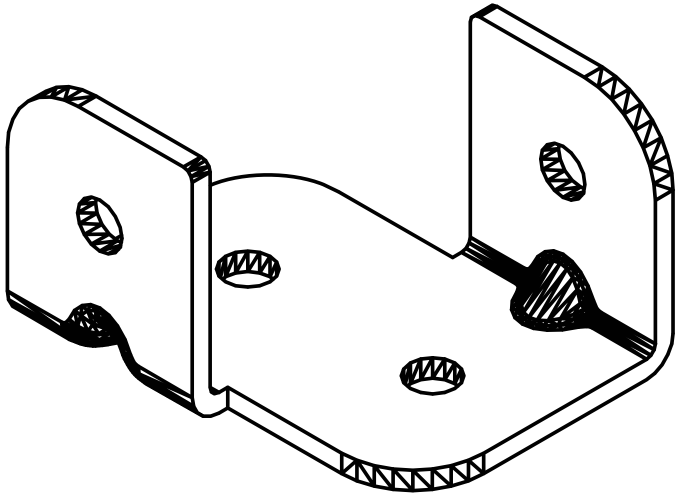
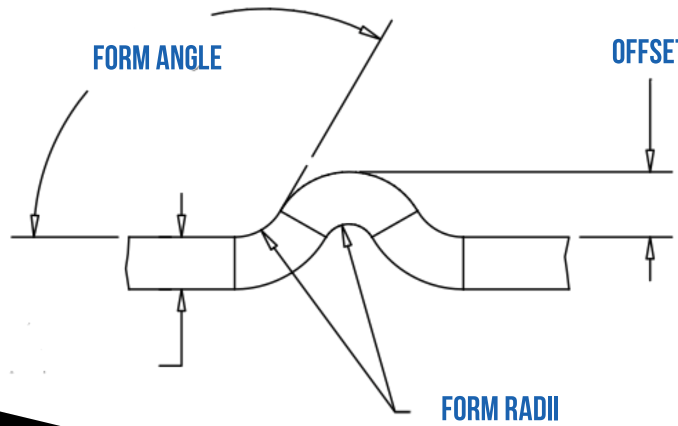
FROM CONCEPT TO COMPLETION, THE ONLY SOURCE YOU'LL NEED

Incodema houses one of North America's most advanced prototyping facilities. With a wide array of machines and complementary processes, we can easily find the most efficient solution to complete even your most complex project.

GUSSET

- Strengthens bends locally.
- Must be formed with custom tooling.
- Minimal tooling cost.





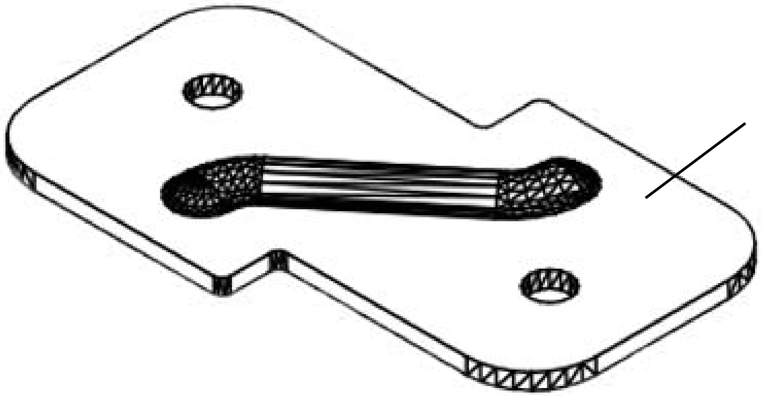
PRO TIP: Design Tips apply to other features like ribs and embosses.

DESIGN TIPS

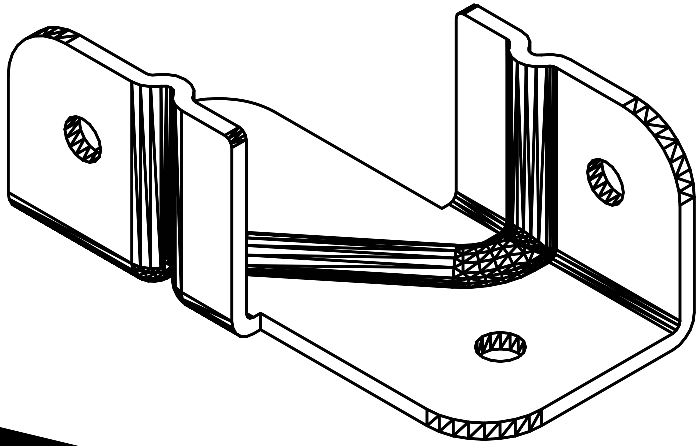
- Whenever possible, maintain minimum spacing of 2-2.5x raw material thickness from edge of cutout to bend radius tangency.
- Lesser spacing requires secondary operations after bending and adds to manufacturing costs.
- Form angle and form radii should be made as large as possible.
- Offset should be minimized.

RIB

- Stiffens flat sections.
- May require secondary trimming.
- Moderate tooling cost.



Entire section must be restrained flat while forming with custom tooling.



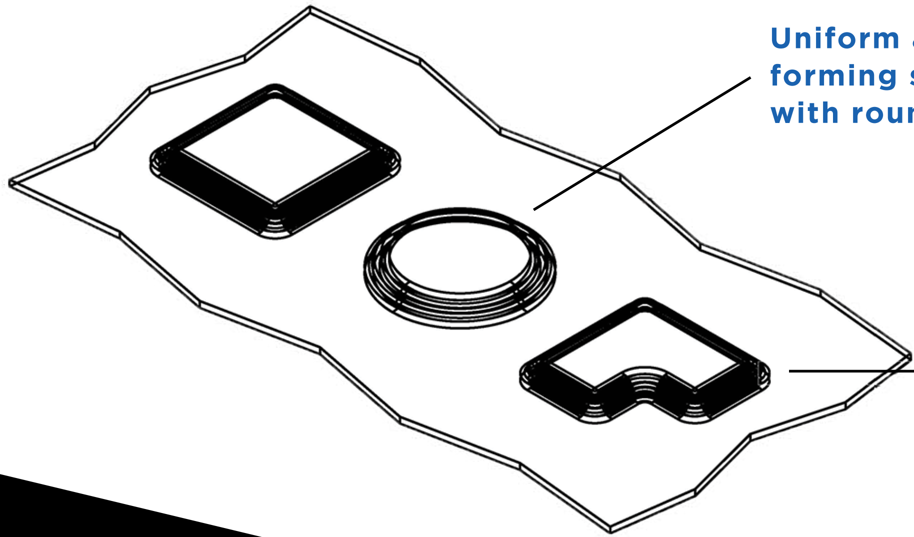
PRO TIP:
Gusset and rib combinations require high-cost tooling, secondary trimming and progressive forming.

DESIGN TIPS

- Close proximity form features can cause secondary operations after forming and adds to manufacturing cost.
- Form features in close proximity to each other increase forming strain which may cause “oil canning” or other deformation, fracturing or material separation.

EMBOSS

- Adds strength.
- May be used for clearance.
- May be used as a standoff feature.



DESIGN TIPS

- Form radii as large as possible to decrease forming strain. Separation may occur if form radii are too small.
- Raw material type and thickness impact feasibility.
- Create form angles larger than 90 degrees if possible.
- Minimize offset dimension.
- Form angle, offset dimension and overall shape of emboss are all factors that impact manufacturability.

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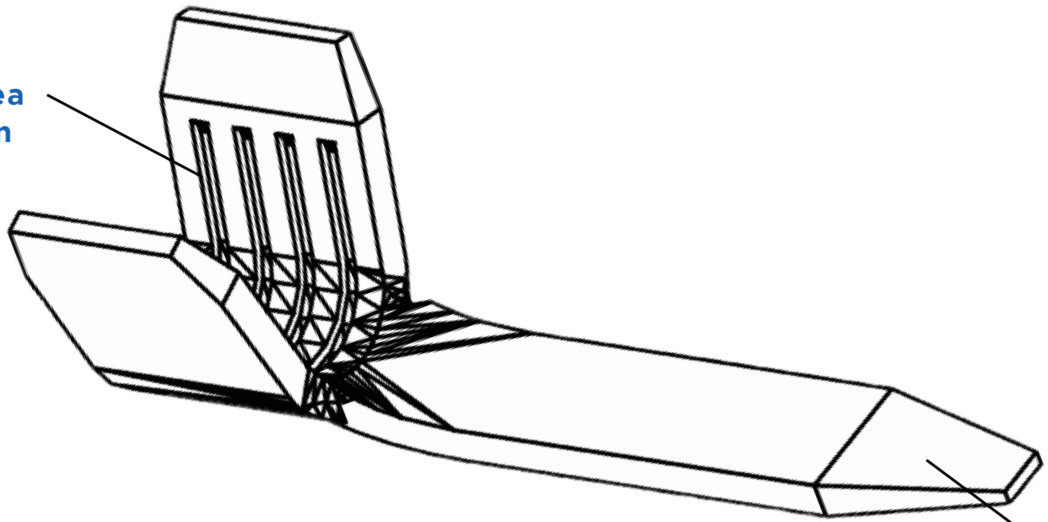
COIN

- Process by which metal currency is minted.
- Surface material is pressed.
- Requires moderately priced tooling.



DESIGN TIPS

- Tooling cost depends on the size of coin features. Smaller features require more expensive tooling and forming processes.
- Significant material displacement may cause deformation of surrounding areas.
- Secondary operations may be required to trim displaced metal.
- Design for minimal material displacement.

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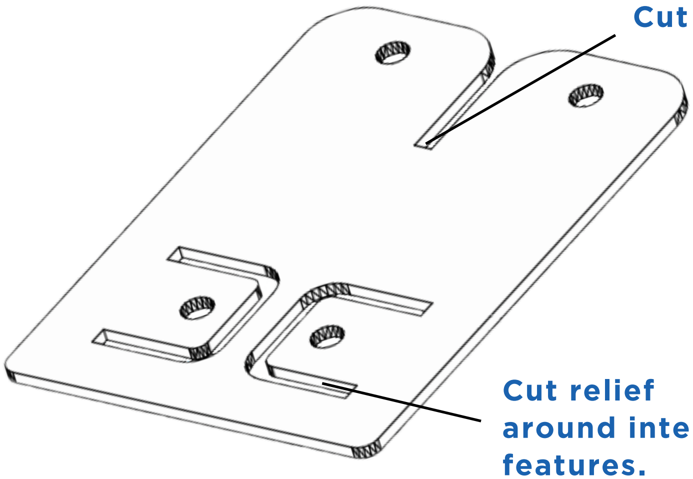
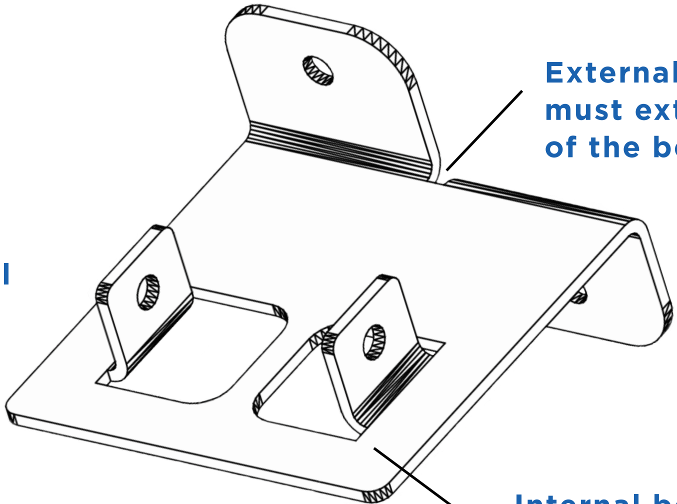
CUT/BEND RELIEF





DESIGN TIPS

- To ensure cost-effective production, design cut and bend reliefs with a minimum of 2.5x material thickness.
- For prototype and short-run quantities, the minimum cut relief can be a laser or water jet cut kerf (0.010” - 0.040”).
- Lanced (sheared) features with zero cut relief are possible but require high-cost tooling.

ALUMINUM ALLOYS

ALLOY	TEMPER	DUCTILITY	STRENGTH	CORROSION RESISTANCE	HEAT TREATABLE	COMMENTS
6061	T6	Low	Mid	Good	No	Minimum bend radii of 3x raw material thickness.
6061	T0	High	Low	Good	Yes	Higher-cost heat treating due to warping and need for secondary straightening.
5052	H32	High	Mid	Good	No	Most commonly used aluminum alloy and temper.
5052	H34	Mid	High	Good	No	Small radii bends in line with grain may fracture.
3003	H14	High	Low	Good	No	Good for deep drawn parts.

STAINLESS STEEL

ALLOY	TEMPER	DUCTILITY	STRENGTH	CORROSION RESISTANCE	HEAT TREATABLE	COMMENTS
301 302 304	* Range	** High	High	Excellent	No	Small radii bends in line with grain may fracture in full hard temper. Full hard temper is cost effective for springs as there is no need for heat treating or plating.
316 316L	Annealed	High	High	Excellent	No	Used heavily in the medical industry.
410	Annealed	High	Mid	Mid	Yes	Excellent for springs. Stays stable in heat treating and has a bright finish.
17-4 PH	Annealed	Low	Excellent	Mid	Yes	Small radii bends in line with grain may fracture.
17-7 PH Cond. A	Annealed	Mid	High	Mid	Yes	Excellent for springs intended for repeated cycles. Remains stable during heat treating.
17-7 PH Cond. C	Mill Hardened	Low	High	Mid	Yes	Small radii bends in line with grain may fracture. Highest hardness and strength achievable in alloy 17-7 PH.

** Annealed, 1/2, 1/4, 3/4, and full hard possible*
*** Ductility decreases in harder tempers and mill hardened materials*

LOW CARBON AND SPRING STEEL

ALLOY	TEMPER	DUCTILITY	STRENGTH	CORROSION RESISTANCE	HEAT TREATABLE	COMMENTS
1008 1010	Soft, 1/2, 1/4 Full Hard	High	Mid	* Poor	** Yes	When rolled at or near room temperature, excellent ductility and strength is produced and is more uniform than hot rolled steel.
1008 1010	Annealed	High	Mid	* Poor	** Yes	Rolled at a temperature greater than the recrystallization point, which produces surface scale. Good ductility, but weaker and less uniform than cold rolled steel.
HSLA	Annealed	Mid	High	* Poor	** Yes	Requires 25-30% more power to form than cold rolled steel or hot rolled steel.
1050 1074 1075 1095	Annealed	Excellent	*** High	* Poor	Yes	1095 has the highest carbon content of the materials listed. Higher carbon content yields higher strength with less ductility after heat treating.
1095	Blue Tempered	Low	High	Mid	No	Good for flat springs or leaf springs with large radii.

** Poor without plating or surface treatment*
*** Limited to carburizing*
**** High strength after heat treatment*

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COPPER ALLOYS

ALLOY	TEMPER	DUCTILITY	STRENGTH	CORROSION RESISTANCE	HEAT TREATABLE	COMMENTS
C10 Copper	Wide Range	High	Mid	Good	No	Highly conductive. High cost.
C172 Beryllium Copper	Wide Range	Excellent	Excellent	Fair	Yes	Excellent for electrical spring contacts. Highly conductive, excellent electroplating adhesion coefficient and remains very stable during heat treating. Moderate cost.
C260 Brass	Wide Range	* Ranges	High	Good	No	Small radii bends in line with grain may fracture in full hard and spring tempers.
C510 Phosphor Bronze	Wide Range	* Ranges	High	Fair	No	Small radii bends in line with grain may fracture in full hard and spring tempers.

** Ranges according to temper*

RAW MATERIALS SELECTION

HEAT TREATABLE ALLOYS

When stiffness and spring characteristics are required, the design engineer should consider the following:

For parts with small radius forms, high carbon spring steel or another heat treatable metal with good ductility may need to be used. The part may require heat-treating after forming to achieve necessary stiffness or spring performance characteristics, which adds to manufacturing cost.

Note that broad flat sections in high carbon spring steel parts tend to warp during heat treating. Where potential warping may be a factor, it is wise to consider alternate materials that may have a marginally higher cost but stay more stable during heat treating.

- 410 Stainless Steel
- 17-7 PH stainless steel, condition A (annealed)
- C172 Beryllium copper
- Low Carbon Cold Rolled Steel - carburizing hardens the surface while reducing spring characteristics.

RAW MATERIALS SELECTION

MILL HARDENED ALLOYS

For flat parts or parts with large radius form features, a mill-hardened alloy may be selected based on hardness or spring performance characteristics to eliminate the need for heat treating. Consider the following:

- 6061 Aluminum in T4 or T6 temper
- 300 series Stainless Steel in 1/4, 1/2, 3/4 or full hard temper
- 1095 blue temper spring steel
- C110 Copper and C260 Brass in H04 (hard), H06 (extra hard), H08 (spring temper) and H10 (extra spring temper)
- C510 Phosphor Bronze in H06 (extra hard), H08 (spring temper) and H10 (extra spring temper)

Note that raw material grain impacts forming characteristics in all materials, but more so in mill-hardened alloys.

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