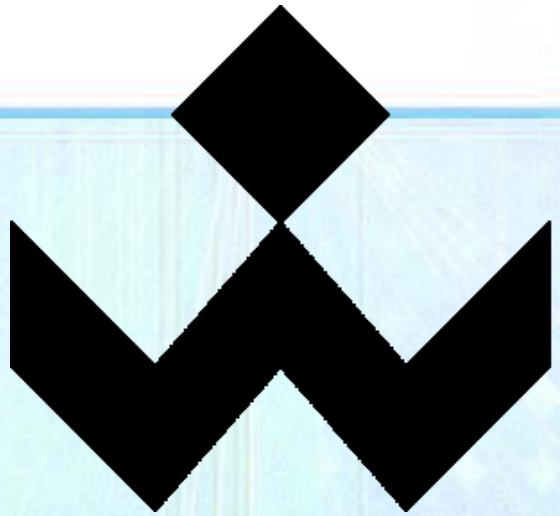

wesgar

Wesgar Inc.

Custom Precision Sheet Metal Manufacturing

Seminar Agenda

November 23, 2011

10:00 – 10:30	Overview of Wesgar and Sheet Metal Manufacturing
10:30 – 10:45	Q & A
10:45 – 12:00	Sheet Metal Design & Manufacturing Part 1
12:00 – 12:30	Lunch Break
12:30 – 1:15	Sheet Metal Design & Manufacturing Part 2
1:15 – 1:30	Q & A
1:30 – 3:30	Plant Tour

Overview of Wesgar and Sheet Metal Manufacturing

Presented by

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www.wesgar.com

About Us

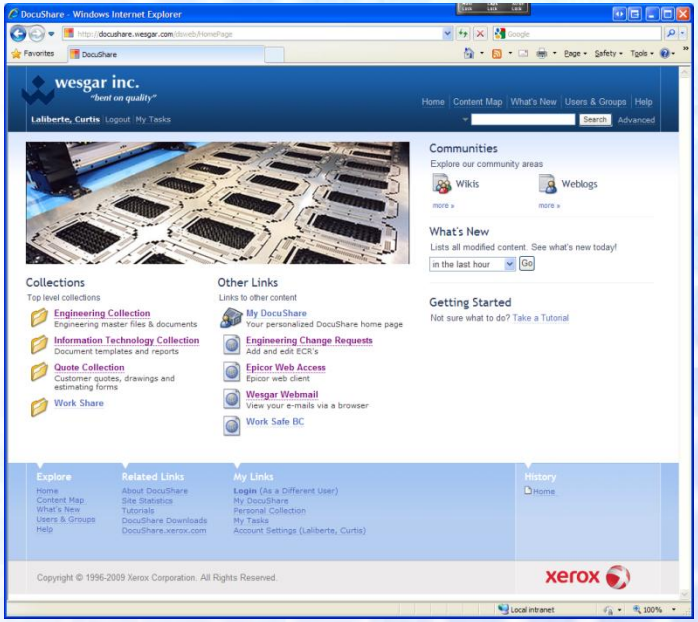
- Wesgar has been serving our customers since 1965
- Largest custom precision sheet metal manufacturer in British Columbia
- 70,000 sq ft plant, occupying 3 buildings
- ISO 9001 quality management system certified
- Over 160 employees
- Customers throughout North America
  - Western Canada
  - United States
  - Mexico

Computer Systems

- Epicor Vantage ERP system
  - Live labour and material transactions
  - More flexible scheduling and tracking
  - Fully customizable

EPICOR®
Vantage®

- Xerox DocuShare document management
  - Web-based interface (accessible from any web-enabled device)
  - Storage of quotations, subcontract information, and all drawings



Lean Manufacturing

- Rolled out in 2004
- 5 certified Lean Greenbelts
- 1 certified Lean Blackbelt
- 5S
- Kaizen (continuous improvement)
- Value stream mapping
- Ongoing employee training

Material Capabilities

- Aluminium
- Mild Steel
  - Cold Rolled Steel (CRS)
  - Hot Rolled Steel (HRP&O)
- Galvanized Steel
- Satin Coat Steel
- Stainless Steel
  - 304 series
  - 316 series
- Aluminized Steel
- Copper
- Plastic

Concept to Finished Product

Design for Manufacture & Assembly (DFMA)

- Product Support
- Prototyping
- Engineering

Fabricating

- Shearing
- Punching
- Laser Cutting
- Graining & Deburring
- Forming
- Hardware Insertion
- Welding
- Dressing
- Inspection

Finishing

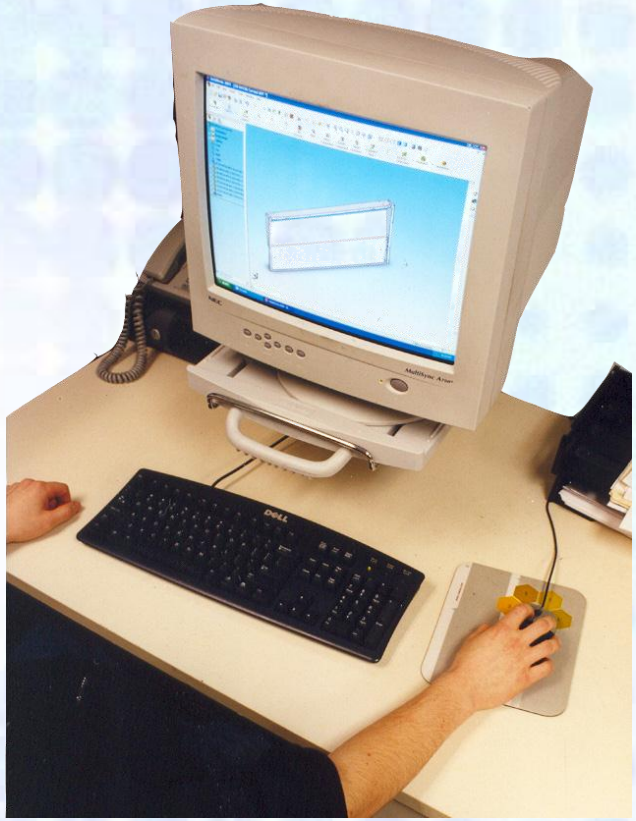
- Plating
- Powder Coating
- Screen Printing
- Assembly
- Shipping

Product Support Team

- Team of 6 individuals with over 60 combined years of industry experience
- Works with customers to provide manufacturability assistance and cost reduction solutions
- Estimates the cost to manufacture products
  - Material requirements
  - Manufacturing processes
  - Subcontracting
- Works with suppliers for sourcing, pricing, and lead time
- Collects feedback from customers and shop floor personnel
- Provides feedback to Engineering Team to improve manufacturing process of future orders

Engineering Team

- Assists Product Support Team with customer design issues
- Creates solid models of products, to generate:
  - Flat pattern drawing for punching or laser
  - Detailed drawing for forming (bending)
- Generates NC code for punch presses, laser cutting machine, and forming press brakes, based on flat pattern data
- Ensures work instructions (job traveler) is correct and efficient

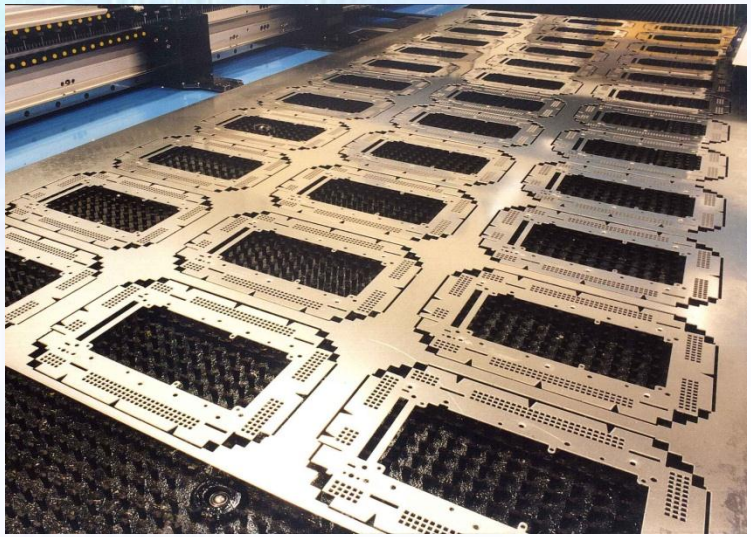


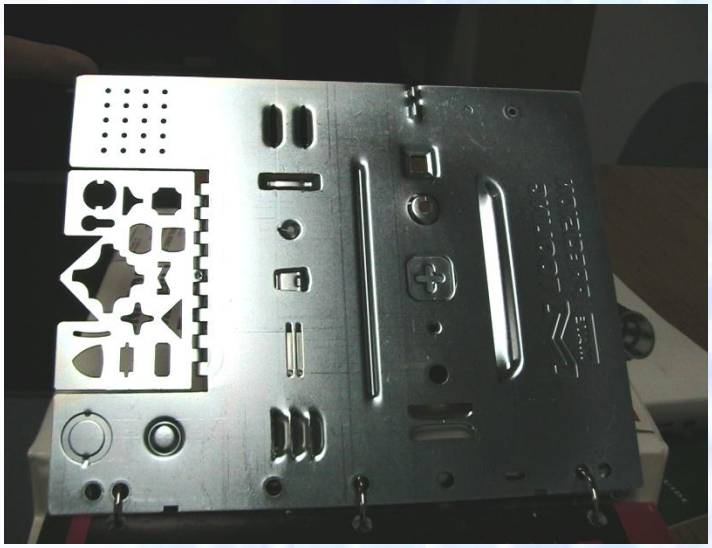
Shearing

- Receives and organizes all incoming sheet material
- Queues material for punching & laser departments
- Shears sheets down to custom sizes to suit order quantity and maximize material utilization

Punching

- Our punching department is capable of punching simple to complex parts by using standard and custom tooling to meet the customer's specifications





Punching

- Finn-Power Express F6 Turret Punch Press
  - Equipped with auto sheet loader and unloader to handle large tasks efficiently and unmanned

Punching

- 2 Finn-Power C5 Turret Punch Presses
  - Manual load and unload provide a short lead time for small or medium runs and prototyping

Punching

- Finn-Power Shear Genius SG6 Turret Punch Press
  - Equipped with auto sheet loader and unloading conveyor to handle large tasks efficiently and unmanned
  - Results in fully punched & sheared parts; sheet skeleton can be automatically cut into smaller pieces

Laser Cutting

- Trumpf TruLaser 3030
  - 120” x 60” work area
  - Thicknesses up to 3/4” steel, 1/2” stainless, or 3/8” aluminum

Pre-Form (graining & deburring)

- Graining – often used for parts that later get alodined or anodized
- Deburring – removal of sharp edges caused by punching, performed by hand or with fibre wheel
- Tumble deburring – efficient removal of sharp edges from small parts

Forming

- With the use of modern press brake technology, very complex bends can be achieved

Forming

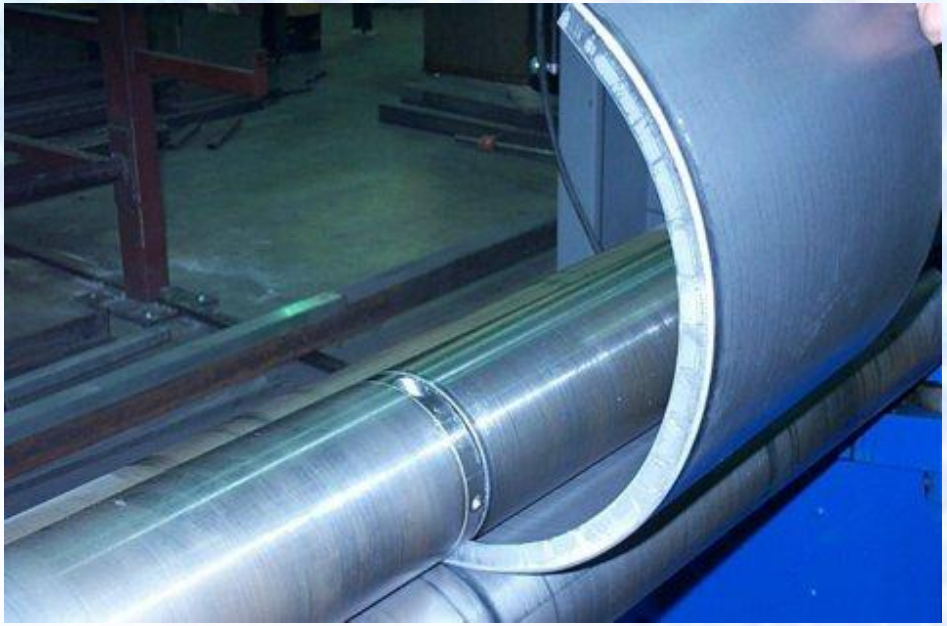
- 4 Trumpf Press Brakes
  - 130kN (14.6 Tons) capacity
  - 10’ bed lengths
  - Intelligent 6-axis back gauge
  - 3D NC programming system
  - Quick-change tool system for low setup time

Forming

- 3 Amada Press Brakes
  - Various tonnages
  - 6’ and 8’ bend lengths
  - Modern back gauges
  - Numerical and graphical NC programming systems
  - Capable of small or large runs
  - Flexibility aids in quick turn around

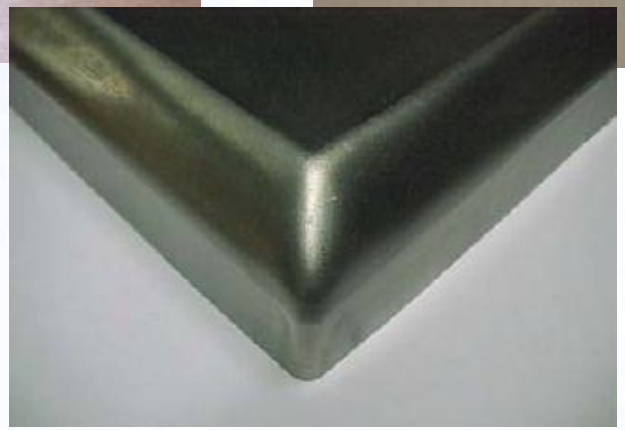
Forming

- Roll Forming
  - Creates curved shapes for custom designs



Corner Forming

- Dedicated corner forming machine
  - Eliminates costly welding & dressing



Hardware Insertion

- Self-clinching fasteners allow components (such as electronics) to attach to your products
- Primary vendors
  - PEM
  - Captive Fasteners

Hardware Insertion

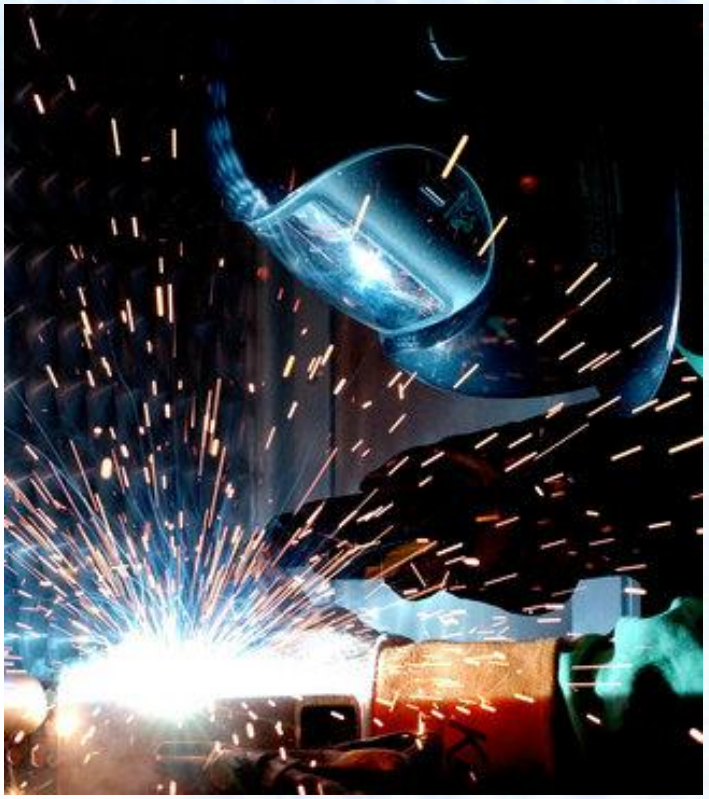
- Haeger 824 One Touch
  - Capable of inserting 4 different types of fasteners with a single handling of the part
  - Hopper system feeds fasteners automatically
  - Tools change automatically for different sized fasteners
  - Programmable

Machining

- Mill
- Lathe
- Saws
- Drill Presses
- Haas VF-7 CNC Machine
  - 3-axis
  - 70” x 30”
  - 24 tool stations

Welding

- Welding techniques for a variety of materials
  - MIG welding
  - TIG welding
  - Seam welding
  - Spot welding



Robotic Welding

- Fanuc ArcMate 120iB welding robot
  - MIG welding of steel, stainless steel, and aluminum

Dressing (grinding)

- Remove imperfections from surfaces
- Clean up welded areas where cosmetic appearance is important

Inspection

- Products must pass inspection criteria at each work center
- Products are checked near the final stages of manufacturing to ensure they meet the customer's specifications
- Faro Arm CMM measures 3D points efficiently, and can compare part to CAD model
- Inspection reports are generated

Plating

- Capable of Metalast and Oxsilan clear chromate conversion (for aluminum products) in-house
- Resists corrosion and enhances appearance

Clear Chromate Conversion

Powder Coating

- Hanging conveyor line (with 2 spray booths) and batch systems in-house
- Variety of standard and custom colors and textures

Screen Printing

- Screen printing can set your product apart from the competition

Assembly

- Assembly services
  - Hinges & doors
  - Gaskets
  - Pneumatic systems
  - Electronic systems & wiring
  - Mechanical components
  - Complete turn-key solutions

Shipping

- Quality packing to ensure your products arrive the way you expect
- Custom packaging or crate systems
- Kanban delivery system available
- Short Order Product (SOP) or Vendor-Managed Inventory (VMI) systems available
- Shipping throughout North America and Mexico

Subcontracting

- We can arrange to have approved vendors take care of other manufacturing processes
  - Plating (such as zinc plating & anodizing)
  - Machining or laser cutting beyond our capabilities

Question & Answer period

Sheet Metal Manufacturing & Design

Don’t hesitate to ask questions!

Purpose

- To improve the information conveyed by drawings and solid models
  - Parts meet customer's expectation
- To improve the efficiency of estimating and manufacturing
  - Shorter lead time
  - Reduced cost

Manufacturing Processes

- Shearing
- Punching
- Laser Cutting
- Pre-Form (hand finishing)
- Forming
- Pemming (hardware insertion)
- Welding
- Inspection
- Plating
- Thermal Spray Coating (metalizing)
- Painting (powder coat)
- Screen Printing
- Assembly

Common Materials

	Cost difference (compared to CRS of same thickness)	Weight difference (compared to CRS of same thickness)
Galvanized	5-10% more	Same
Satin Coat	20-30% more	Same
5052 H32 Alum	30-40% more	65-70% lighter
304 2B Stainless	4X more	2-5% heavier
304 #4 Stainless	5X more	2-5% heavier

Other Materials

- Copper
- Plastics
  - Lexan
  - ABS
  - Polycarbonate
  - PETG

Shearing

- General tolerance: +/- 0.040” (1.00mm)
- Possible tolerance: +/- 0.010” (0.25mm)
- Only required if parts are punched from partial sheets

Punching

- Tolerance
  - Hole size: +/- 0.003” (0.08mm)
    - with appropriate tooling
  - General position: +/- 0.008” (0.20mm)
  - Possible position: +/- 0.005” (0.13mm)
- Punching is much more cost effective than
  - Milling
  - Drilling
  - Plasma, laser, waterjet (which can’t do formed features)
- Punching cost: $0.01 per hit
- Example program shown in image above
  - 4’ x 8’ sheet of 30 parts
  - 8640 hits per sheet (288 hits per part)
  - 40 minutes per sheet (80 seconds per part)

Punching – Capabilities

- Maximum sheet size
  - 48” x 192” (1219.2mm x 4876.8mm)
  - 60” x 124” (1254.0mm x 3149.6mm)
- Material thickness
  - Steel: 0.022”-0.250” (0.56mm-6.35mm)
  - Aluminum: 0.030”-0.250” (0.76mm-6.35mm)
  - Stainless: 0.024”-0.119” (0.61mm-3.02mm)
  - Plastics: 0.030”-0.250” (0.76mm-6.35mm)

Punching – Blank Sizes

- Prefer to use full sheets
  - 4’ x 8’
  - 4’ x 10’
  - 5’ x 8’
  - 5’ x 10’
  - 12’, 14’, or 16’ lengths if part size requires it
- Precut blanks of custom lengths available for high quantities
  - 3’ wide (some materials)
  - 4’ wide
  - 5’ wide
- Possible to use fractions of full sheets
  - 48” x 20”
  - 48” x 24”
  - 48” x 30”
  - 48” x 32”
  - 48” x 40”
  - 48” x 48”
  - 60” x 48”
  - 72” x 48”
  - Etc.

Punching – Material Utilization

- Standard sheet borders
  - 4” on clamp edge (long edge), 1” on other 3 edges
  - 1” spacing between parts
    - Blank Size Calculator spreadsheet provided

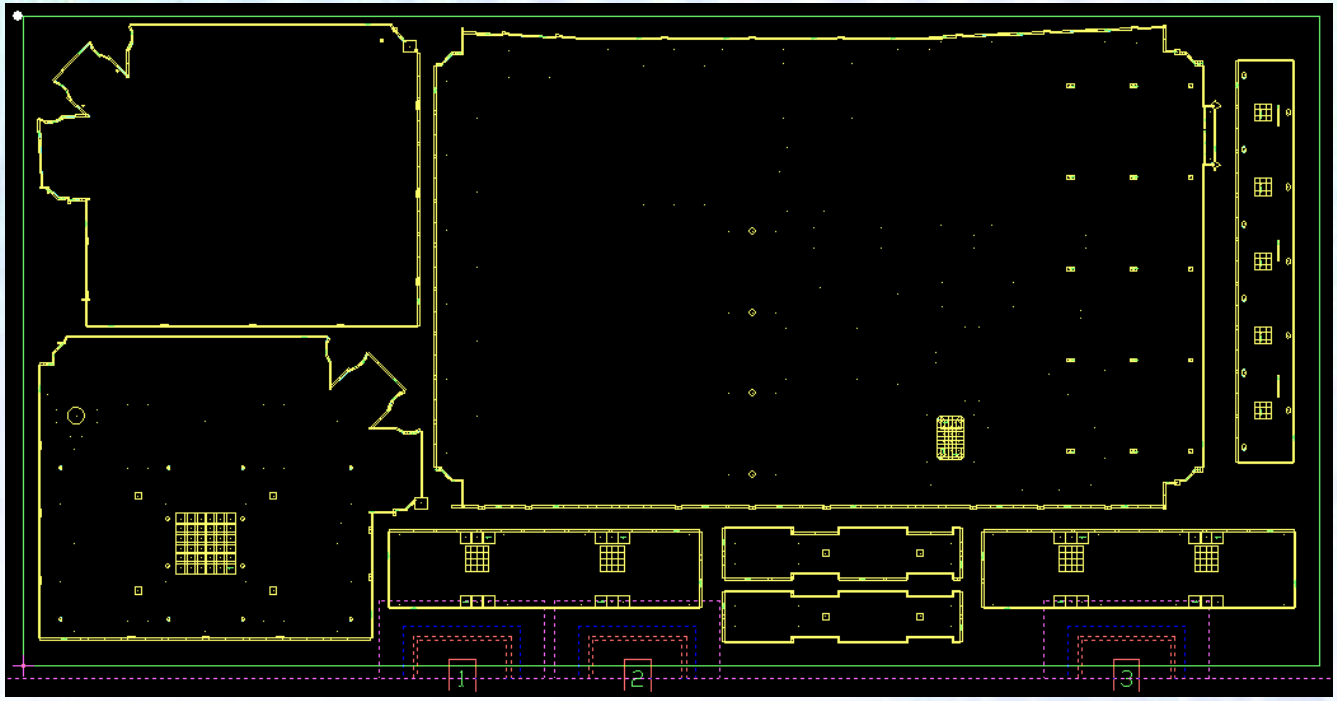
Wesgar Blank Size Calculator

Part Size X	16.000	inches
Part Size Y	12.000	inches
Blank Size X	96.000	inches
Blank Size Y	48.000	inches
Grid Spacing X	1.000	inches
Grid Spacing Y	1.000	inches
Bottom Border	4.000	inches
Top Border	1.000	inches
Left Border	1.000	inches
Right Border	1.000	inches

	Part Not Rotated	Part Rotated
Number of Parts in X	5.588	7.308
Number of Parts in Y	3.385	2.588
Parts per Blank	**15**	**14**
Square Feet per Part	**2.133**	**2.286**
	BEST	

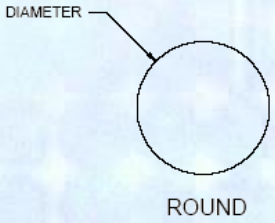
Punching – Nesting

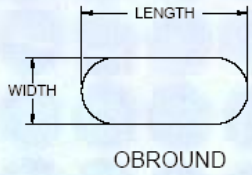
- Nesting different parts from same assembly can reduce costs
  - Parts must be same material and thickness
  - Better material utilization
  - Single setup for multiple different parts

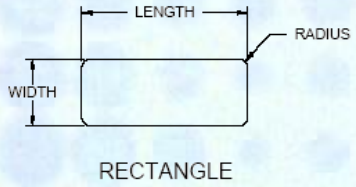


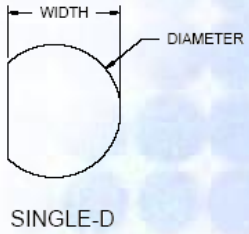
Punching – Tool Shapes

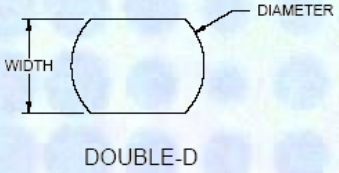
- Standard Shapes
- Maximum punch size Ø3.500” (Ø88.90mm)
- Tool List provided
- Special Tool Details provided
- Die clearance required depends on material hardness and thickness
  - Die Clearance Table provided

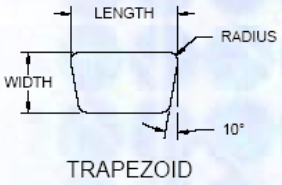












Punching - Restrictions

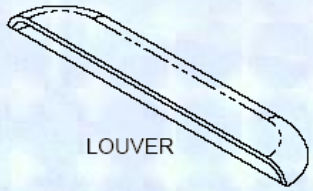
- Width of tool (round, rectangle, etc.) must be larger than material thickness, preferably 1.5x larger
- Gap between holes or cutouts must be larger than material thickness, preferably 1.5x larger, or material will twist

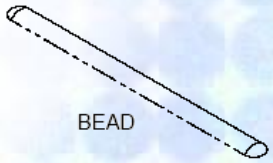
Punching - Countersinks

- Information required
  - Major diameter, minor diameter, angle, or
  - The screw or rivet it is intended for
- Countersink methods
  - Universal countersink punch tooling if countersink depth is less than 60% material thickness (most cost-effective method)
  - Special countersink punch tooling if countersink depth is between 60% and 80% (extra one-time tooling cost)
  - Manual countersink drilling if depth exceeds 80% (extra per-part cost)
  - As an alternative, could use dimple with hole
- Countersink Chart for standard screws provided
- Countersink Calculator to calculate depth provided
- Ensure minor diameter is mathematically achievable

Punching – Formed Features

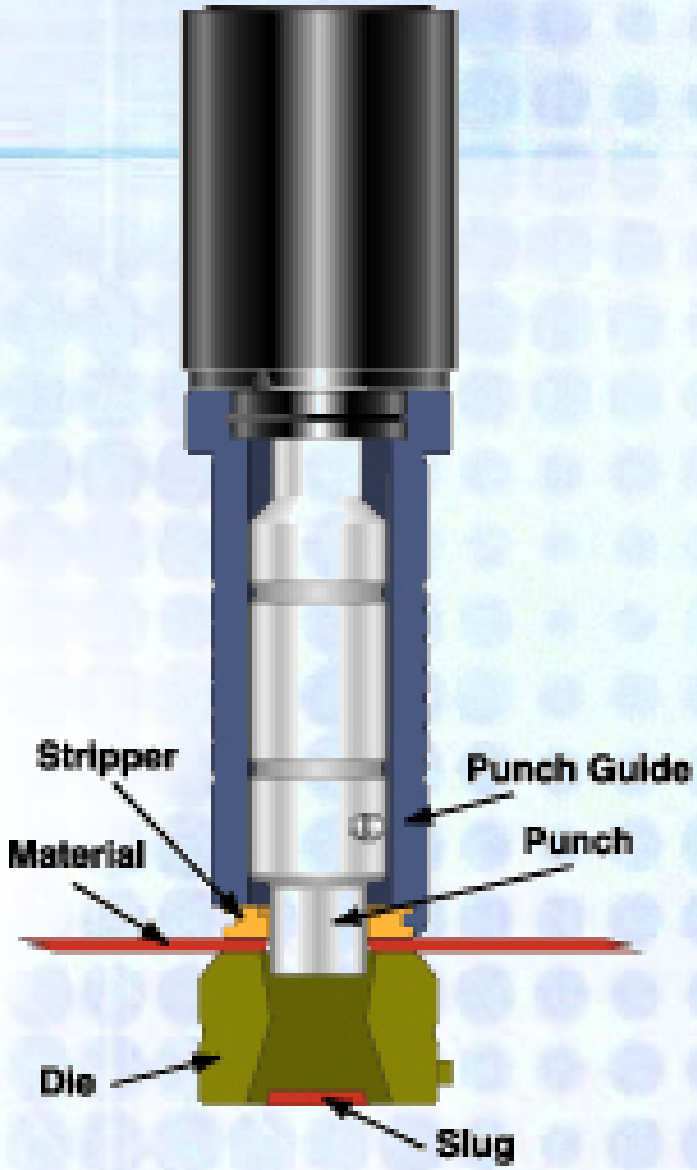
- Information required
  - Shape & dimensions
  - Offset distance (section view preferred)
  - Direction (isometric view preferred)
- Design considerations
  - Too many formed features may cause bowing
  - Maximum down offset on turret press is 0.300” (7.62mm)
  - Maximum up offset on turret press is 0.600” (15.24mm)
  - Extreme forms may cause material to tear





Punching – Formed Features (continued)

- Formed features (dimples) too close to holes or edges, causing those features to stretch or move (called “pulling”)
- Formed features (dimples, half-shears, etc) too close to each other
  - By design, punch tooling flattens the area around the feature, on the top surface (“punch side”) and bottom surface (“burr side”)

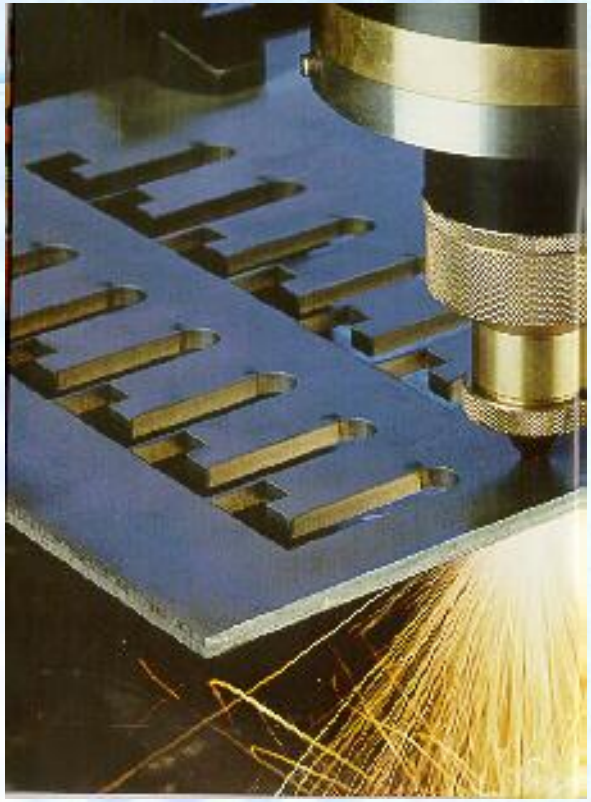


Punching – Tooling Costs

- Punch tooling costs depend on
  - Size
  - Complexity
  - Forming requirements
  - Standard vs. heavy duty
- Lead time 5 – 15 working days

Tool Description	Cost (CDN)
Round up to Ø1.250”	$150
Round up to Ø3.500”	$275
Countersink	$475
Extrude	$550
Dimple up to Ø2.000”	$600
Louver up to 3.500” wide	$2250
Hinge up to 1.250” wide	$2750
Hinge up to 2.000” wide	$5150

Laser Cutting



- Tolerance
  - Hole size: +/- 0.004” (0.10mm)
  - General position: +/- 0.008” (0.20mm)
  - Possible position: +/- 0.004” (0.10mm)
- Materials
  - Steel: 0.010”-0.750” (0.38mm-19.05mm)
  - Stainless: 0.007”-0.500” (0.38mm-12.70mm)
  - Aluminum: 0.015”-0.375” (0.38mm-9.53mm)
- Restrictions
  - Maximum size 60” x 120” (1524mm x 3048)
  - Generally, for material up to 0.060” (1.50mm) thick, round holes must be larger than material thickness
  - Generally, for material over 0.060” (1.5mm) thick, round holes must be larger than 2/3 of material thickness

Laser Cutting - Advantages

- Advantages compared to punching
  - Can handle thinner and thicker materials
  - Thinner cuts – kerf width 0.008”-0.020” (0.20mm-0.50mm)
  - Can cut complex curved profiles
  - Generally smaller burrs (dross) on bottom side
  - No tooling required
    - Shorter lead times for prototypes
    - Quick setup time (select lens and nozzle only)
    - No tool sharpening required
  - No tool selection required during NC programming
- Good for prototypes, low quantities, or parts with few holes

Laser Cutting - Disadvantages

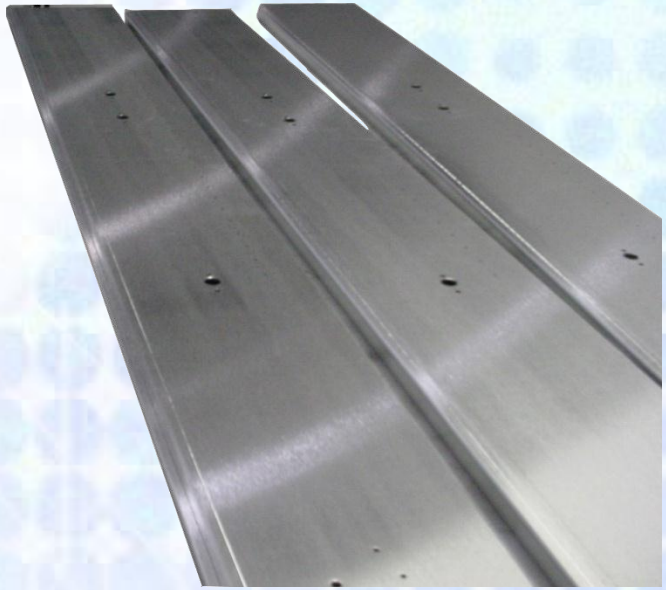
- Disadvantages compared to punching
  - Considerably slower if many holes
  - Can’t do formed features, even countersinks
  - Not suitable for some materials (copper, plastic)
  - Gas consumables are expensive
- Not recommended for large quantities if parts have many holes

Pre-Form (Hand Finishing)

- Cosmetic expectations should be specified, for entire part or specific areas
  - Edge burrs (sharp edge on bottom edges)
  - Edge nibs (punching tool endpoints or laser start/stop points)
  - Surface scratches or tool marks
  - Acceptable bow direction and distance
    - Parts with no bends
    - Large parts
  - Direction of grain, if grained finish required

Pre-Form - Methods

- Hand filing, belt sanding, or fibre-wheeling edges
- Tumble deburring
  - Removes sharp edges only
  - Surfaces appear speckled
  - Parts must be smaller than 8” (200mm approx)
- Fladder
  - Series of spinning rotating sanding brushes that remove burrs and imperfections on one surface
- In-line graining (“timesaving”)
  - Belt-sanding parts in flat state before forming
  - Maximum part width 36” (915mm approx)
- Dressing surfaces or corners
  - Grinding & sanding, usually done after welding

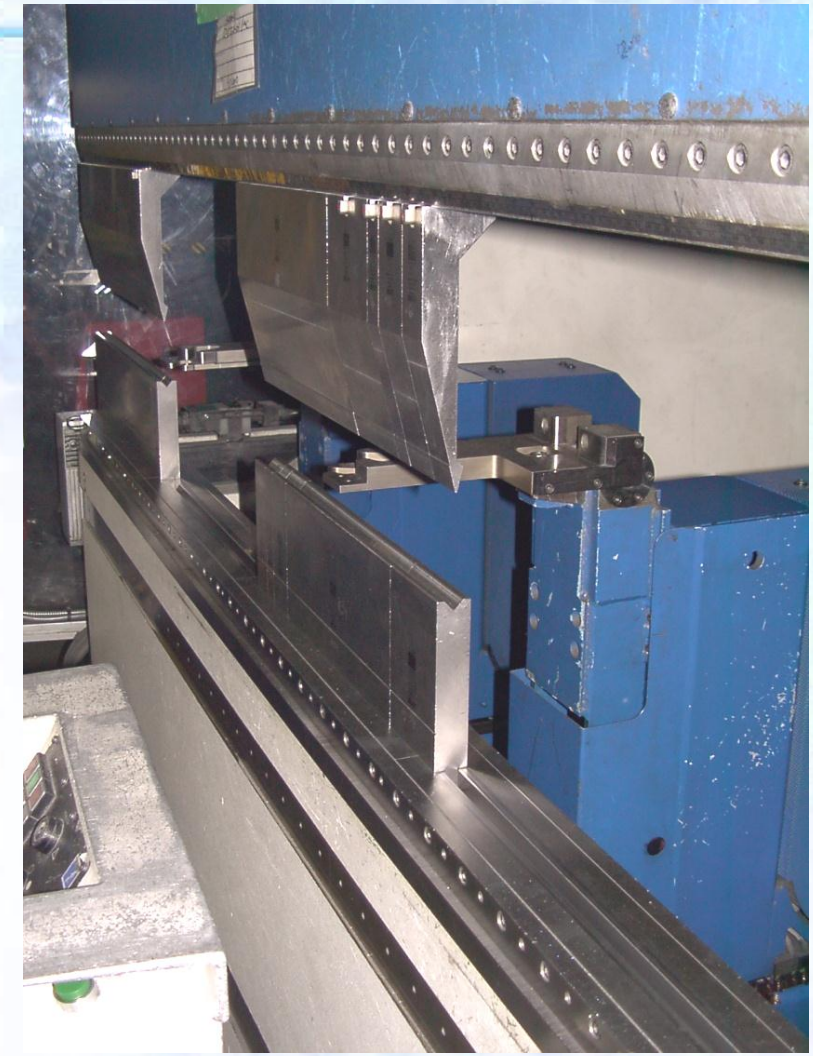


Pre-Form – Design Considerations

- Cosmetic appearance directly affects cost
- Scratches easiest to cover with paint (powder coat), especially textured powder
- Plating may make imperfections more noticeable
- Wesgar appearance specifications (Metalwork Appearance Codes) provided

Forming

- Tolerance
  - General flange size: +/- 0.015” (0.40mm)
  - Possible flange size: +/- 0.005” (0.13mm)
    - Very difficult to achieve tight tolerance on adjacent flanges
  - General angle tolerance: +/- 1.0°
  - Possible angle tolerance: +/- 0.5°
- Some materials are less consistent than others, such as galvanized steel and plastic
- Labour costs: $20 setup for 4 bends, $0.30 per bend per operator

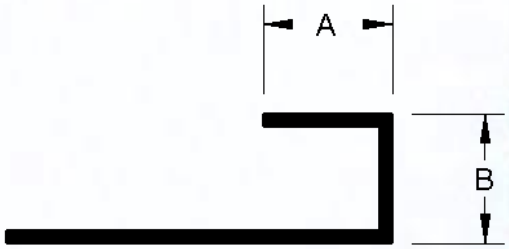


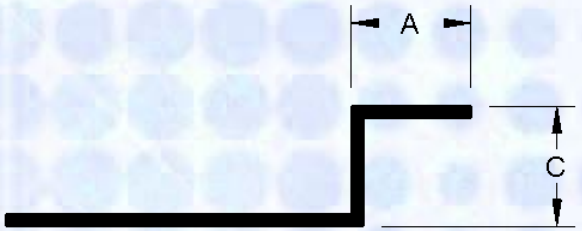
Forming - Capabilities

- Restrictions
  - Maximum tonnage: 130 metric tons
  - Maximum flange size:
    - 14” flange x 120” wide (355mm x 3048mm)
    - 33” flange x 105” wide (838mm x 2667mm)
  - Tonnage restrictions may reduce maximum bend width (refer to Forming Table provided)
  - Large or heavy parts may require 2 operators

Forming – Restrictions & Specs

- Wesgar Forming Table provided
  - Minimum flange dimensions (most common issue)
  - Distortion region for holes & cutouts near bends
  - Maximum bend length (due to tonnage)
  - Recommended bend relief hole size
  - K-factor & bend allowance to calculate flat size
- Try to have a straight edge parallel to bend line(s) for press brake back gauge, or temporary forming tabs will be needed
- For aluminum 0.077” (2mm) or thicker, hem bends parallel to grain direction are likely to crack



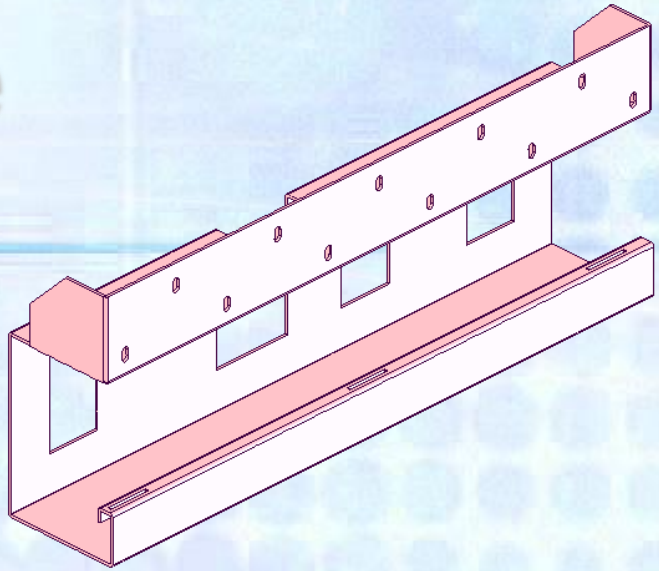


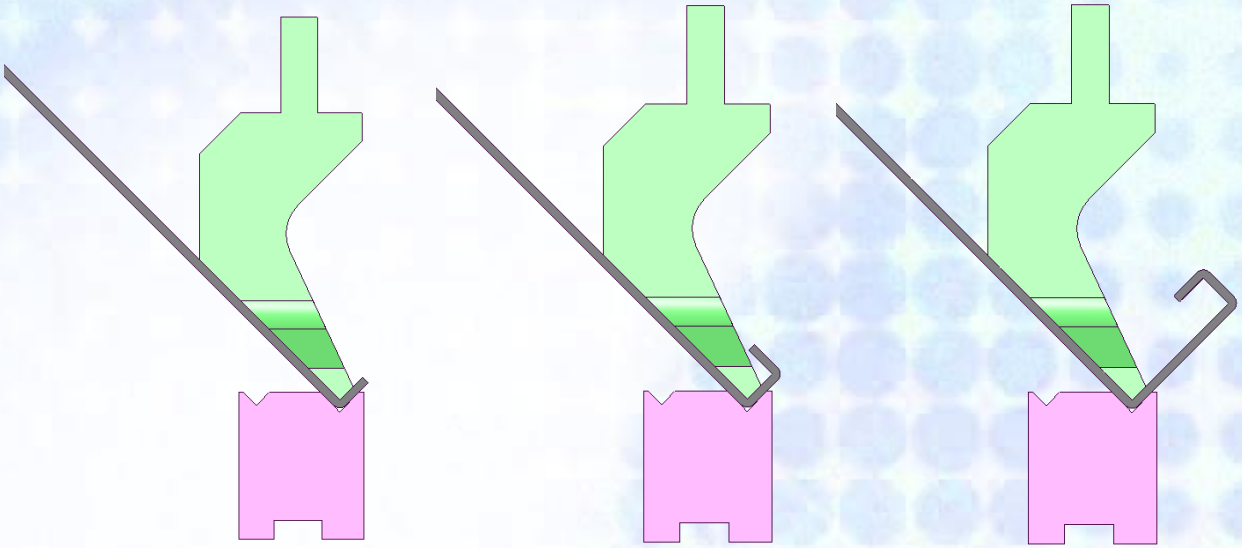
Forming – Bend Table

Material	Gauge	Thickness inches	Thickness mm	Lapped Corner Relief Hole Dia inches	Lapped Corner Relief Hole Dia mm	Inside Bend Punch Radius inches	Inside Bend Punch Radius mm	Die Name	Die V Width inches	Die V Width mm	Acute Bends Possible?
ALUMINUM	26	0.014	0.36	0.000	0.00	0.008	0.20	50180S	0.157	4	N
ALUMINUM	24	0.018	0.46	0.000	0.00	0.008	0.20	50180S	0.157	4	N
ALUMINUM	22	0.023	0.58	0.000	0.00	0.008	0.20	50810S	0.157	4	N
ALUMINUM	20	0.030	0.76	0.062	1.57	0.008	0.20	50280S	0.236	6	N
ALUMINUM	20	0.030	0.76	0.062	1.57	0.008	0.20	50180L	0.276	7	N
ALUMINUM	20	0.030	0.76	0.062	1.57	0.008	0.20	50380S	0.315	8	N

Bend Allowance inches	Bend Allowance mm	K-Factor (0-1)	"A" Min Flange OD inches	"A" Min Flange OD mm	"B" Min J Flange OD inches	"B" Min J Flange OD mm	"C" Min Z Flange OD inches	"C" Min Z Flange OD mm	Pulling Region OD inches	Pulling Region OD mm	Max Bend Length inches	Max Bend Length mm
-0.025	-0.64	0.2926	0.116	2.95	0.403	10.24	0.189	4.81	0.050	1.27	120	3048
-0.030	-0.76	0.3336	0.119	3.02	0.411	10.44	0.196	4.97	0.062	1.57	120	3048
-0.040	-1.02	0.2611	0.124	3.14	0.421	10.69	0.206	5.23	0.077	1.96	120	3048
-0.045	-1.14	0.3912	0.166	4.21	0.435	11.05	0.255	6.46	0.098	2.49	120	3048
-0.050	-1.27	0.2851	0.188	4.77	0.435	11.05	0.277	7.04	0.098	2.49	120	3048
-0.055	-1.40	0.1790	0.210	5.33	0.435	11.05	0.300	7.61	0.098	2.49	120	3048

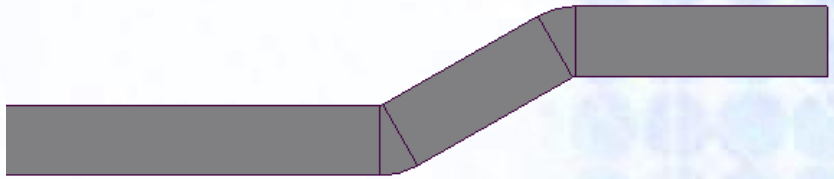
Forming - Example





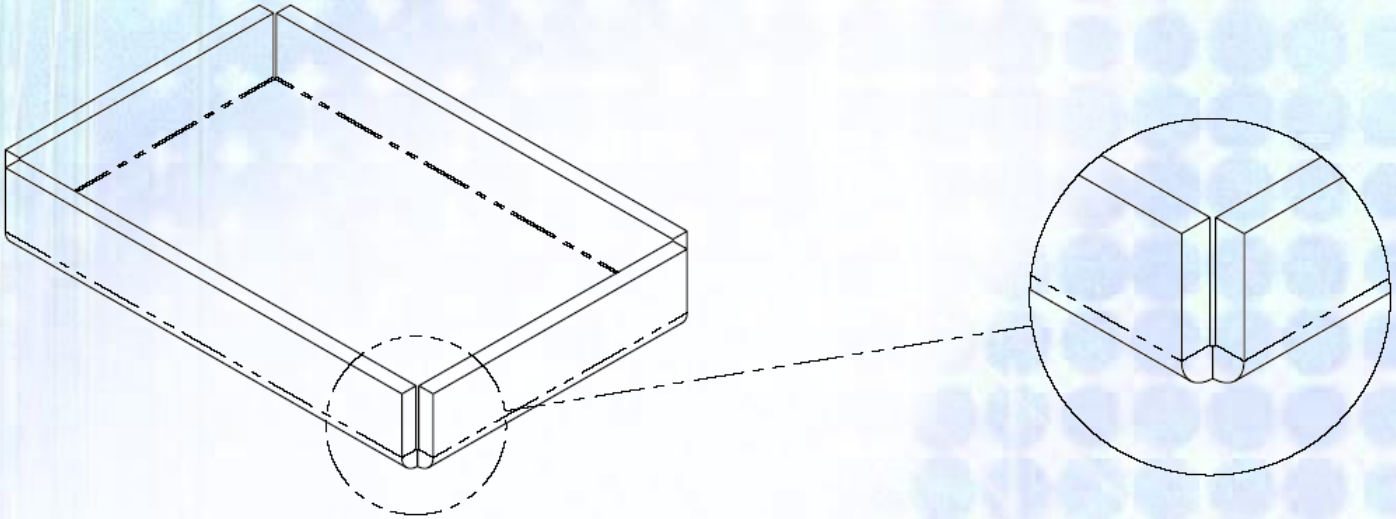
Forming – Jog (Offset) Bends

- Methods
  - Form as 2 bends with conventional tooling
    - Angled flange must exceed minimum flange size
  - Form as single jog bend with jog tooling
    - Able to achieve smaller angled flange
    - Specify offset, and one bend point
    - Angle of middle section determined by tooling and offset
  - Use punch tooling (rectangular dimple) if feature is small enough
    - Quantity must offset tooling cost



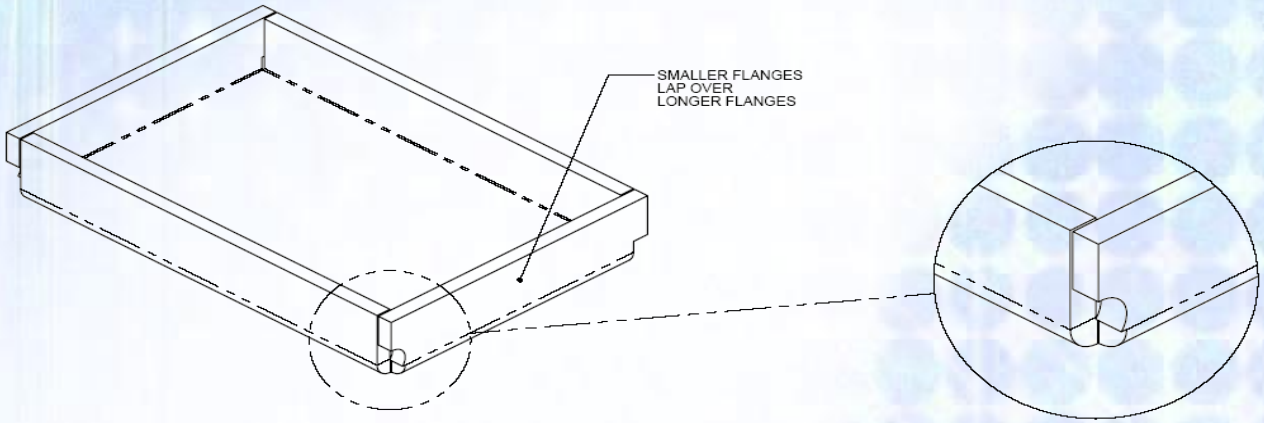
Forming – Open Corner Notch

- Simplest method to design and manufacture
- Suitable for MIG welding inside or outside, with or without dressing



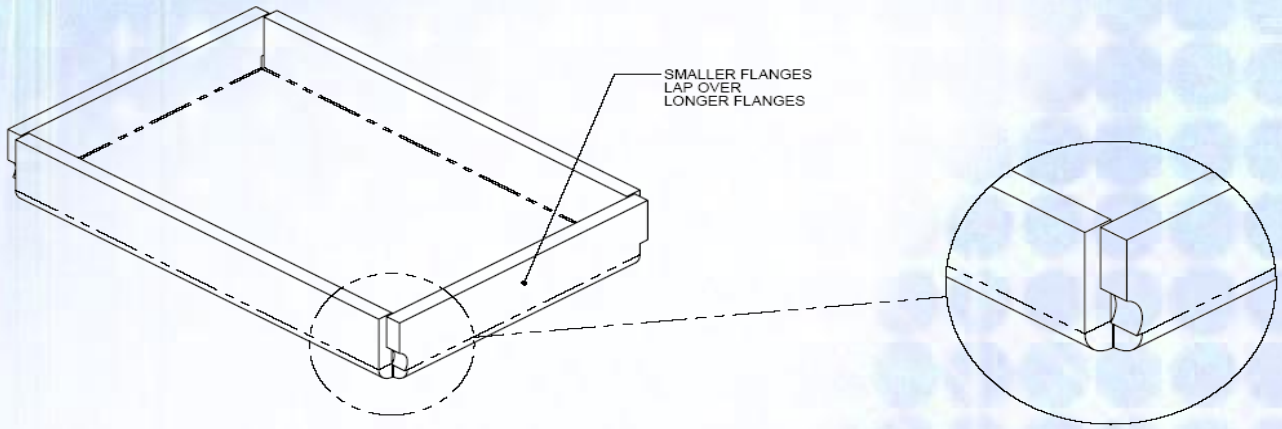
Forming – Lapped (Closed) Corner

- Requires relief hole
- Recommended that shorter edge overlaps longer edge, so all bends can be done in a single setup
- Suitable for TIG fusing, with or without dressing
- Suitable for MIG welding inside, without dressing



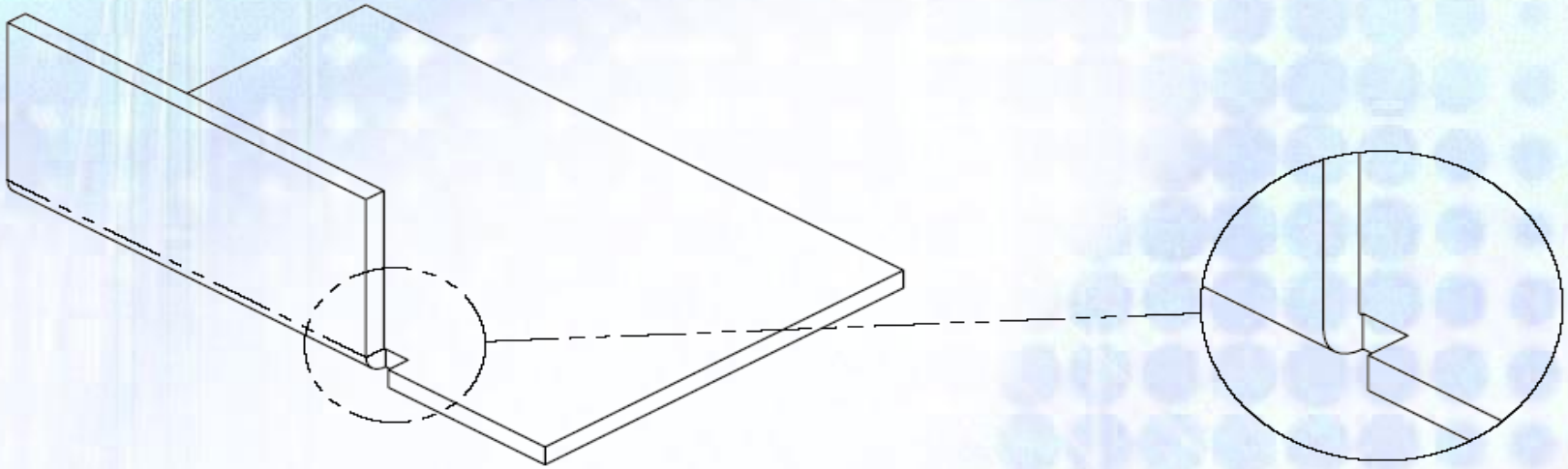
Forming – Half-Lapped Corner

- Similar to lapped corner, except only overlaps by half of material thickness
- Suitable for MIG welding inside, without dressing
- Suitable for MIG welding outside, with dressing - usually for material 0.080” (2mm) or thicker



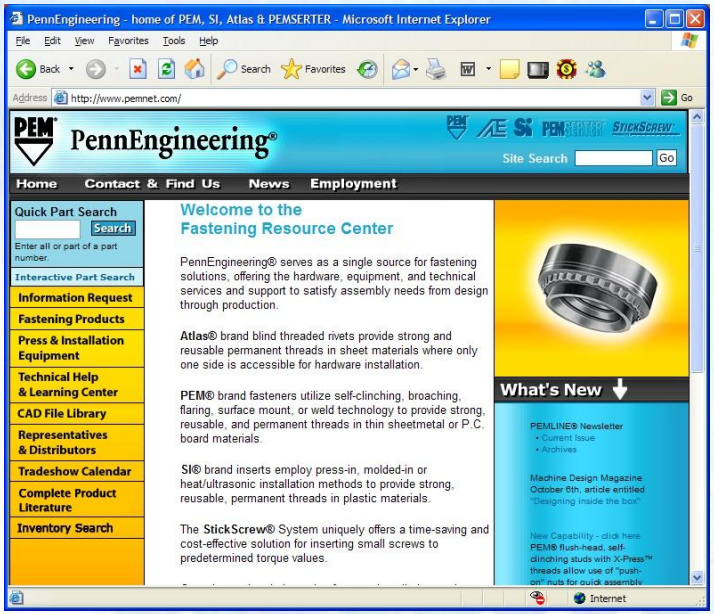
Forming – Bend Relief

- Holes or notches must be cut past the bend radius, otherwise flange will not form properly



Pemming (Hardware Insertion)

- Position tolerance: +/- 0.010” (0.25mm) [sum of punching and PEM size tolerance]
  - Can be taken into account by increasing size of hole on mating part
- Refer to PEM web site www.pemnet.com or PEM catalog
  - Hardware specifications
  - Hole sizes
  - Minimum material thickness
  - Minimum hole-to-edge distance
- Hardware and clearance hole chart provided



Pemming – Fastener Cost Examples

Part Number	Description	Cost (compared to S-832-1)
S-832-1	8-32 steel nut	-
CLS-832-1	8-32 stainless nut	2X
CLA-832-1	8-32 aluminum nut	2X
F-832-1	8-32 flush nut (stainless)	4X
LK-832-1	8-32 lock nut (steel)	7X
FH-832-12	8-32 steel stud, 0.750” long	1X
FHS-832-12	8-32 stainless stud, 0.750” long	2X
FHA-832-12	8-32 aluminum stud, 0.750” long	2X
SO-832-12	8-32 thru steel standoff, 0.375” long	4X
BSO-832-12	8-32 blind steel standoff, 0.375” long	6X
SOS-832-12	8-32 thru stainless standoff, 0.375” long	6X
BSOS-832-12	8-32 blind stainless standoff, 0.375” long	8X

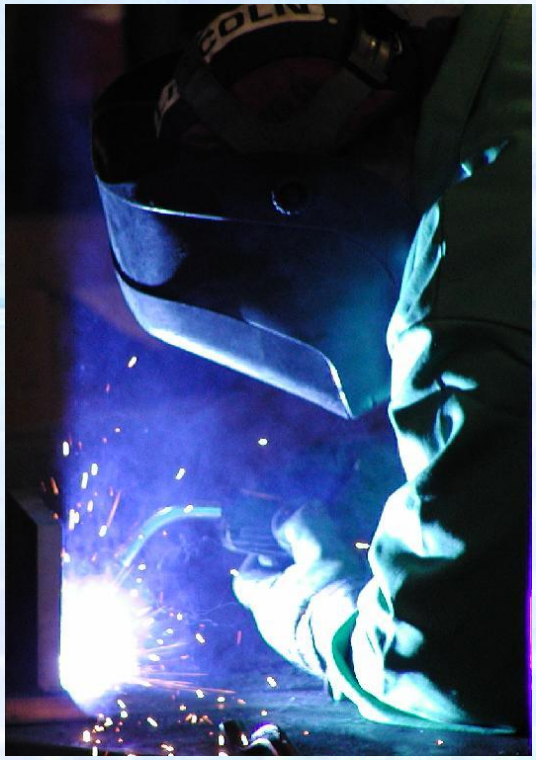
Pemming - Considerations

- Design considerations
  - Specify direction or side to be inserted from
  - Both sides of PEM hardware must be accessible for proper installation
  - Be aware of “minimum distance to edge” requirement
  - Tapping is less expensive than using PEM nuts, but not always an option (material too thin, aluminum threads too weak, lock nuts required, etc.)
  - Labour cost: $10 setup per fastener type, $0.24 per fastener inserted
- Material considerations
  - Steel parts can’t use aluminum PEM hardware
  - Stainless steel parts can’t have steel or aluminum hardware
    - Recommended to use PEMs designed for stainless steel, such as SP nuts, FH4 studs, and SO4/BSO4 standoffs
    - For stainless steel parts, holes must be punched slightly small and drilled to size, otherwise PEMs will not clinch properly

Pemming – Plating Issues

- Steel PEMs can’t be chromated
- Steel or stainless steel PEMs can’t be anodized
- Plating chemicals often get trapped in blind standoffs, resulting in corrosion or discoloration
- Possible to insert PEMs after plating, but may be costly due to extra handling and repacking

Welding



- Design considerations
  - Weld gaps/seams should be as small as possible
    - .000-.010” (.00-.25mm)
  - Material will distort (“pull”) towards the weld location
- Tolerance (depends on design and size)
  - General tolerance: +/- 0.030” (0.76mm)
  - Possible tolerance: +/- 0.010” (0.25mm)
- Information required
  - Type of weld – full weld, stitch weld, spotweld
  - Locations – inside, outside, fillet size, length, quantity, spacing
  - Dressing requirements
- Costs:
  - Minimum $30 setup, $0.40 per inch of weld
  - Additional $0.60 per inch of dressing
- Welding symbols chart provided

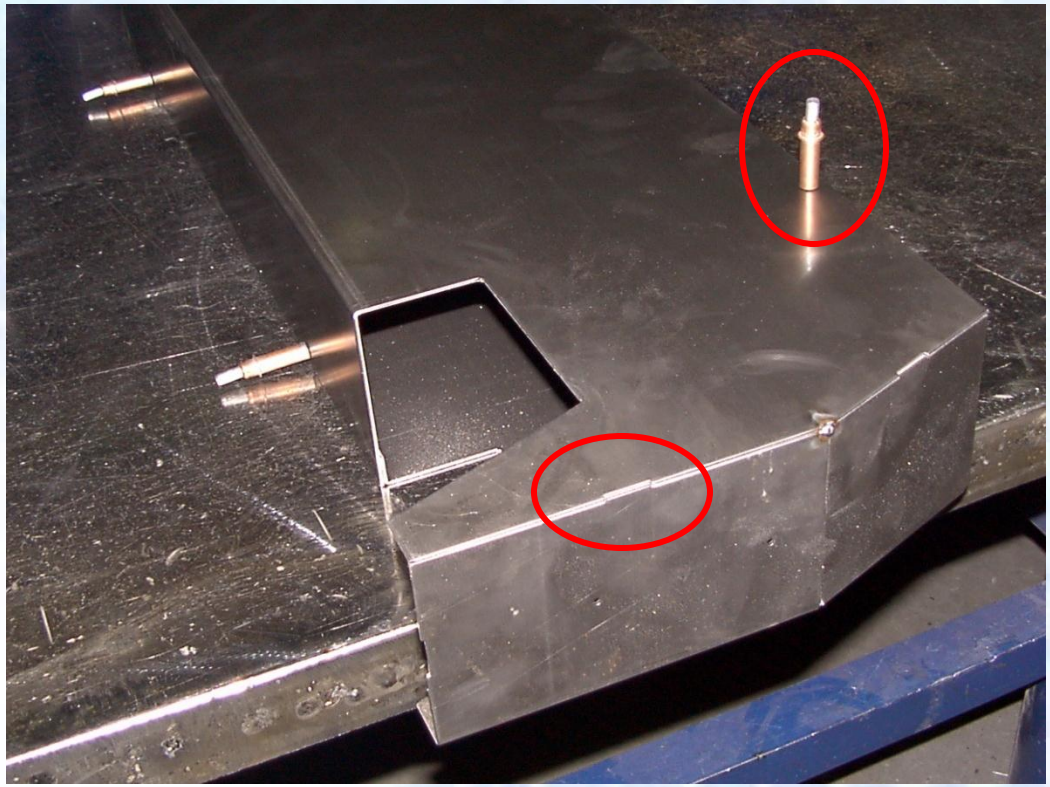
Welding – Alignment Methods

- Ø.128” (Ø3.25mm) cleco holes in both parts
  - May be filled and dressed if required
- Ø.125” (Ø3.18mm) half-shear in one part, Ø.128” (Ø3.25mm) hole in other part
- Ø.125” (Ø3.18mm) half-shear in one part, Ø.130” (Ø3.30mm) half-shear in other part
  - Larger half-shear may be ground flush if required
- Tabs & slots
- Jigs
  - Costly for small quantities
- Alignment methods should incorporate error-proofing so only the proper parts can fit together only one way
- Seam to be welded should have a gap no larger than 0.015” (0.38mm)

Welding – Alignment Examples

- Clecos

- Tab & slot



Welding - Panels

- Considerations for panels where appearance is important
  - Avoid welding the end of a plate to the inside face of a panel (T-shape)
    - Often causes warping that is difficult to correct by body-working
    - Instead, add a flange to the plate, and weld the end of the flange to the panel
  - On curved panels, add small flange to the curved edges to avoid long welds

Welding – Material Issues

	Spotwelding (combined thickness)	MIG/TIG welding	Dressing
Aluminum	0.060”-0.200” (1.5mm-5.1mm)	Yes	Easier than steel
Steel	0.055”-0.260” (1.4mm-6.60mm)	Yes	Yes
Stainless	0.055”-0.210” (1.4mm-5.3mm)	Yes	More difficult than steel
Satin Coat	0.055”-0.260” (1.4mm-6.60mm)	Not Recommended	Removes finish
Galvanized	Not Recommended	Not Recommended	Removes finish

Inspection

- Tolerance
  - +/- 0.002” (0.05mm) with calipers
  - +/- 0.003” (0.08mm) with Faro arm
    - Up to 96” (2438mm) length with single origin
  - +/- 0.020” (0.50mm) with tape measure

Plating

- Purposes
  - Corrosion resistance
  - Electrical conductivity or resistance
  - Hardness
  - Appearance
- Thickness
  - Zinc plating: 0.0001” – 0.0005” (0.003mm – 0.013mm)
  - Anodizing: 0.0001” – 0.0010” (0.003mm – 0.025mm)

Plating – Common Types

- Steel

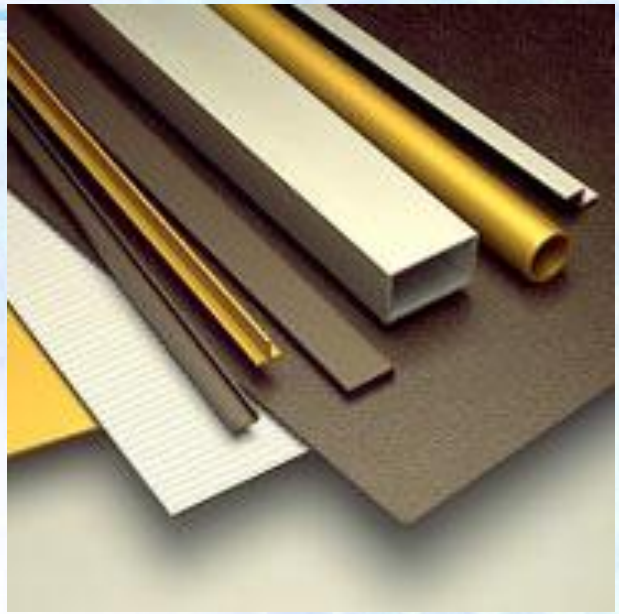
Plating	RoHS Compliant	RoHS Alternative
Zinc / Bronze	No	Zinc / Clear
Zinc / Clear	Yes	

- Aluminum

Plating (done at Wesgar)	RoHS Compliant	Notes
Metalast TCP-HF 	Yes	• Trivalent chromium • Very slight iridescent blue color • MIL-DTL-81706B • MIL-C-5541 class 1A & 3
Oxsilan AL-0500 	Yes	• Chromium-free • Slight discoloration and leaching may occur • MIL-C-5541

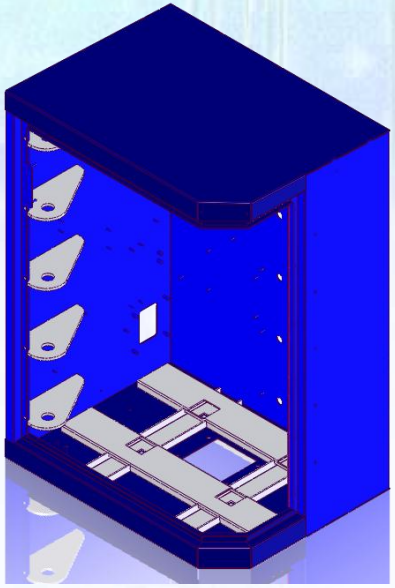
Plating – Other Types

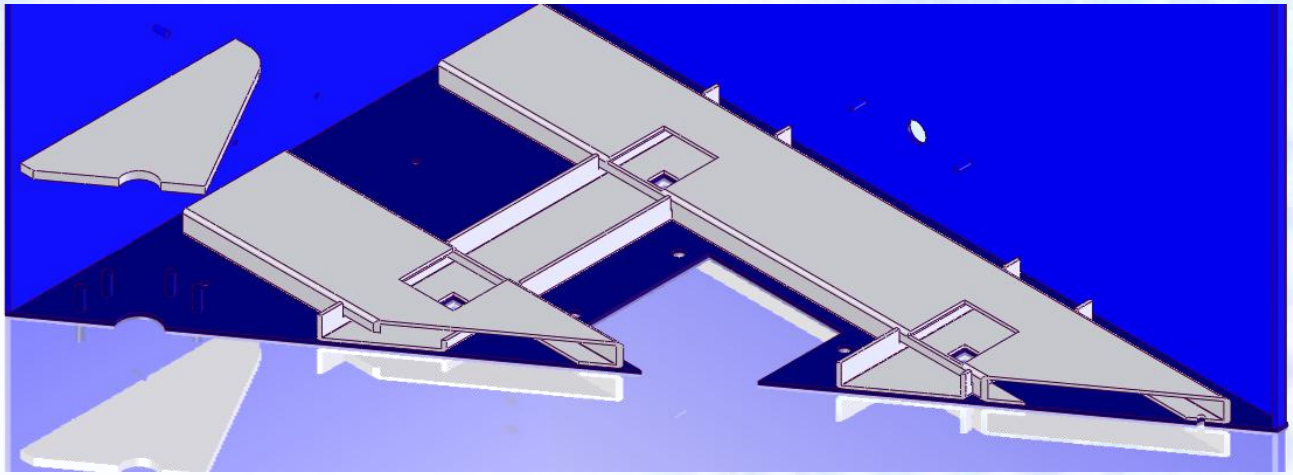
- Steel
  - Electroless Nickel
  - Bright Tin
  - Silver
- Aluminum
  - Anodize
    - Black, blue, red, green, etc.



Plating – Design Considerations

- Avoid overlapping surfaces where chemicals can get trapped, or corrosion (leaching) will appear over time





Thermal Spray Coating (Metalization)

- Surface is prepared by media blasting to allow for proper adhesion
- Atomized melted zinc coating is sprayed onto surfaces
- Provides good corrosion resistance to ferrous (iron-based) metals
- Superior to electroplating or galvanizing
- Can be used prior to painting (powder coat)
- Different textures possible (non-slip, etc)

Painting (Powder Coat)

- Purposes
  - Corrosion resistance
  - Appearance
- Surface thickness
  - Regular: 0.002” – 0.005” (0.05mm – 0.13mm)
  - Textured: up to 0.008” (0.20mm)
- Edge thickness
  - Regular: 0.004” – 0.008” (0.10mm – 0.20mm)
  - Textured: up to 0.015” (0.38mm)
- RoHS compliant

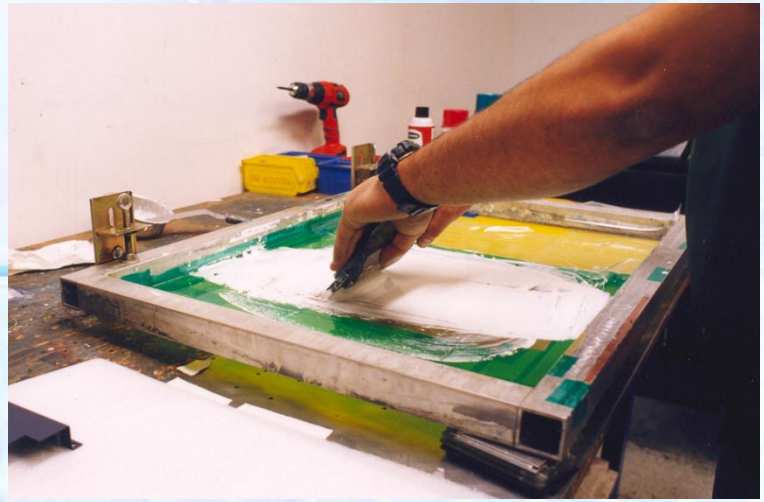
Painting - Information

- Manufacturer and name of powder
  - Color-matching available
- Do interior or non-visible surfaces need to be painted? Is overspray acceptable?
- Areas to be masked (for grounding, etc.)
  - Threads are always masked

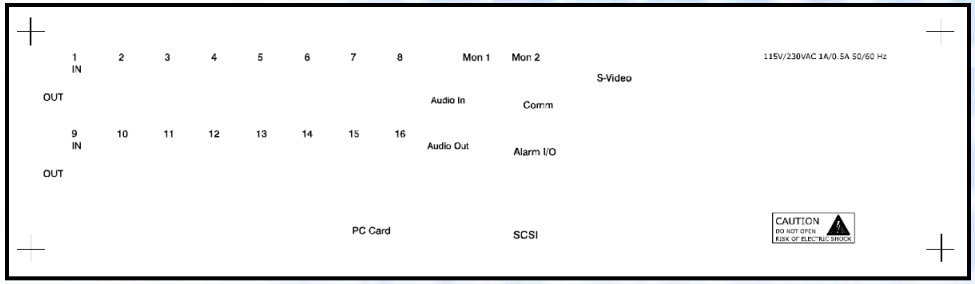
Painting – Design Considerations

- For conveyor line process, Ø.125” (Ø3.18mm) or larger hole for hanging
  - 1 hole for small parts
  - 2 holes for large parts
  - Should indicate specific holes if hook marks are an issue
- Large cabinets or boxes may require a hole at opposite end to drain excess fluid (from wash process)
- Custom powder can cost up to 5 times more than standard powder, and increase lead time

Screen Printing

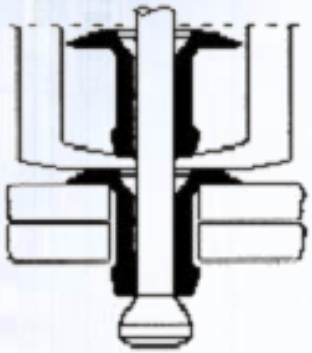


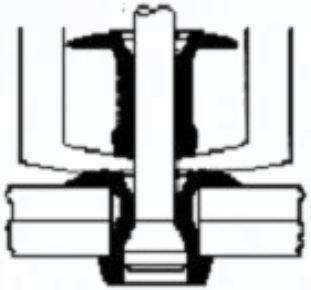
- Information required
  - Drawing for visual representation
    - Position and orientation on part
    - Ink color specifications
    - File or hardcopy – preferably in color
  - 1 film-positive artwork for each color
    - Clear mylar with black artwork
    - Reference points for alignment
    - Adobe Illustrator 10 file can be used to generate film positive (at extra cost)
- Cost considerations
  - More colors increase cost

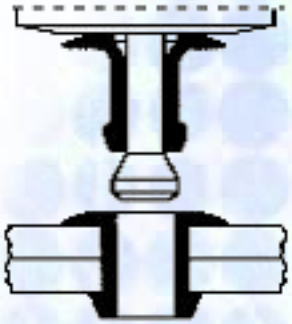


Assembly

- Rivets or nut/bolt assembly often a good alternative to welding
  - Usually less expensive (and no dressing required)
  - Rivet holes automatically position parts
  - Allows for disassembly or component replacement
  - Can be performed before or after finishing, depending on design or appearance requirements
- Rivet head must be accessible for proper insertion
- Holes should be 0.015” (0.38mm) larger than rivet diameter
- Mandrel rivets less efficient to install ($0.23 per rivet) than mandrel-less rivets ($0.16 per rivet)
  - Like comparing a hammer to a nail gun







Sheet Metal Aesthetics

- Curves
  - Single curve
  - Intersecting curves
- Formed features
  - Beads
  - Dimples (flat, spherical, odd-shaped)
  - Stamps
- Aesthetic advantage must outweigh cost

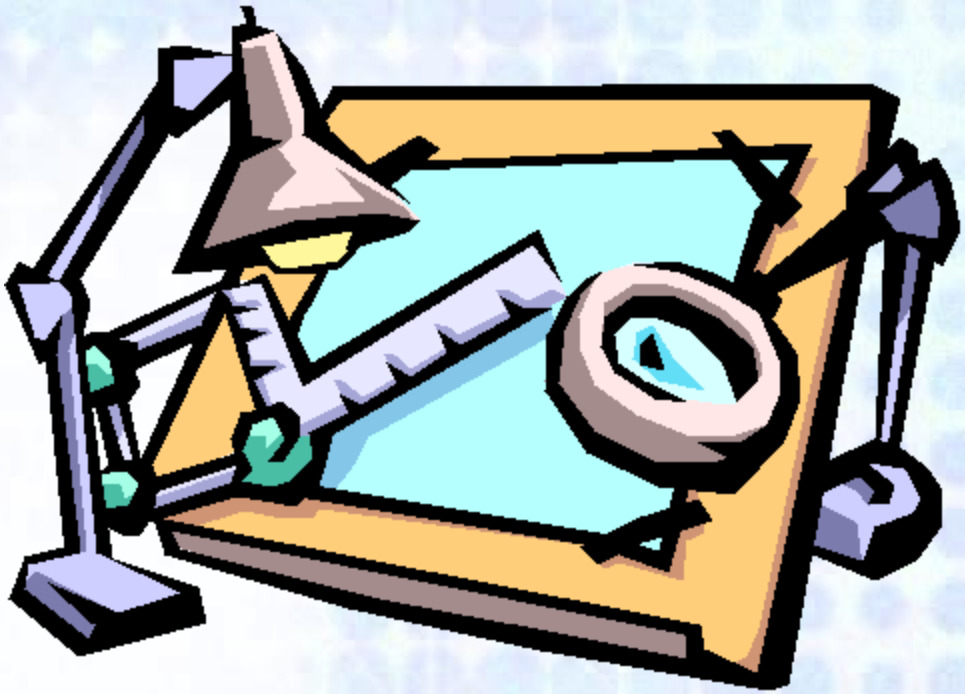
Design - Considerations

- Cost made up of
  - Materials
  - Labour (setup & run-time)
  - Subcontracting (and associated shipping)
  - Programming, tooling, jigs
- Cost of single part vs. multiple assembled parts
  - Depends on complexity
    - For example, forming a small flange on large parts could be more expensive than riveting or welding a small bracket
  - Can offset cost of multiple parts if they are similar
    - Setup cost split among multiple parts
- Ask us for assistance!

Lunch Break

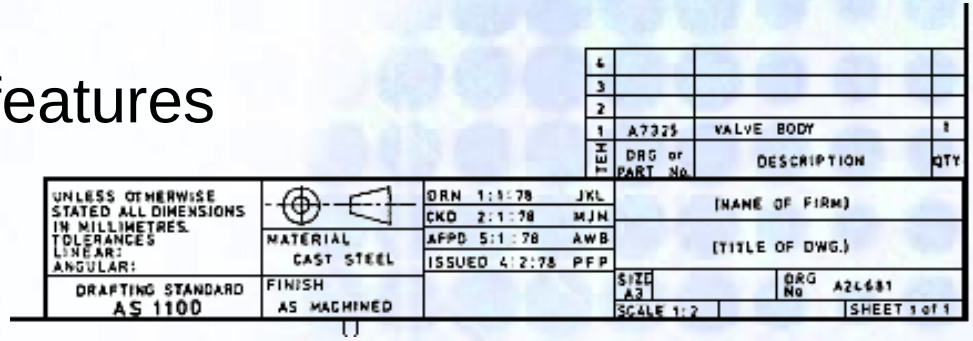
Design Information

- Drawings
- Solid Models
- SolidWorks Tips



Drawings

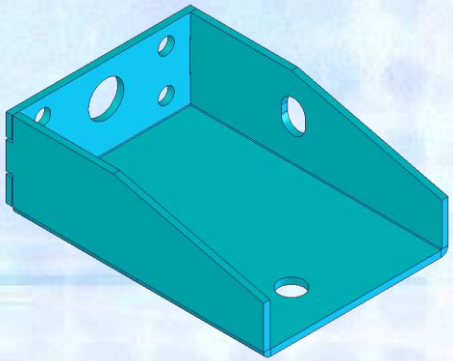
- Information required
  - Part number
  - Revision (and revision history if available)
  - Description
  - Material type
  - Material gauge or thickness
  - Finish
  - Appearance specifications
  - Tolerances
  - Critical dimensions or features



Drawings

- Information required (continued)
  - PEM hardware part number, location, direction, quantity
  - Welding and dressing details
  - Assembly details
- If drawing is not fully dimensioned (but solid model is provided), overall size dimensions should be shown for visual reference
- It is recommended that there is a separate drawing (or page) for each component of an assembly, as well as an assembly drawing
  - Each component is manufactured separately

Solid Models



- It is very important that sheet metal parts have uniform thickness, and match the thickness specified on the drawing
- Holes for PEM hardware should be modeled to the correct size (per PEM catalog/website), but actual PEM hardware should not be merged with the body of the main part
  - Include hardware as separate solid bodies in the same part model, or
  - Use assembly models to include hardware
- Assemblies should be broken down into separate part models
- Assemblies must have no interferences, and take tolerances into account
  - Try to use symmetric tolerances whenever possible, so manufacturer can aim for the middle of the acceptable range
- Models must match drawings

SolidWorks Tips

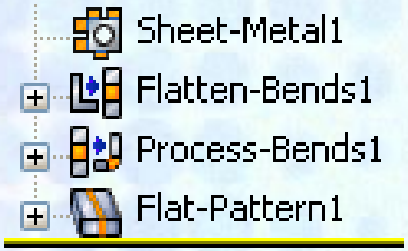
- Link extruded bosses and cuts to the “thickness” variable, where it makes sense
- Countersinks should be constructed with the hole wizard, not as chamfers on holes
- Model with design intent
  - Don’t specify outside dimension of a flange if it’s the inside dimension that is important

SolidWorks Tips - Features

- Features should be given meaningful names
- Features should be in logical sequence
  - Main shape
  - Large features
  - Small features
  - Chamfers, fillets, etc.
  - Relief notches, weld alignment, etc.
  - Sheetmetal-specific features
- Sketches should be as simple as possible, and always be fully-defined
- There should be no visible sketches
- There should be no suppressed features
- There should be no feature errors

SolidWorks Tips – Sheet Metal Features

- Avoid using sheetmetal-specific features whenever possible, except for the following at the very end of the feature tree
  - Sheet-Metal
  - Flatten-Bends
  - Process-Bends
  - Flat-Pattern (in SolidWorks 2006 or newer)



- Sheet-Metal and Flat-Pattern features must have same face selected (punch side of part)
- K-factor method of bend calculation recommended
  - Bend Deduction method acceptable if all bends are same radius and angle
- Best to manually create bend relief notches instead of allowing SolidWorks to automatically create them
- Flat pattern must unfold properly with no errors

SolidWorks Tips - Configurations

- Model should contain 2 part configurations
  - Default – The part in the formed state
    - Flat-Pattern feature suppressed (SolidWorks 2006 or newer)
  - DefaultSM-FLAT-PATTERN – The part in the flat state
    - Flat-Pattern feature unsuppressed (SolidWorks 2006 or newer)
    - Process-Bends feature suppressed (SolidWorks 2005 or previous)
    - This configuration is automatically created when the flat pattern is first placed on a drawing
- All configurations should have the “Suppress Features” setting unchecked, so any new features will be applied to both the formed and flat configurations

Cost Reduction Techniques

- Material
- Labour
- Subcontracting
- Tooling and Jigs

Ways to Reduce Material Cost

- Use less material
  - Use same material type & thickness for different components of an assembly (nested punching or laser cutting)
- Use less expensive material
- Use thinner material

Ways to Reduce Labour Cost

- Eliminate processes
  - No shearing required if parts fill whole sheet (4’ x 8’ or larger)
  - Use a single cutting method
    - Punching, laser cutting, OR machining
  - Use a single fastening method
    - Spotwelding, MIG/TIG welding, OR assembly
- Reduce setup times
  - Use “standard” punching tooling
  - Simplify forming so all bends use a single setup
  - Punch different parts on single nested program
    - Setup time split among multiple components
- Reduce cycle times
  - Simplify each process

Ways to Reduce Labour Cost (continued)

- Avoid non-automated processes
  - Welding & dressing
    - Usually higher cycle time (minutes instead of seconds)
    - Higher skill level required (increased shop rate)
  - Drilling
  - Manual surface or edge treatment

Ways to Reduce Subcontracting Cost

- Select vendor that best suits the product
  - Subcontracting also adds cost of shipping between vendors
- Order similar parts (or sets of parts) as a group instead of as individual items
- Look at alternatives to processes not offered by most fabricators
  - Use pre-treated materials instead of plating

Ways to Reduce Tooling/Jig Cost

- Use specialized tooling only if cost can be justified by large part quantity
- Eliminate need for jigs by incorporating alignment methods into the parts
  - Tabs & slots for welding
  - Cleco holes for welding
  - Error-proofing techniques so parts can’t be assembled incorrectly

Conclusion

- Improving the communication between customer and supplier
  - The cosmetic quality you expect
  - The right price
  - On time

Best to involve the manufacturer early in the design process, *before* the request for quote.

Thank You

Technical inquiries can be directed to:

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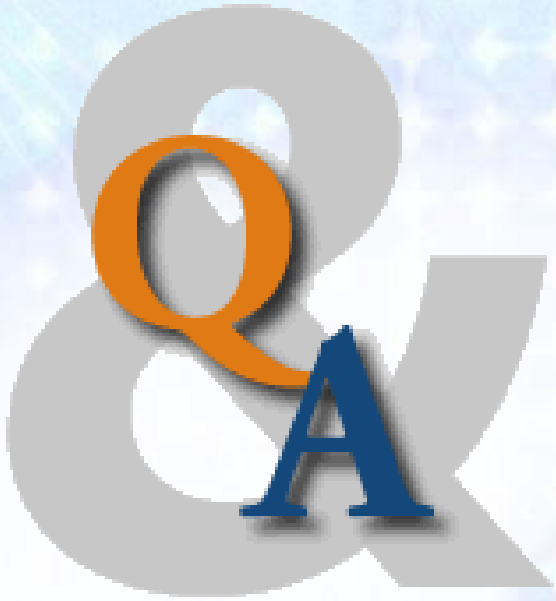
Question & Answer period



Plant Tour

- Safety concerns
  - Hi-Vis vests in forklift areas
    - Punching/laser building
    - Shipping area
  - Earplugs when exposed to loud noise for extended periods
    - Punching/laser building
  - Welding flash
    - Do not look directly at welding arcs
  - Please do not touch any products or equipment unless it is handed to you
  - Do not wander from the group