TRADE OF

Industrial Insulation

PHASE 2

Module 1

Sheet Metal and Insulation Fundamentals

UNIT: 4

Notching, Folding & Joining

Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

In cooperation with subject matter expert:

Michael Kelly

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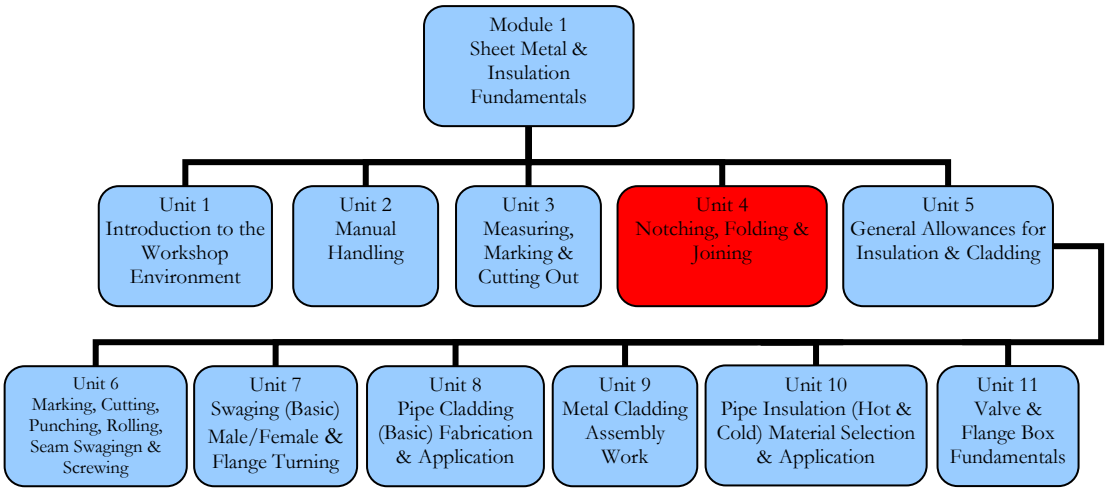
Unit Objective

By the end of this unit **each apprentice** will be able to:

- Understand simple mechanical drawings.
- Notch various sheet metal blanks.
- Set up a box and pan folding machine.
- Fold sheet metal blanks.
- Drill and join sheet metal blanks.



Introduction

Mechanical drawings are a form of communication between one tradesperson and another. They contain the information required for the manufacture of a specific item or fitting. The apprentice at an early stage should have a good understanding of mechanical drawings, and the representation of different angle views within the drawing.

1.0 Mechanical Drawings

Key Learning Points

- Reading and interpretation of drawings, symbols, dimensions and notations.
- Marking out of pattern development from supplied drawings: straight lines, arcs and angles.

A working or mechanical drawing shows the exact size and shape of an object to be manufactured. The drawing should give all the information necessary to complete the job. The drawing should include different viewing angles or elevations so the piece can be manufactured correctly. In most cases there are three views shown – front elevation, plan view and side elevation.

1.1 First and Third Angle Orthographic Projection

There are two systems of projection, first angle and third angle, which are based on a framework of planes at right angles. In first angle projection, each view shows what would be seen by looking on the far side of an adjacent view. In third angle projection, each view shows what would be seen by looking on the near side of an adjacent view. The projection symbol must be added to the drawing to indicate which system has been used.

Refer to module 2 – unit 2.

1.2 Line Work and Lettering

Technical drawings are prepared using two line thicknesses, a continuous wide line for component edges and outlines and continuous narrow lines for dimension lines. The letters, numbers and symbols should be clearly written and it is important to remember that the drawing is the main line of communication between the draftsperson and the end user.

1.3 Drawing Layout

The drawing should have adequate information to allow the work piece to be manufactured without having to source further information.

1.4 Job Planning

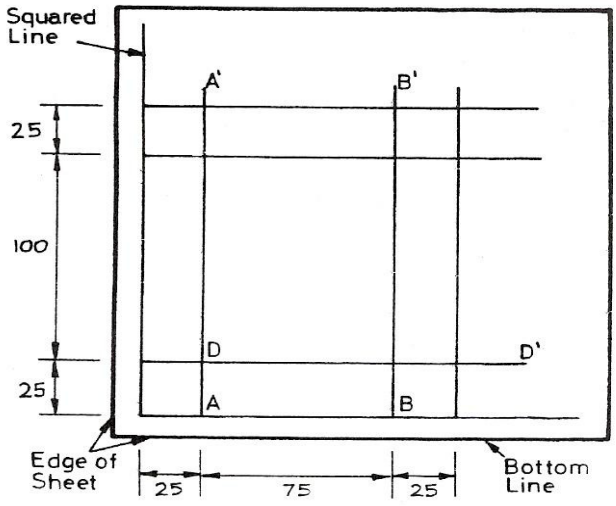
Job planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The work piece is marked out using the dimensions and datums as specified on the drawing. A basic level of mathematics is required such as addition, subtraction, multiplication, division, fractions, decimals and percentages.

1.5 Pattern Development

Though the patterns the industrial insulator develops may vary, the steps by which the patterns are developed remain the same. By applying the following rules in the process of laying out patterns, you will avoid both errors and waste of materials.

Check the sheet of material to make sure it is not bowed or warped as this will effect the accuracy of the finished job.

1. Square up the bottom left hand side of the sheet using a large metal square and scribe a line 5mm from the left edge using the bottom of the sheet as a datum edge. Take all measurements from the datum edge and the squared vertical line as these are now accurate.
2. Draw in all vertical and horizontal lines to develop the required pattern. Then add lines for notches, seams, edges and laps as shown on the drawing. If all vertical and horizontal lines are drawn and all allowances are added for seams and edges then the basic pattern is complete.
3. Once the pattern is complete check the overall dimensions of the flat development. This is particularly important on patterns drawn with parallel lines as the measurements at the top of the pattern should be exactly the same as the measurements on the bottom of the pattern. The golden rule of pattern development is to check measurements twice and cut once.



2.0 Notching

Key Learning Points

- Accurate notch and corner cutting without overcutting. Shearing process. Correct use of the hand snips.

Nothing is the term used for cutting away portions of metal to prevent overlapping and bulging on seams and edges. The exact amount of material must be removed in order for the seams and edges to fit together precisely.

2.1 Material Allowances

Whenever a sheet metal object is manufactured, some sort of seam or edge must also be formed on the piece to either join two pieces together or to stiffen an edge or make an edge safe. In order to make these seams and edges extra material must be added to the pattern to make them.

Some common sheet metal seams and edges are:

Swaged edge | Male/Female swage | Flanged edge | Safe edge or single hem

2.2 Accurate Notching

Many different notching arrangements are used in pattern developing, however the same principle applies whether you are notching a simple tray or a complicated piece of cladding, the amount of material removed has to be exact. If you remove too much material the joint or seam will be loose and sloppy and may have a gap, if you do not remove enough material you will have bulging and tearing at the joint when it is folded. Some standard notches are:

- Square Notch: The square notch is used on pans and boxes to enable the corners to fit together. The size of the notch is determined by the bend lines and the height of the sides of the pan or box.
- 45º Degree Notch: The 45 degree notch made in the form of a V is used when double seaming the ends of projects such as pans, or when making a 90 degree bend or internal flange. When the bend of an inside flange meets at an angle other than 90 degrees, the notch must be marked to the necessary angle.

- Straight Notch: A straight notch or a slit edge is made by making a straight cut along the bend line. The cut should be perpendicular to the edge of the sheet of metal and stop at the hem line.

2.3 Snips

The most commonly used types of snips used in the workshop are the combination and the aviation snips right and left hand forms. Combination snips are used for cutting both light and heavy materials in straight or curved lines where the aviation snips are used for lighter materials due to their shorter length. Aviation snips are a very versatile tools with many applications in the metal shop. The advantage of the aviation snips is that they can cut very small and complex curves that would be difficult with the bigger combination snips.

There is more to using the snips than merely working the handles. Both practice and knowledge are necessary to be able to make a clean cut on sheet metal in all circumstances. Some simple tips to using the snips correctly are:

1. Trim off the excess metal around the pattern before making the final cut on the line.
2. When cutting on the line keep the small piece of scrap metal over the bottom blade of the snips, as the metal is being cut. The scrap should then curl up out of the way and the cut can be made easily.
3. When notching, keep the end of the snips at the point where the notch will end as allowing the blades beyond the notch end results in having to make a very slow and careful cut so as not to cut past the end of the notch.
4. Keep oil from the blades of the snips as it will cause the metal to slip between the blades.
5. Cut only sheet metal with a snips as the clearance between the blades is for thin sheet metal only. Never attempt to cut wire or mesh with a snips.

2.4 Hand Shears

The hand shears or the bench lever shears is used in almost every sheet metal shop. The operating principles of these shears is the same as the snips except they are built stronger and have a compound leverage system for greater power. The shearing capacity of the hand shears should be more than the shearing strength of the material being cut. When using these shears some basic principles apply:

1. Make sure the shears is tightly clamped to the bench so that it cannot move during the cutting process.
2. Keep the work area around the shears tidy so the material will not get snagged as it is passing through the shears.
3. If you are cutting a large piece of material get a colleague to help you hold the material in position and to take the strain.
4. Cut away any excess material before cutting on the line.
5. Keep the good piece of material over the lower blade and allow the scrap material to run under the upper blade since the piece that goes under the upper blade will be curled and distorted by the cutting action.
6. Remove all scrap and place it in the scrap bin for recycling.

3.0 Folding

Key Learning Points

- Safe setup and operation of the folders.
- Accurate folding to marked lines.
- Quality checking of finished work.
- Safe work practices observed throughout.
- Composition of sheet metals.
- Working unassisted.
- Communication skills and initiative.

Folding sheet metal to form edges and seams of various kinds is one of the most important operations in the metal shop. The edges and seams have various purposes. They are used to improve the appearance of finished articles projects, to strengthen edges, and to fasten or hold parts of the job together.

3.1 Box and Pan Folders

Refer to Module 1 – Unit 3 – 2.2

3.2 Setting Up the Folding Machine

Before beginning to operate the box and pan folding machine, the apprentice should study the various adjustments and operations of the machine. There are six important considerations that must be remembered when using the folding machine, namely:

- Adjustment for the thickness of the material.
- Sharpness of the folded edge.
- Width of the edge to be folded.
- Angle of the fold
- Type of metal.

Each step should be carefully thought out before making the fold as once the piece has been folded it is almost impossible to flatten the fold and then fold it again on the other side of the material without spoiling the appearance of the metal or the finished job.

The **three main steps** in folding work are:

Clamping

In clamping, the amount of lift of the clamping beam is important. It should be sufficient to allow the fitting to be removed after folding, or to give adequate clearance for previous folds.

Folding

Care must be taken to see that the folding beam will clear the work, particularly when making second or third folds. Some folding machines are designed to fold radii above the minimum, either by the fitting of a radius bar or by adjustment of the folding beam.

Removal of the Work

Care must be taken in folding to ensure that the work may be easily removed on completion of the final bend. The sequence of folding must be carefully studied. The lift of the clamping beam is important here. Some folding machines known as **universal folders** have a swing beam. The work may be completely folded around this beam, which is then swung out to allow removal of the work.

3.3 Folding a Sheet Metal Blank

Before folding a sheet metal blank the various adjustments as set out in ***section 3.2*** should be followed. Once these procedures are carried out the following steps should be taken to ensure a perfect job on completion:

1. Study the shape of the pattern and work out the bend sequence of folds so all folds can be made on the machine. An incorrect bend sequence can lead to some folds not been achievable on the machine.
2. Ensure that all edges of the pattern are de-burred before folding as de-burring edges after the piece has been folded can be quite difficult.
3. Place the piece in the folding machine and position the edge to be folded underneath the top blade of the machine.
4. Close the top blade down onto the pattern and realign the piece so as the blade is perfectly positioned on the bend line. Clamp the piece tightly between the top beam and the bottom bed and proceed to fold the edge to the required angle.
5. Caution should be taken not to over fold the edge, that is to fold the metal past the required angle as over-folding causes the corner of the fold to bulge and distort.
6. When all edges are completely folded check to see that all angles are correct and that the corners are tight fitting.
7. Check all measurements against the drawing and ensure that the measurements are within tolerance, that is that all measurements are within the allowed variance as per the drawing.

3.4 Sheet Metals

Refer to Module 1 – unit 3 – section 4.0

4.0 Joining

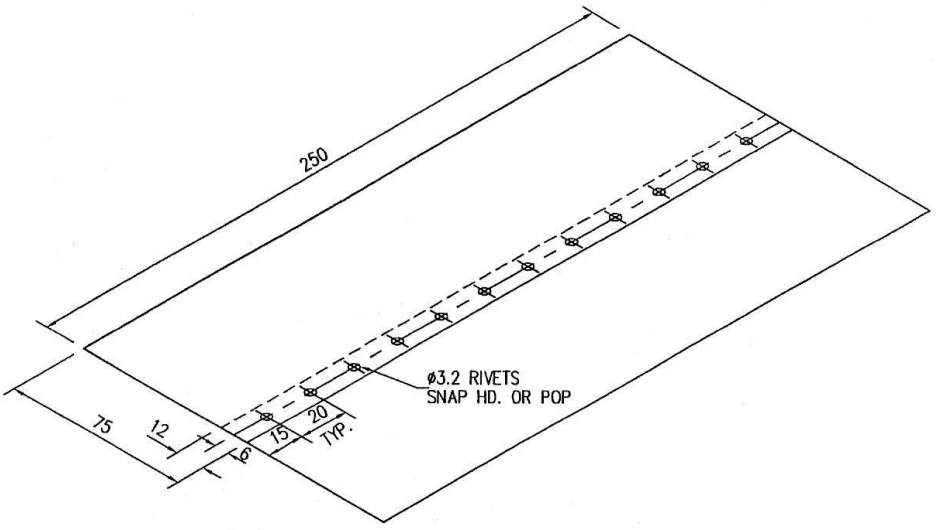
Key Learning Points

- Hand riveting operation and applications.
- Safe use and operation of pop riveting tool.
- Calculation of correct drill speed.
- Safe setup and use of a power drill (110 volt and cordless 12 volt).

There are several types of fasteners used to join pieces of sheet metal and to attach sheet metal to other materials. When sheet metal is fabricated, holes must often be drilled or punched in it for bolts, rivets, or other attachments of some type.

4.1 Riveting

Riveting is a method of making permanent joints. The process consists of drilling or punching the sheets to be riveted, inserting the rivet, and then closing it by an applied compression force so that it completely fills the hole and forms a rigid joint.

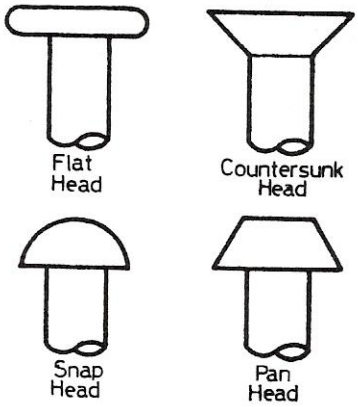


Riveting may be done by hand or by machine. When the job is performed by hand, as is usually the case in cladding work, it is done with a riveting gun.

4.2 Types of Rivets

Many types of rivets are used in the industry. The most common types are the tinman's rivets, flathead, snap head (also called roundhead) and "pop" rivets.

The countersunk is used where a flush surface is desired, and the snap head when exceptional strength is required.



Types of Rivets

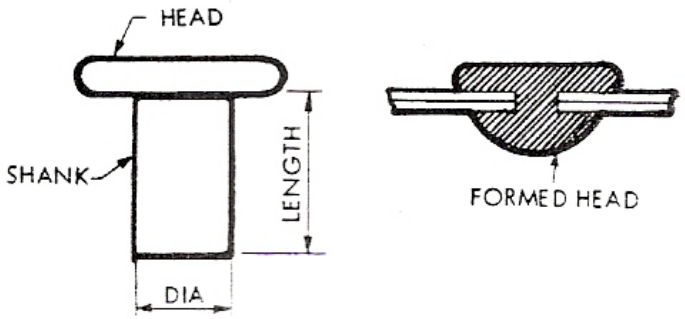
4.3 Rivet Sizes

The size of the tinman's rivets are determined by the weight of 1,000 rivets i.e. 1 lb. rivets weigh 1 lb. per thousand, 2 lb. rivets weigh 2 lb. per thousand.

Flathead rivets vary in diameter from 3/32" to 7/16" in steps of 1/32". Other rivets vary in size with 1/8" and 3/16" snap head rivets being the most popular in the sheet metal shop.

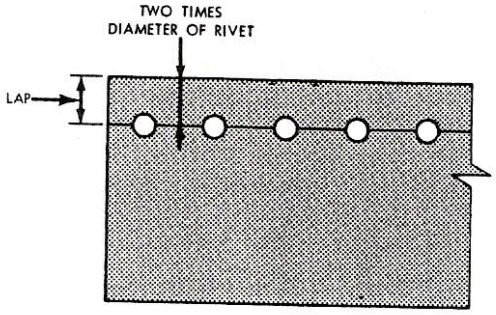
F1athead, snap head and countersunk rivets may be purchased in various lengths depending upon the thickness of the metal being joined.

There are no definite rules to follow in selecting the size of a rivet. In general the length should be sufficient to protrude through the pieces being joined, this is usually from about l½ times the diameter of the rivet. This allows ample material for forming the head.



4.4 Spacing Rivet Holes

Rivet holes should be spaced according to the job specification. The space from the edge of the metal to the centre of the rivet line should be at least twice the diameter of the rivet, thus preventing the rivet from tearing out. The minimum distance between the rivets should be three times the rivet diameter approximately. The maximum distance between rivets should never be such that the material is allowed to buckle or fish mouth between them.



4.5 Defects in the Riveted Joint

When making joints with rivets, the following points should be followed to prevent many common defects:

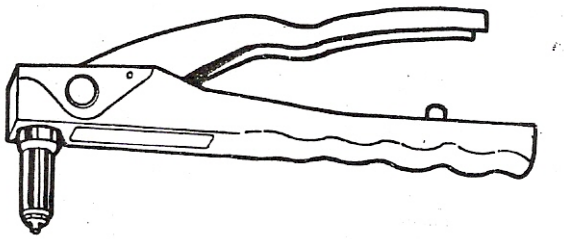
- Use the correct allowance for edge clearance and pitch when marking out;
- All drilled or punched holes should be made to the correct clearance size to suit the rivet diameter, or as specified on the drawing;
- Remove any 'burrs' from around the edges of all holes before finally assembling the parts to be joined;
- Ensure that holes are correctly aligned and matched before inserting the rivet;
- Use the proper type of rivet as specified on the drawing;
- Use rivets of the correct length;
- When inserting rivets, do not attempt to force or drive them into the hole;
- Always use the correct tools for the job.

4.6 Pop Riveting Guns

“Pop” Riveting Guns are used extensively with “pop” rivets for the assembly of light fabrications and are particularly useful for the assembly of cladding where access is restricted to one side of the work only. There are three different types available: hand “pop” gun, lazy tongs and pneumatic (air).

Hand "Pop" Gun

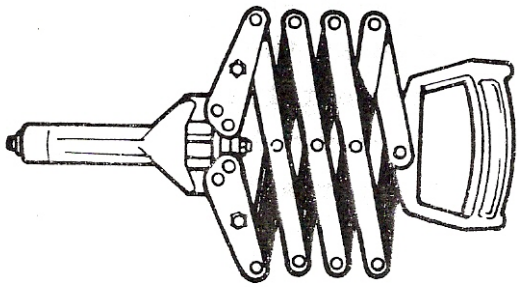
Riveting in confined spaces requires the use of a hand "pop" gun. These are unsuitable for larger dimensions of rivets, due to the reduced amount of leverage available.



Hand "Pop" Gun

Lazy Tongs

Lazy Tongs are used for the larger diameters of rivets, where sufficient working space is available to permit operation of the tool. The construction of the tool permits a moderate pressure on the handle to provide a strong pulling force on the rivet mandrel. Eye protection should be worn at all times when using these tools as the waste shaft of the "pop" rivet can exit the gun at high speed.



Lazy Tongs

4.7 Drilling

Drilling holes to the proper size and spacing for the riveted seam determines to a large extent the strength and appearance of the joint. Using a power operated drill or a battery drill to drill rivet holes requires skill and accuracy. The apprentice should take great care when using these machines as inexperience can lead to accidents and injury. Always refer to the manufacturer's manuals for the correct drill speeds and settings before operating a power drill or battery drill.

4.8 Safe Handling of Portable Power and Battery Drills

Portable power drills and battery drills are one of our most useful tools and with care, they can be among the safest. But electric drills can be dangerous if not handled carefully. They can cause injuries in many ways – from being struck by flying material from the drilling process to eye injuries, face injuries or electric shock.

When drills are treated roughly, dropped or hit against things, or if they get wet, their insulation can weaken. Without proper insulation you may have a "live" drill in your hand. Then, if you stand in a wet place, sit on a steel beam or floor plate or if you're very sweaty, the drill can give you a shock which could be fatal.

Before starting a drilling job, look the drill over carefully. Locate any hazards and decide on a safe plan of action. Here are some points to check:

1. Thoroughly review and understand information provided in the portable power drill operator's manual with particular attention given to descriptions of safety procedures.
2. Before using the equipment always inspect the portable power drill for damage. In addition, make sure the drill chuck is functioning properly and inspect the electrical cord and battery to make sure all are working correctly.
3. If the portable power drill fails your inspection, notify your supervisor and remove the portable power drill from service.

Operating Precautions

- Never wear a tie, loose clothing or jewellery when using a portable power drill. Tie long hair back or secure under a cap. Always wear safety glasses or goggles when drilling.
- Only use a 110 volt drills in the workshop and on site.
- Avoid using a portable electric drill when it is raining or in wet conditions.
- Use the correct drill bit for the type of material to be drilled to suit the task at hand.
- Before inserting a battery or plugging in a portable power drill, turn the power switch off.
- Make all portable power drill adjustments with the power switch off and the drill unplugged.
- Insert the drill bit into drill chuck and tighten with the chuck key. Remove the chuck key from the drill chuck before starting the portable power drill. Start the drill to ensure that the drill bit is fitted correctly in the chuck.
- Keep your hands and fingers away from the rotating drill chuck and bit.
- Do not force a drill bit against the work piece being drilled. If a drill bit is not penetrating properly, turn the drill off and change the drill bit.

- Use caution when changing drill bits, as they are sharp and can become hot during use
- Only recharge a portable power drill battery or battery pack with a battery charger recommended by the manufacturer.
- Always use the type of battery or battery pack specified for the portable power drill.
- Never carry a portable power drill by the power cord.
- When carrying a portable power drill, turn the drill off and keep your index finger away from the power switch.
- Never stop the rotation of the drill chuck or bit with your hands or fingers.
- Always clean your work area upon completion of the drilling task.

When you finish drilling, replace the drill in its case. Never leave your power drill plugged in while not in active use. When returning the drill to the tool room or carrying it to a jobsite, take out the bit. This eliminates the chance of your stabbing yourself or a co-worker; even a dull bit can dig into flesh quickly and cause serious harm.

Summary

Mechanical drawings are a method of communicating and exchanging ideas within industry. Multi-view orthographic projection is used in engineering drawing. There are two systems of projection, First Angle and Third Angle, which are based on a framework of planes at right angles. In first angle projection, each view shows what would be seen by looking on the far side of an adjacent view. In third angle projection, each view shows what would be seen by looking on the near side of an adjacent view. Grid paper is used for drawing free hand sketches of a component.

During the manufacturing process of any part or fitting the apprentice will use the skills and knowledge he/she has learned in the workshop. These skills include : marking out, cutting, folding, drilling and final assembly of the part or fitting. It is important that the apprentice has a good understanding of each of these skills to ensure that the part or fitting is manufactured correctly and in a safe manner.

SOLAS
An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Castleforbes House
Castleforbes Road
Dublin 1