MEM05 Metal and Engineering
Training Package

MEM05038B
Perform advanced geometric development
cylindrical/rectangular

Learner guide
Version 1

Training and Education Support
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Meadowbank

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Table of Contents

Introduction ..................................................................................................... 7

1. General introduction ................................................................................. 7
2. Using this learner guide .............................................................................. 7
3. Prior knowledge and experience ............................................................... 8
4. Unit of competency overview .................................................................... 8
5. Assessment .................................................................................................. 10

Topic 1: Principles of parallel line development .............................................. 13

Uses and applications ..................................................................................... 13
Patterns and templates ..................................................................................... 13
Labelling and storage of templates ................................................................ 14
Developing cylindrical/rectangular/square branch connections (penetrations) ........................................................................ 15
Determination of true length of lines (TL) ....................................................... 15
Calculation of pattern blanks ......................................................................... 16
Folded sections .................................................................................................. 17
Square and radiused corners ......................................................................... 17
Estimating quantities of materials from drawings ........................................ 19
Calculating areas ............................................................................................. 19
Packing and nesting ....................................................................................... 21
Safety ................................................................................................................. 22
Review Questions ............................................................................................. 23

Topic 2: Parallel development of complex shapes .......................................... 25

Determination of true shape (TS) ................................................................ 25
Determination of true shape of section (TSS) ............................................... 25
The ellipse .......................................................................................................... 26
Practical methods of constructing an ellipse .................................................. 26
Geometric construction of an ellipse ............................................................. 27

Approximation of an ellipse ........................................................................... 27
Circumference of an ellipse ............................................................................ 28
Review Questions ............................................................................................. 29

Suggested practical jobs and projects ........................................................... 31

Job 1: Standard square notched corner ......................................................... 32
Job 2: External mitred corner .......................................................................... 34
Job 3: Recessed mitred corner ......................................................................... 36
Job 4: Box gutter mitred corner ...................................................................... 38
Job 5: Radiused edge corner .......................................................................... 40
Job 6: Box gutter corner .................................................................................. 42
Job 7: Rainwater head ..................................................................................... 44
Job 8: Square ogee hood ................................................................................ 46
Job 9: Compound bend ................................................................................... 48
Job 10: Compound curve reducing elbow ..................................................... 50
Job 11: Offset cylinder ................................................................................... 52
Job 12: Flaring section .................................................................................... 54
Job 13: Two way branch in round pipe .......................................................... 56
Job 14: Unequal diameter intersection ......................................................... 58
Job 15: Flashing piece for ridge of a roof ....................................................... 60
Job 16: Intersection of elbow and cylinder ................................................... 62
Job 17: Intersection of square and cylindrical branch .................................... 64
Job 18: Hood .................................................................................................... 66

Terms and definitions ..................................................................................... 68

Resource Evaluation Form ............................................................................. 69
Topic 1: Principles of parallel line development

Pattern development in the metal fabrication industry

Pattern development is used to produce templates or to develop a single pattern which is then cut, formed, joined, assembled, finished and installed to become a completed article.

Methods of pattern development

There are three (3) common methods of developing pattern/templates which include:
1. Parallel line.
2. Radial line.
3. Triangulation.

Patterns based on the above methods may also be generated by computer packages such as Fastshapes, Fastcam or Fastplot etc.

The method used will depend upon the geometric form of the article. In this unit, we will apply the parallel line development method to develop patterns for complex shapes.

Uses and applications

Parallel line development is used in the following occupational areas of the sheetmetal industry.

- **General manufacture:** storage containers and fire tanks
- **Ventilation/air-conditioning:** ductwork, cowls and hoods
- **Stainless steel:** kitchen sinks, food preparation equipment and handrails
- **Cubicle manufacture:** switchboards, cabinets and cupboards
- **Rainwater fittings:** rainwater heads, downpipes and roof flashings

Applications

Parallel line development is used in industry to develop patterns for articles which have parallel sides. This method is based on a system of lines drawn parallel to one another on the surface of a material to allow forming of a hollow prism or cylinder. The prism must have a constant cross section equal in shape (constant true shape) and size, throughout the length of the prism.

To identify an article where patterns may be developed using this method, you must determine the true shape of section (TSS) of the article and in most cases the sides in the front view are parallel. Complex irregular shapes including hoods, compound curves-bends and elbows can be developed using this development method.

- The following articles are typical of those developed using the principles of parallel line development:

  ![Pattern Examples](image)

  - (a) Rainwater head
  - (b) Compound curve
  - (c) Moulding

Patterns and templates

Use of patterns

Parallel, radial line and triangulation development methods are used to produce patterns either directly onto the material to be formed or on a sheetmetal template as an overlay.

Use of templates

A template is a piece of material which is marked out and cut to the exact size and shape of the product to be made. Templates can indicate the exact location of holes and slot centres, allowances for edges, seams, notches, bend lines and production instructions for forming.

They are used to reduce the need for repetitious marking out and drilling. Templates are also used to check the forming and assembly of fabrications. When templates are used repeatedly they are made from thicker and/or harder material to avoid wear or damage.

Wrap around templates are an important aid when fabricating components from pipe or tube. Wrap around template allows quick marking of pipe bends and connections. Templates are normally made of cardboard or sheetmetal so they can easily wrap around the outside of the pipe or tube.

**Note:** When using wrap around templates always check the outside diameter of the pipe or tube supplied.

Because the template is wrapped around the outside of the pipe, the outside diameter of the pipe or tube is used to calculate the length of the template. The template is then cut to shape and wrapped around the pipe, engineers chalk or a scriber is then used to trace around the template. Once this is done the pipe is then cut to the required shape to give a close fitting joint.

Templates must be clearly labelled, secured together (if there is more than one) and safely stored for future identification and use.
Labelling and storage of templates

Some important points to include are:

- Job number or name/title of the template
- Part or item number
- Name of the person who produced the template
- Date the template was produced
- Sizes of the finished item
  - Height
  - Length
  - Width
  - Thickness
  - Angles
  - Shape.

Note: Identification details need to be made with a durable marker that won’t remove or fade easily.

Storage

Cardboard or even paper templates need to be filed according to their job number or job type and stored in an office, storeroom or cabinet to prevent damage. Templates are usually stored flat on wide shelves which are also labelled.

Storage tubes are suitable for paper templates. Sheetmetal templates can be stored flat on wide shelves or hung in a convenient location.

Labelling

To identify lines and points the fabricator must use a labelling system. There is no standard labelling system however; it is common practice to use letters, numbers or a combination of both. Fabricators will use a system they are most familiar with when developing patterns.

When using the parallel line development method it can be an advantage to use one letter or number to identify the same point and line in each view.

Labelling patterns

To develop patterns a labelling system is used to identify parallel generator lines and points. To label the views for rectangular, square and cylindrical articles the following procedure is normally used:

1. Identify the position of the seam on the view showing the true shape of section (TSS).
2. Label the view, starting at the seam, in a clockwise direction.
3. Label the remaining views to correspond.

Note: The position of the generators will vary from view to view. The number of divisions of a circle will depend upon its diameter.

Methods commonly used to label folded or curved sections are shown below.
Developing cylindrical/rectangular/square branch connections (penetrations)

Branch connections have a variety of applications in the fabrication industry. Typical applications include:

- Air-conditioning and ventilation ducting
- Mill extraction systems
- Pipelines for liquid and gases
- Pressure equipment
- Handrails.

Branch connections and can be fabricated from ferrous and non-ferrous sheet, coil, plate, tube and pipe materials. They usually comprise of two components, the main duct and the branch duct. These components can vary in size and shape.

Branch duct connections to the main duct may be on centre, off centre or inclined at an angle to the main duct. Some examples are illustrated below.

Remember, parallel line is a development method applied to an object which has sides that are parallel. The outside of the object can be divided into a series of parallel lines and then the true length of these lines can be found and transferred onto a flat pattern.

Due to the object having parallel sides it is easy to use this method to develop the patterns for branch connections. Pattern developments can be marked onto a template material (cardboard or sheetmetal) and used as a wrap round template for pipe/tube connections.

Two patterns are required for branch connections, one for the branch duct and the other for the hole in the main duct. It is important to determine whether you need both views or only one view of the branch connecting to the main duct.

Different types of branch connections need either one to two views. You will also need to determine the line of intersection where the main and branch duct connect (penetrate). When developing patterns for branch ducts:

- All generator lines must be labelled and appear on the branch duct.

If both the main and branch duct are equal in diameter the line(s) of intersection will appear to be straight in the front view.

If the diameters of the main and branch duct are unequal the lines of intersection will be curved.

Determination of true length of lines (TL)

Identification of lines and points is very important when developing patterns and templates using geometric development methods. When interpreting the views on a drawing you must be able to identify the lines which are true length (TL). Lines shown on a drawing may appear to be an actual true length but this is not always the case.

Example

The illustration below shows a ladder leaning against a wall. The true length of the ladder can only be seen by viewing from the side. The ladder would appear shorter in length in both the front and top views.

On any front, top or side view, some lines are true lengths. The lines which are not true lengths must be identified so their true length can be determined. On a drawing, lines which are at 90° to the viewer’s line of vision are natural true lengths. Lines which are inclined at an angle towards or away from the viewer are not true lengths.
To determine if a line is a true length the drawing must show the line projected into two (2) or more views. Illustrated below are five (5) examples of how a line must be viewed to determine its true length.

If none of these examples apply, then the line is not a true length. When producing patterns using the parallel line method of development all generator lines used to mark out the pattern must be true lengths.

These principles apply to all geometric development methods and form a basis on which the true shape (TS) and true shape of section (TSS) or profile view of components can be determined.

**Calculation of pattern blanks**

When the true shape of section and true length of lines/generators has been established calculations can be applied to determine the cutting sizes for the pattern blank. The length of the pattern blank will equal the stretch-out of the true shape before forming.

The width would be equal to the longest true length generator line on the prism. Allowances for metal thickness and seams must also be taken into account. When calculating pattern blanks the inside dimensions are to be used. Calculation of pattern blank sizes will ensure maximum economy of material.

**Example**

Determine the cutting size of the pattern blank required for the folded section draw below.

Pattern blank = Perimeter x length of section

\[
\begin{align*}
A-B &= 100 - 1 = 99 \\
B-C &= 220 - 2 = 218 \\
C-D &= 350 - 2 = 348 \\
D-E &= 220 - 2 = 218 \\
E-F &= 150 - 1 = 149 \\
\text{Totals} &= 1040 - 8 = 1032
\end{align*}
\]

In this case the total bending allowance is 8 mm

Cutting size = 1032 mm x 450 mm.

**Note:** Calculations using zero bending allowance are not always accurate as the bend may have a radius.