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<th>Sheetmetal Fundamentals</th>
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<td>Unit 7:</td>
<td>Tapping, Threading and Assembly</td>
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Module 1 – Sheetmetal Fundamentals

Unit 7 – Tapping, Threading and Assembly

Duration – 3.5 Hours

Learning Outcome:

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

- Select appropriate drill sizes for tapping
- Drill and tap a range of hole sizes, metric and imperial
- Cut a range of threads on round BMS
- Select correct lubricant for tap and die threading
- Fit threaded bar into tapped holes

Key Learning Points:

<table>
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<th>Rk</th>
<th>Metric and Imperial taps and dies.</th>
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<td>Rk</td>
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<td>Rk</td>
<td>Tapping sizes (Zeuc chart) and types.</td>
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<tr>
<td>Sc</td>
<td>Friction.</td>
</tr>
<tr>
<td>Sc</td>
<td>Principle of moments and application to problems.</td>
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Training Resources:

- Apprentice tool kit
- Selection of drills
- 75x10x60 Long BMS
- Drawings 2.1.6 (A,B)
- Die Handle
- Taps and dies
- 12mm Dia. Round Bar
- Bench vice
- Tap wrench
- 120 Long BMS
- Instructor demonstrations
Exercise:

Complete sample exercise numbers 2.1.6 (A,B).

Key Learning Points Code:

\[ M = \text{Maths} \quad D = \text{Drawing} \quad RK = \text{Related Knowledge} \quad Sc = \text{Science} \]

\[ P = \text{Personal Skills} \quad Sk = \text{Skill} \quad H = \text{Hazards} \]
Friction and Lubrication

Friction

Friction is the resistance to motion which takes place when one body is moved upon another, and is generally defined as "that force which acts between two bodies at their surface of contact, so as to resist their sliding on each other." The force of friction, $F$, bears according to the conditions under which sliding occurs - a certain relation to the pressure between the two bodies; this pressure is called the normal pressure $N$. The relation between force of friction and normal pressure is given by the coefficient of friction, generally denoted by the Greek letter. Thus:

$$F = \mu \times N, \text{ and } \mu = \frac{F}{N}$$

Example: A body weighing 8 pounds rests on a horizontal surface. The force required to keep it in motion along the surface is 7 pounds. Find the coefficient of friction.

$$\mu = \frac{F}{N} = \frac{7}{8} = 0.875$$

If a body is placed on an inclined plane, the friction between the body and the plane will prevent it from sliding down the inclined surface, provided the angle of the plane with the horizontal is not too great.

There will be a certain angle, however, at which the body will just barely be able to remain stationary, the frictional resistance being very nearly overcome by the tendency of the body to slide down. This angle is termed the angle of repose, and the tangent of this angle equals the coefficient of friction. The angle of repose is frequently denoted by the Greek letter. Thus $\pi = \tan \theta$. 
A greater force is required to start a body from a state of rest than to merely keep it in motion, because the friction of rest is greater than the friction of motion.

1. Nature of friction - when one surface rubs against another the resistance to sliding is called friction.
2. Nature of resistance - magnification shows roughness of apparently smooth surfaces. These surface asperities interlock and prevent free sliding.
3. Reducing friction between moving surfaces:
   a) Reduction of surface asperities by mechanical means. Cannot be fully eliminated.
   b) The interjection of a lubricant between the surfaces.
4. Action of a lubricant:
   "Oiliness" - define - Effect of friction (no lubrication) - asperities of surfaces rubbing together generate heat. Heat causes fusion or welding of asperities. Welding causes the asperities to be torn from each surface causing scoring and running of bearings. Lubrication - reduces friction and force necessary to produce motion. Reduced temperature rise but does not eliminate. Heat thins the lubricant.

**Figure 1 – Effect of Lubricant on Friction**
Lubricants and Lubrication

A lubricant is used for one or more of the following purposes:

1. To reduce friction
2. To prevent wear
3. To prevent adhesion
4. To aid in distributing the load
5. To cool the moving elements, and
6. To prevent corrosion.

The range of materials used as lubricants has been greatly broadened over the years so that in addition to oils and greases many plastics and solids and even gases are now being applied in this role. The only limitations on many of these materials are their ability to replenish themselves, to dissipate frictional heat, their reaction to high environmental temperatures, and their stability in combined environments. Because of the wide selection of lubricating materials available, great care is advisable in choosing the material and the method of application. The following types of lubricants are available:

1. petroleum fluids
2. synthetic fluids
3. greases
4. solid films
5. working fluids
6. gases
7. plastics
8. animal fat
9. metallic and mineral films, and
10. vegetable oils.
Hand Tapping

Tap wrenches are tools used to hold and turn a tap when producing internal threads by hand. They are made from steel and usually have:

- Centrally placed jaws for holding a range of different sized taps.
- Means of adjusting the size of the jaw opening.
- Handles to turn the tap.

Hand taps are made from carbon or high speed steel that is hardened and tempered and have:

- Accurately cut or ground external threads.
- Chamfers ground on the leading threads of the tap to allow easy starting.
- Three or more flutes to form cutting faces on the external threads and channels for removal of chips.
- The ends of their shanks squared to allow them to be gripped firmly in the tap wrench.
- Markings on the shank to indicate the size and type of thread.

![Figure 2 - Hand Tap](image)
Types of Tap Wrenches

Bar-Type

Bar-type tap wrenches have a flat centre section holding jaws shaped to grip the squared end of the tap. One sliding jaw is adjusted by a screw operated by rotating one of the handles about its axis. The ends of the two handles are knurled.

![Bar Type Tap Wrench](image)

Tee-Type

Tee-type tap wrenches have a small adjustable two-jaw chuck on the end of a stem with a handle. The largest capacity takes taps up to 13 mm in size. One hand is used to turn the handle.

!["T"-Type Tap Wrench](image)
Pin Chunks

Pin chucks for delicate tapping of small threads in instruments. Pin chucks have a very small adjustable two-jaw chuck mounted on the end of a knurled rod.

Figure 5 - Pin Chunk for Instrument Threads
Types of Taps

Taps are normally used in sets of three, to allow progressive cutting of the threads.

Regular hand taps are used for most general work. Each set consists of a taper, intermediate and plug or buttoning taps. Each tap in a set has identical length and thread measurements and only the tapered lead is different.

- The Taper Tap should always be used to start the thread. Through holes can be completely threaded with the taper tap.

- Use the Intermediate Tap in deep through holes and in blind holes.

- Use the Plug or Bottoming Tap to complete the thread to the correct depth in a blind hole.
Holes for Tapping

Holes of the correct size and condition are essential for successful tapping. The importance of drilling tapping holes correctly is shown in Figure 6.

For deep hole tapping or average commercial work a thread depth of 60% - 70% will usually provide a greater strength than that of the mating screw.

For correct drilling:
- Use correct tapping size
- Have drill correctly sharpened
- Clear swarf from blind holes

Figure 6 - Holes for Tapping
### Tapping Drill Sizes for ISO Metric Threads

<table>
<thead>
<tr>
<th>Nom. Dia. Tap m/m</th>
<th>Pitch m/m</th>
<th>Tapping Drill</th>
<th>Nom. Dia. Tap m/m</th>
<th>Pitch m/m</th>
<th>Tapping Drill</th>
</tr>
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<tbody>
<tr>
<td>2.0</td>
<td>0.40</td>
<td>1.65 or 1.60 m/m</td>
<td>14.0</td>
<td>1.50</td>
<td>12.50 or 12.60 m/m</td>
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<tr>
<td>2.2</td>
<td>0.45</td>
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<td>12.80 or 12.90 m/m</td>
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<tr>
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<td>0.45</td>
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<td>14.50 or 14.60 m/m</td>
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<td>0.60</td>
<td>2.95 or 2.90 m/m</td>
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<td>2.50</td>
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<tr>
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<td>0.80</td>
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<td>2.50</td>
<td>17.50 or 11/16&quot;</td>
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Table 1 - Tapping Drill Sizes for ISO Metric Threads
The formulae below are used for calculating the depth of threads:

\[
\begin{align*}
P &= \text{pitch} \\
\text{ISO} &= 0.6495 \times P \\
\text{BSW} &= 0.640 \times P \\
\text{BA} &= 0.600 \times P
\end{align*}
\]

**Tapping Drills for Fractional Inch Size Taps**

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<td>44.5 m/m 46.5 m/m</td>
<td>1.27/32&quot;</td>
<td>1.27/32&quot;</td>
<td>1.25/32&quot;</td>
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Table 2 - Tapping Drills for Fractional Inch size Taps
# Tapping Drills for Taps with a Designating Number

<table>
<thead>
<tr>
<th>No.</th>
<th>B.A.</th>
<th>N.C. U.N.C.</th>
<th>N.F. U.N.F.</th>
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<td>1.50 m/m</td>
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<td>1.85 m/m</td>
<td>1.90 m/m</td>
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<td></td>
<td>5/32&quot;</td>
<td>1.80 m/m</td>
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<td>3/32&quot;</td>
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<td>2.90 m/m</td>
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<td>7</td>
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<td>-</td>
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<td>-</td>
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<td>3.50 m/m</td>
<td>9/64&quot;</td>
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<td>3.50 m/m</td>
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<td>9</td>
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<td>-</td>
<td>-</td>
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<td>1.50 m/m</td>
<td>-</td>
<td>-</td>
</tr>
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<td>10</td>
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<td>3.90 m/m</td>
<td>4.10 m/m</td>
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<tr>
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<td>3.80 m/m</td>
<td>4.05 m/m</td>
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<td>11</td>
<td>1.20 m/m</td>
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<td>3/64&quot;</td>
<td>-</td>
<td>-</td>
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<tr>
<td>12</td>
<td>1.05 m/m</td>
<td>4.50 m/m</td>
<td>4.70 m/m</td>
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<tr>
<td></td>
<td>1.00 m/m</td>
<td>4.40 m/m</td>
<td>4.60 m/m</td>
</tr>
</tbody>
</table>

Table 3 - Tapping Drills for Taps with a Designating Number
B.A. - British Association  
N.C. - National Coarse  
U.N.C. - Unified Coarse  
N.F. - National Fine  
U.N.F. - Unified Fine

Tapping a Through Hole

The method of tapping a through hole is shown in the following sequence:

![Figure 7 - Tapping a Through Hole](image-url)
Tapping a Blind Hole

Blind holes cannot be tapped right to the bottom. As the tapping hole is drilled, depth gauge on the drilling machine should be used. The depth of the hole should be greater than the depth of thread required.

A nut on the top to act as a stop can be used.

Use normal tapping procedures but clear out chips frequently.

Clear chips from the job by inverting small jobs.

Never blow out chips with compressed air.

If excessive resistance is felt before the measured depth is reached, clear out all the chips and try again with the taper tap. Repeat the procedure of changing taps until the correct depth is reached.

Figure 8 - Tapping a Blind Hole
Hand Threading

The stock is the tool used to hold and turn a threading die when producing external threads by hand.

Stocks are made from mild steel or malleable cast iron and usually have:

- A central recess for holding one of a range of different sized dies.
- Means of slightly adjusting the size of the die to alter the depth of the thread cut.
- Provision for guilding the die.
- Knurled handles to turn the die

![Figure 9 – Stock](image)

Dies are made from alloy tool steel that is hardened and tempered and have:

- Accurately cut internal threads.
- Three or more flutes to form cutting edges on the internal threads and cavities for removal of the chips.
- Chamfers ground on the first few threads of the leading end of the die to allow easy starting.
- Some form of split or division to permit a very small adjustment to the depth of thread they cut. Screws in the die or in the stock or both are used for this adjustment.

![Figure 10 - Large Button Die](image)
The size and type of threads is marked on the die.

The cutting size marked on the die corresponds to the maximum diameter of the material to be threaded. Use on oversize material will damage the die.

Round sections and pipes are prepared for threading by filing, cutting or grinding a small chamfer on the end. To start a thread, insert the die with its leading end and face on the leading side of the stock.

![Figure 11 - Starting a Thread](image)

**Types of Stocks and Dies**

Button-type stocks are solid stocks with a shoulder and locking screws. They hold a single piece disc-shaped diameter.

![Figure 12 - Button Pattern Stock with Button Die](image)
Quick cut stocks are designed to hold two-piece adjustable dies.

These dies usually have a double level on their outer sides to match the stock. The dies may be held in the cap or collet into which a guide is screwed. Adjusting screws in the cap bear on the back of the die halves. Greater adjustment of the depth of thread is possible with two piece dies.

![Figure 13 - Assembling a Two-Piece Die](image)

![Figure 14 - ????](image)
Elastic-type stocks have one side split and fitted with a clamping screw. Pins in the recess of the stock locate a guide plate.

Figure 15 - Elastic Type Stock
Diagrammatic Sequence of Cutting a Thread

After grinding the chamfer on the edge of the material; the sequence for cutting the thread is shown in the following diagram.

Figure 16 - Cutting a Thread
If the thread has to be run right to the shoulder:

- Screw the die until its leading face is just clear of the shoulder.
- Reverse the screwing action and take the die off the thread.
- Remove the die and reverse it in the stock.
- Run down the new thread until the other face of the die just contacts the shoulder.

Figure 17 - Cutting a Thread to a Shoulder
Self Assessment

Questions on Background Notes – Module 1.Unit 7

1. There are six basic steps to remember when using a Folding Machine. List three.

2. There are five points to observe regarding safety when operating a Folding Machine. List three.
3. There are seven points to observe if you are to take good care of a Folding Machine. Name three and say why you would or would not do those things.

4. Name four types of Projection.
5. Draw the type line used for the following:

   a. Visible Outlines
   b. Dimension Projection
   c. Break lines
   d. Hidden outlines
6. What does an Orthographic Drawing indicate?

7. What two types of Orthographic Projection are there?
Answers to Questions 1-7. Module 1.Unit 7

1.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Allowance for material thickness.</td>
</tr>
<tr>
<td>b.</td>
<td>Sharpness of the folder.</td>
</tr>
<tr>
<td>c.</td>
<td>Width of lock or edge.</td>
</tr>
<tr>
<td>d.</td>
<td>Adjustment for material thickness; edge.</td>
</tr>
<tr>
<td>e.</td>
<td>Angle of fold.</td>
</tr>
<tr>
<td>f.</td>
<td>Type of material.</td>
</tr>
</tbody>
</table>
2.

a. Before use ensure all blades are securely fitted.

b. Do not place your hand in machine when someone else is operating the handle.

c. When operating the machine see that no one is near enough to the counterbalance weights to be hit.

d. Stand well back from front handle.

e. Never swing on counter weights.
3.

   a. Never Bend rods or wire in the machine.

   b. If you must pound on metal job in machine use a wooden or rubber mallet.

   c. Machine should be level and bolted to the floor.

   d. Oil all moving parts.

   e. Don’t exceed capacity of machine.

   f. You can again considerable mechanical advantage through clamping down the handle nearest the work first and then the other handle.

   g. Do not use pipe extension on brake handles to clamp down the work. This will over strain the machine.
4.

- Oblique
- Isometric
- First Angle
- Third Angle

5.

Visible Outlines
Dimension Projection
Break Lines
Hidden Outlines
6.

An orthographic drawing indicates the shape of a component by using a number of views.

7.

First Angle: The plan is on the bottom.

Third Angle: The plan is on the top.
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