Trade of Toolmaking	
Module 2:	Turning
Unit 1:	Machine Controls and Operations
	Phase 2

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Document Release History

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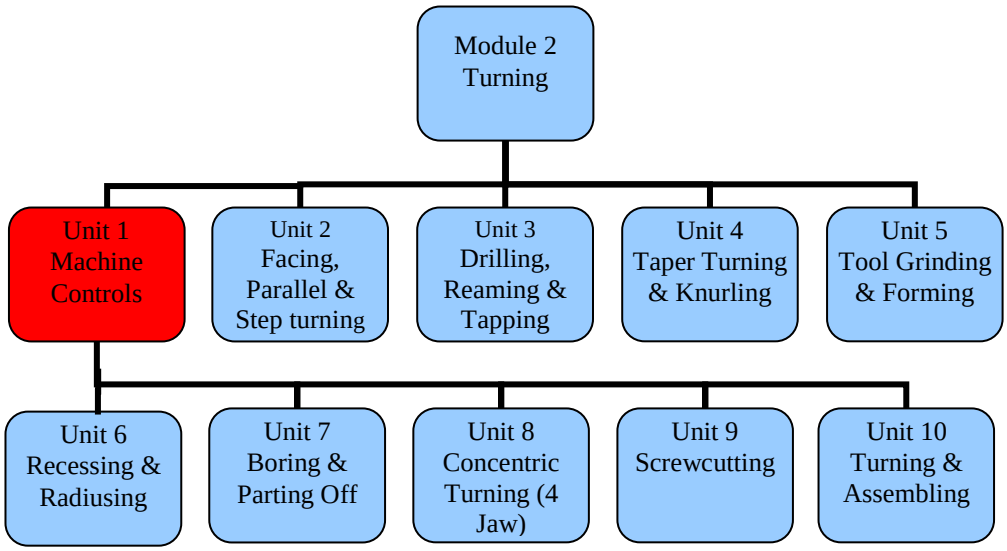
Unit Objective

On completion of this unit you will be able to operate a lathe, describe the functions and features of the lathe, identify and safely operate all leavers and controls.

Introduction

Module two of this course covers turning. This is the first unit in module two and introduces the techniques associated with operating a lathe. The workpiece to be machined is normally held and rotated in a chuck, but can also be held on a face plate or between centres. A cutting tool is fed along the work to produce a cylindrical shape or across the work to create a flat surface. The spindle speed can be varied to suit the material and the diameter of the part being turned. Other operations include drilling, reaming and thread cutting.

A general purpose lathe is called a Centre Lathe and is used in most workshops and Toolrooms. The centre lathe is used for one-off components or low volume work. For high volume production, lathes such as the Capstan, Turret and CNC Turning Centres are used.



By the end of this unit you will be able to:

- Apply the appropriate safety precautions when operating the centre lathe
- Identify and describe the function of the main parts and features of the lathe.
- Identify and safely operate all leavers and controls i.e. isolation switch, emergency stop and brake.

1.0 Safety Precautions When Operating The Centre Lathe

Key Learning Points

Safety and hazardous situations. Professional attitude towards safety and job planning

1.1 Safety And Hazardous Situations

When using a lathe, safe working procedures need to be applied. Wear safety glasses at all times. Keep hands away from swarf and use a long handed rake to remove swarf, only after the lathe has been stopped. Wear suitable protective clothing. Loose clothing, long sleeves, ties and long hair are a source of danger and therefore should be securely contained. Remove the chuck key immediately after use. Keep the area around machine clean and tidy and free from wet or oily patches.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 1, *Safe practices*.
ISBN-13: 9780750660730

1.2 Professional Attitude Towards Safety And 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 workpiece should be cut from bar stock using the bandsaw. The sequence of operations should be planned so as to minimise the number of setups in the chuck.

2.0 Identifying The Functions And Features Of The Lathe

Key Learning Points

Identification and description of the main parts of a centre lathe. Methods of describing centre lathe capacity. Knowledge and understanding of functions and features of a centre lathe. Standard lathe accessories. Safe mounting of 3-jaw self centring and 4-jaw jaw chucks. Tailstock location and clamping, morse tapers. Ratios, proportion and percentages.

2.1 Identification And Description Of The Main Parts Of A Centre Lathe

The lathe is made up of various parts, such as the: **Headstock -** located on the left hand side of the machine and houses the gearbox and the spindle. **Bed** – a strong bridge-like structure made from cast iron. Its upper surface carries the main slideways. **Chuck** – work holding device that can be locked onto the spindle. **Carriage** – controls the movement of the cutting tool and consists of a number of parts such as the Cross Slide, Tool Post, Top Slide, Saddle and the Apron, **Tail Stock** – located at the opposite end of the headstock and can be moved along the bed slideways. It can be used to hold the workpiece between centres or can be used to drill or ream the workpiece.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 140.
ISBN-13: 9780750660730

2.2 Methods Of Describing Centre Lathe Capacity

The capacity of the lathe refers to the size of work that it can accommodate. Heavy work should not be carried out on a small capacity lathe and also small components being manufactured on a large capacity lathe is not cost effective.

The following terms indicate how the capacity of a centre lathe is determined:

Height of centre: The distance from the centre of the spindle to the bed indicates the maximum diameter of work that can be machined.

Length of bed: This is the total length of the bed.

Distance between centres: The distance that can be machined between centres, which is less than that of the length of the bed.

Diameter of spindle hole: The diameter in the spindle hole gives the maximum diameter of long bars that can be machined.

2.3 Knowledge And Understanding Of Functions And Features Of A Centre Lathe

The *Headstock* houses the gearbox, the spindle and the main motor. The motor drives the gearbox and the spindle through a series of vee belts.

The angled slideways of the *Bed* guide the *saddle* on which the Cross Slide, Tool Post, Compound Slide, Saddle and the Apron are attached.

The *Carriage* consists of the Cross Slide, Tool Post, Compound Slide, Saddle and the Apron.

- The Cross Slide is mounted on the dovetail slideways and is driven by a leadscrew. It moves at right angles to the axis if the spindle.
- The Tool Post is used to secure the tool in plate and can be adjusted to the required angle.
- The Top Slide, can also be called the compound slide, is mounted on the dovetail slideways and is driven by a leadscrew, which is rotated by hand. It is aligned to the axis if the spindle, but can be unlocked and rotated to the required angle, when manually turning a tapered workpiece.
- The Saddle is mounted on the guideways of the bed and supports all the above parts.
- The Apron is placed on the front of the lathe and attached to the saddle. It houses the gears and mechanisms for controlling the above parts. On the front of the apron is the hand wheel for controlling the movement of the carriage and the levers control the automatic feeds.

The *Chuck* is used to hold the work while it is being turned. The most common types of chuck are the 3-jaw, the 4-jaw and the collet chuck.

The *Tail Stock* is used to hold the workpiece between centres or can be used to drill or ream the workpiece.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 140.
ISBN-13: 9780750660730

2.4 Standard Lathe Accessories

Standard lathe accessories are as follows:

- 3-jaw self centring chuck. It is easy to use, as the work piece is self centred. The chuck can hold cylindrical and hexagonal bars.
- 4-jaw independent jaw chuck.
- Chuck key used to open and close the chuck.
- Steadies are used when turning long workpieces. A two point travelling steady supports the work while it is being turned.
- The Face Plate is a round flat plate that can be held in the spindle. It is used for irregular workpieces that cannot be held in a chuck. It has slots that allow the work to be clamped onto the face.

For holding a workpiece between centres, a centre is inserted into the spindle and another is inserted into the tailstock. A work driver plate is attached to the spindle. To drive the work, a carrier is attached to the workpiece which is driven by the work driver

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 140.
ISBN-13: 9780750660730

2.5 Safe Mounting Of 3-Jaw Self Centring And 4-Jaw Jaw Chucks

When removing or fitting a chuck, first place a board on the bed slide ways in order to protect them. A key is used to loosen the cam lock nuts, which are rotated until the indicator marks line up. The chuck should be held with the right hand, while a mallet tapped against the

chuck to remove it from the taper. Both hands should be used to hold the chuck at the sides, not underneath. The chuck should be slowly lowered slowly onto the board.

When lifting the chuck, it is important to keep your back straight and bend your knees when lifting or lowering the chuck. Ensure that the floor space around the lathe is free from debris, oil or coolant. These chucks are heavy, especially the 4-jaw chuck. If you have difficulty lifting or fitting these chucks, ask for help.

When fitting the chuck, it should be carefully lifted onto the board, which should be placed on the bed slide ways. A clean cloth should be used to clean the back face, cam lock studs and taper. Also clean spindle face and taper. The chuck is fitted onto the spindle by locating the cam lock studs in their sockets. While holding the chuck with your right, hand tighten the cam lock nuts. When all nuts have been hand tightened, lock all nuts with the key using both hands.

2.6 Tailstock Location, Clamping And Alignment, Morse Tapers

The tailstock is located at the opposite end of the headstock and is mounted on the bed slideways. It can be unlocked and easily moved along the slideways. It can be used to hold the workpiece between centres or can also be used to drill or ream the workpiece. The quill or central barrel contains a Morse tapered bore, which is used to locate Morse tapered chucks, centres, drills and reamers. A hand wheel at the back is used to feed the drill or reamer into the workpiece. It will also accommodate a centre, which is used to keep the workpiece on centre. Adjustment screws at the side of the tailstock allow the centre on the tailstock to be offset for taper turning and are also used for aligning the centre with the central axis of the chuck.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 142.
ISBN-13: 9780750660730

2.7 Ratios, Proportion And Percentages

Ratios are written as whole numbers with a colon between them, e.g. if two gearwheels have a ratio of 2:1, this means that the one gear wheel will rotate on an axle two turns for every one turn of the other gear. Leavers positioned outside the headstock provide a means of changing the gears to run the chuck at different speeds.

Proportion: There is a very close connection between ratio and proportion.

For example, a ratio of 3:8 is equal to 6:16.

Percentage is a way of expressing a number as a fraction of 100,

e.g. 25% = 25 / 100 = ¼ = 0.25.

Ref Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology, chapter 2, *Ratio and proportion*, p. 8.
ISBN-13: 9780750665759

3.0 Safely Operate All Leavers And Controls

Key Learning Points

Safe starting procedure. Safe shutdown procedures and emergency shutdown procedure.

3.1 Safe Starting Procedure

Before starting the lathe check the following: Ensure that the lever for turning on the spindle is in the neutral position. The leavers for the automatic feeds are disengaged. The tool should be away from the work. Check that the workpiece is securely held in the chuck and that the chuck key is removed.

3.2 Safe Shutdown Procedures And Emergency Shutdown Procedure

Before using the lathe there are some safety rules you should know:

- Know what is going to happen before starting the lathe or operate a lever.
- Know how to stop the lathe in an emergency.
- Ensure guards are in position.
- Stop the lathe before leaving it for any reason.
- Keep tools and instruments away from revolving or moving parts.
- Always securely clamp work piece and cutting tools.

The lathe is shut down as follows: disengage the automatic feed, hand feed the tool away from the work and then turn off the spindle. If you are going away from the machine, turn off the main switch.

In an emergency, press the red button on the headstock, it is also important to return the spindle lever to the neutral position and then wind back the carriage away from the workpiece.

4.0 Technical Drawing

Key Learning Points

Engineering drawing: part drawings, assembly drawings and sectional drawings. Metric system: units of length.

4.1 Engineering Drawing: Part Drawings, Assembly Drawings And Sectional Drawings

Multi-view orthographic projection is used in engineering drawing to represent component parts, with the views in first or third angle and in accordance with BS 8888. The assembly drawing shows the components assembled together and may be sectioned to show internal parts. The individual parts are numbered on the drawing and a table is used to list the components, the part number and the quantity required of each component.

Ref: Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology, chapter 4, *Principles of first and third angle orthographic projection*, chapter 7, *Drawing layouts and simplified methods*, chapter 8, *Sections and sectional views.*
ISBN-13: 9780750651202

4.2 Metric System: Units Of Length

The universal standard of length is the metre.

1 metre = 100 centimetres = 1000 millimetres.

Summary

Safety precautions when operating the centre lathe: When using a lathe, safe working procedures need to be applied. Wear safety glasses at all times. Keep hands away from swarf, use a long handed rake to remove swarf only after the lathe has been stopped. Wear suitable protective clothing. Loose clothing, long sleeves, ties and long hair are a source of danger and therefore should be securely contained. Remove the chuck key immediately after use. Keep the area around machine clean and tidy and free from wet or oily patches.

Identifying the functions and features of the lathe: The lathe is made up of various parts, such as the: **Headstock -** located on the left hand side of the machine and houses the gearbox and the spindle. **Bed** – a strong bridge-like structure made from cast iron. Its upper surface carries the main slideways. **Chuck** – work holding device that can be locked onto the spindle. **Carriage** – controls the movement of the cutting tool and consists of the Cross Slide, Tool Post, Compound Slide, Saddle and the Apron, **Tail Stock** – located at the opposite end of the headstock and can be moved along the bed slideways. It can be used to hold the workpiece between centres or can be used to drill or ream the workpiece.

Safely operate all leavers and controls: Before starting to turn on the lathe there are some safety rules you should know:

- Know what is going to happen before starting the lathe or operate a lever.
- Know how to stop the lathe in an emergency.
- Ensure guards are in position.
- Stop the lathe before leaving it for any reason.
- Keep tools and instruments away from revolving or moving parts.
- Always securely clamp work piece and cutting tools.

In an emergency, press the red button on the headstock, it is also important to return the spindle lever to the neutral position and then wind back the carriage away from the workpiece.

Technical Drawing: Multi-view orthographic projection is used in engineering drawing to represent component parts, with the views in first or third angle and in accordance with BS 8888. The assembly drawing shows the components assembled together and may be sectioned to show internal parts. The individual parts are numbered on the drawing and a table is used to list the components, the part number and the quantity required of each component.

Suggested Exercises

1. What safety precautions do you take when using a lathe.
2. Identify and list the main parts of the lathe.
3. What are the functions of the main features of the lathe.
4. Safely remove and refit a 3-jaw chuck.
5. What is the purpose of the tailstock.

Questions

1. Give a brief description of the Headstock on a lathe?
2. Give a brief description of the Bed on a lathe?
3. What is the purpose of the Carriage and list the main parts.
4. How is the size or capacity of the lathe specified?
5. What is the purpose of the Saddle?

Answers

1. The Headstock is located on the left hand side of the machine and houses the gearbox and the spindle.
2. The Bed is a strong bridge-like structure made from cast iron. Its upper surface carries the main slideways.
3. The Carriage controls the movement of the cutting tool and consists of the Cross Slide, the Tool Post, the Top Slide, the Saddle and the Apron.
4. The capacity of the lathe refers to the size of work that it can accommodate.
5. The Saddle is mounted on the guideways of the bed and supports the Cross Slide, the Top Slide Tool Post and the Apron.

Recommended Additional Resources

Reference Books

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

ISBN-13: 9780750660730

Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology.

ISBN-13: 9780750651202

Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology.

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