University of Oxford
Department of Engineering Science

READ THIS HANDOUT BEFORE ATTENDING THE LAB SESSION			
Attendance		**Satisfactory Completion (signed)**	**Comments**
Signed	**Dated**		

Safety: You will be working on machine tools and must be appropriately dressed. No long, loose sleeves, scarves, jewellery etc. Bare toes and legs are unacceptable. (*see page 2 for more details).*

Anybody inappropriately dressed will be turned away !!!

Location:	**Staff/Student Workshop**	Lab Organiser	Cleveland Williams
	Thom Building	Phone:	73903
	4^{th} Floor	Email:	Cleveland.williams@eng.ox.ac.uk

What is the Staff/Student Workshop?

The Staff/Student Workshop provides a facility for students and non-technician staff of the Department to make parts for Fourth Year Projects, research and other purposes. Students wishing to use these facilities should contact the head of the Staff Student Workshop Cleveland Williams.

Safety Statement.

Lathes are potentially dangerous, and should be treated with great caution. The main hazard is that the operator is close to a workpiece which is rotating at high speed against a cutting tool. The main dangers are that material may be flung out or that the operator could come into contact with and be entrapped by the rotating parts.

Please note the following:

- It is essential that you are sensibly dressed for this lab: no long, loose sleeves, scarves, jewellery etc., as these may get caught in the machine.
- Long hair should be tied back.
- Bare toes and legs are unacceptable due to the risk of flying swarf.
- Wear shoes that properly cover your feet – stout shoes, trainers and work boots are acceptable. Sandals, pumps, flip-flops, etc. are not.
- Wear trousers or jeans – thin leggings and thin tights do not provide enough protection.
- Use barrier cream to protect your hands from ingress of grease, oil and dirt

Anybody inappropriately dressed will be turned away!!!

- It is mandatory to watch the short safety video before using the machines. Anybody who turns up late and misses the video will need to arrange another session.
- Please read the risk assessment at the end of this handout, and read the safety notices in the Staff/Student Workshop.

If you are in doubt – stop and ask

Learning Outcomes

Having completed the *Workshop Practice* Lab you should be able to:

- understand how to use a lathe safely for simple turning operations
- understand how to use micrometres
- understand how parts can be machined to high precision
- understand the use of limits and fits and how the definition of these on a drawing relates to how the part is made
- understand how the basic features and geometry of a lathe enable it to produce flat and cylindrical surfaces.

Requirements

You will be required to attend one practical session in the Staff/Student Workshop. No preparation is required, other than reading this handout in full.

In the session you should satisfactorily complete the following:

- See the safety video and be given an appropriate safety talk.
- Manufacture a ‘bush’ and a ‘pin’ to close tolerances.

Times

The lab takes about 2 hours to complete,
Most students should finish the lab within 2 hours.

DO NOT TURN UP LATE!

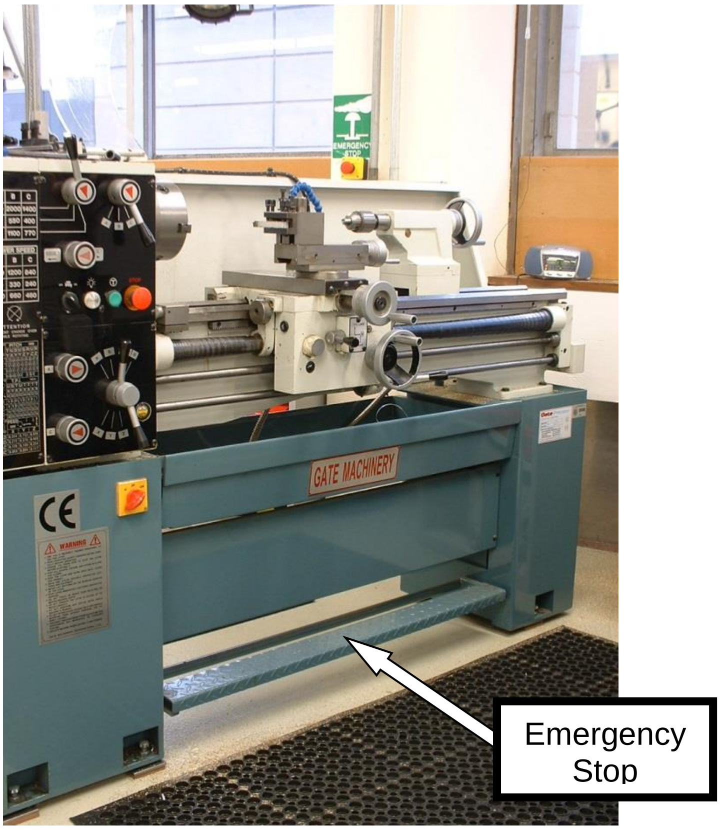
Lateness or Absence.

The guidelines laid down in the Course Handbook apply.

- If you know in advance that you will be unable to attend a lab session try to arrange a ‘swap’ with another student - if you do this, inform Cleveland Williams. If you cannot arrange a ‘swap’ please contact the course work organiser who may be able to arrange an alternate session.

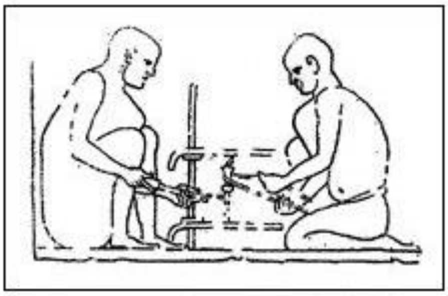
- Be prompt: if you miss the safety video at the start of the session you will be sent away and will have to try to arrange another session, if this is possible.

Paul Bailey

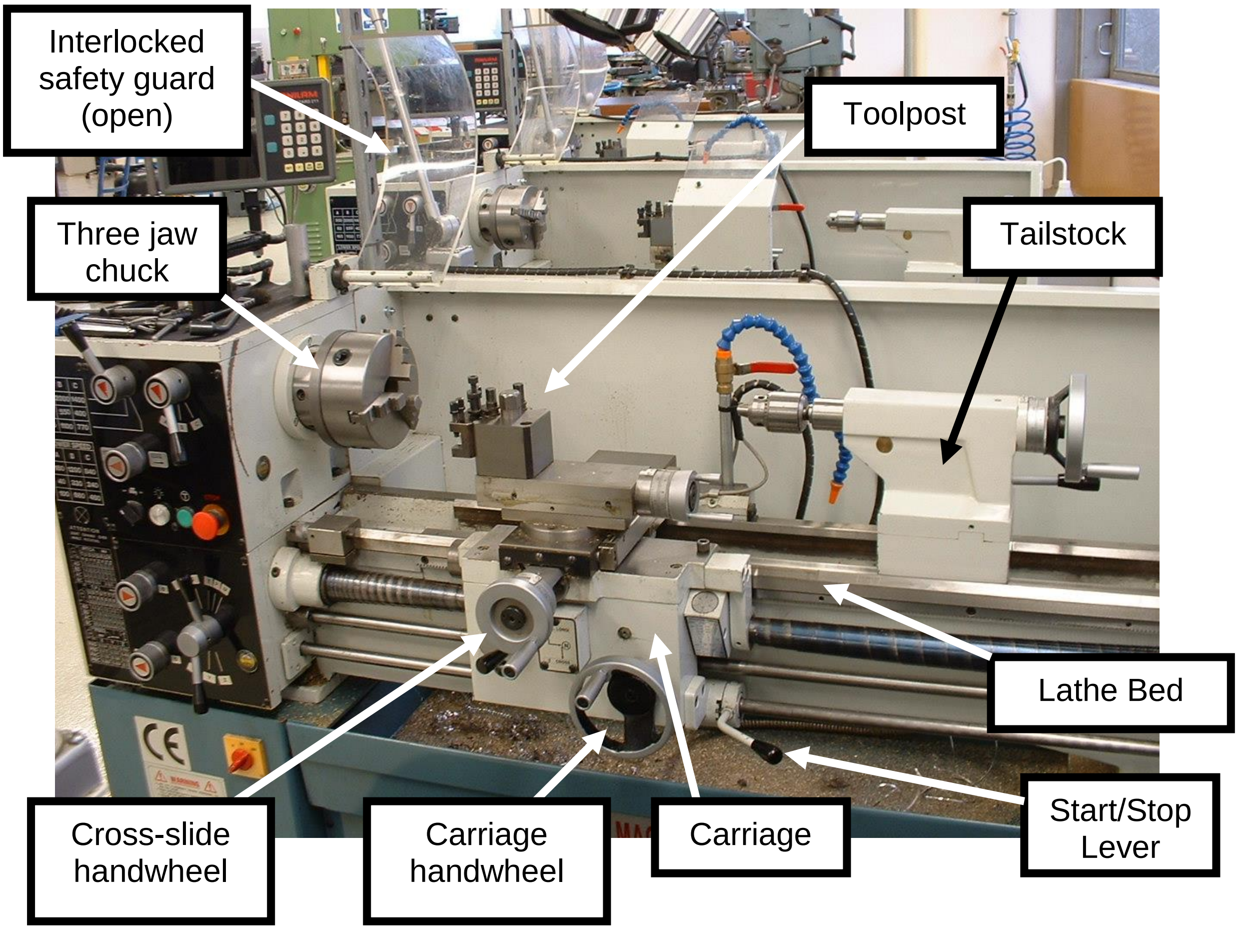


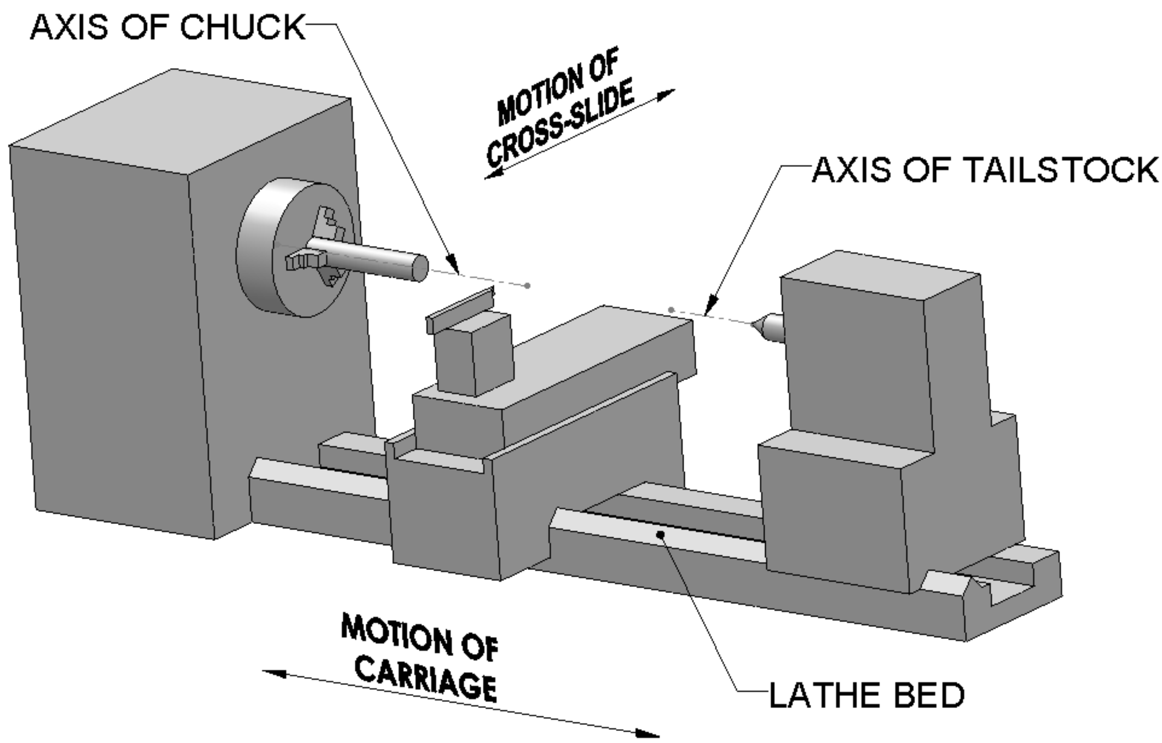
LATHES

Lathes are one of the oldest tools known to mankind, dating back to ancient Egypt, and are almost unique among machine tools in that the *workpiece* is rotated against a stationary tool.



From Egyptian Tomb (≈300 BC)





The key features of the modern metal-cutting lathe are -

- The **workpiece** is held in a chuck rotating in precision bearings
- A lathe **bed**
- A **carriage** which travels along the bed
- A **cross-slide** on the carriage
- The **tool** is usually mounted on a **toolpost** on the cross slide
- The **tailstock** is used either to hold a drill or reamer or it can be used with a ‘centre’ to support a long workpiece.

The carriage and the cross-slide can be moved manually, or can be driven (or **fed**) automatically. In addition, many lathes can be used for **screw-cutting**, where the **carriage** is driven by the **feed screw** which is connected to the **chuck** by a fixed gear ratio. Hence an M4 x 0.8 screw thread can be made by moving the carriage 0.8 mm for every revolution of the chuck.

The accuracy of a lathe comes from several key features

- The structure of the lathe must be stiff enough so that there is minimal distortion due to the weight of the workpiece and the cutting forces.

- The movement of the carriage along the lathe bed must be very linear
- The axis of the chuck must be parallel to the lathe bed
- The cross-slide must move perpendicularly to the axis of the chuck
- The axis of the tailstock must be collinear with the axis of the chuck
- The chuck must be mounted on bearings which are stiff enough to give minimal distortion when subject to the highest cutting loads
- The workpiece must be held in the chuck in a way that will not distort it.
- The cutting tool must be held rigidly.

Lathe Tools

The Lathe tools you will be using have tips made from ‘High Speed steel’. These are supplied as blanks, and have the tips ground to a shape to suit the type of cut, the material of the workpiece, and to ensure good removal of swarf.

“High Speed” steel was introduced about 1900, and is a high carbon steel alloy containing tungsten and chromium. Before 1900, if cutting tools were used at too fast a speed (or with too deep a cut), they would get hot, become annealed and turn soft. ‘High speed’ steels would not anneal (and hence soften) at high temperature, and so could be used at higher speeds

One of the main reasons that these tools worked so well was the formation of tungsten carbide, and this can now be produced and used to make even harder tools. Some of these are known as ’tipped’ tools , which are made from steel, but have a small replaceable tip made from tungsten carbide.

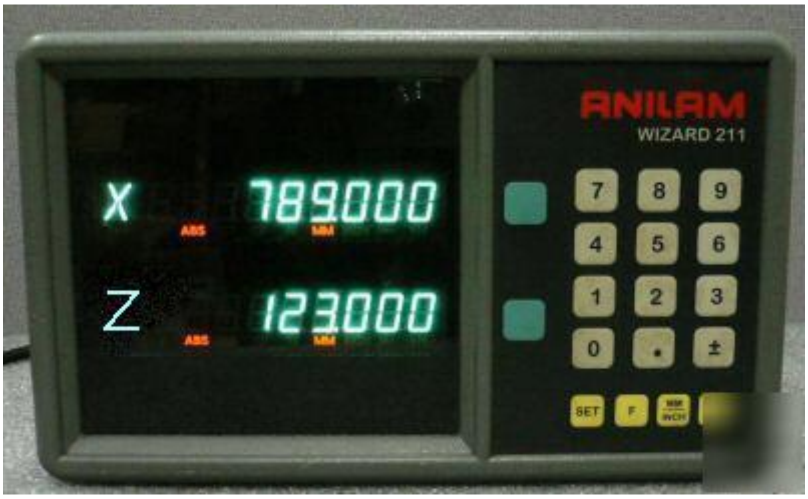
When turning different materials, you should choose an appropriate tool and then use published data to choose an appropriate ‘speed’ (in m/sec; this depends on the diameter and rotational speed of the work) and the ‘feed’ (in mm/revolution)

Coolant.

In a production environment, it is important to maximise the rate of cutting metal. To avoid the tool and work overheating, and to improve the removal of swarf, a coolant is used, which is typically an emulsion of water and oil. You will NOT be using a coolant in this exercise.

Digital Readout.

The lathes you will be working on are fitted with Digital Readouts. These are for measuring the *relative* movements of the carriage and the cross-slide, and they can, if necessary, be 'zeroed' to give an *absolute* measurement. Note that the cross-slide position ("X" on the display) is automatically multiplied by 2 to give a **diameter** (and not a radius).



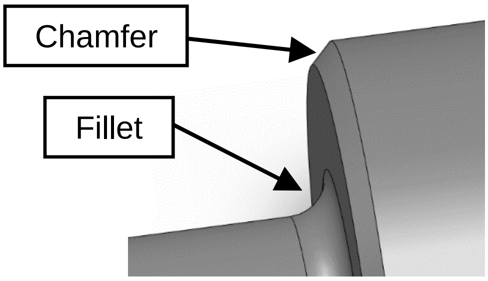
Glossary

Use this in conjunction with the photos and diagrams on pages 4 and 5 of this handout

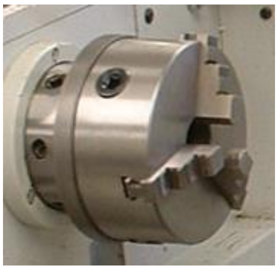
Annealing is the process of heating a material, then allowing it to cool slowly. Annealing usually softens the material.

Boring is the machining of a hole using a single-point lathe tool, rather than a drill.

The **carriage** moves along the lathe bed.



A **chamfer** is when a sharp external corner is removed by a straight cut.



The **chuck** is attached to the end of the spindle of the lathe and holds the workpiece.

Two axes are **collinear** when they are in line with each other.

Two cylindrical surfaces are **concentric** when they have a common axis.

The **cross-slide** is on top of the carriage; moving the cross-slide changes the diameter at which the lathe tool cuts.

Diametral – dimension bases on the diameter not the radius (the equivalent word to ‘radial’).

Facing – machining a flat face by moving the tool on the cross-slide with the carriage fixed.

A **fillet** is a small radius, usually on an internal corner (see picture for Chamfer).

Radii is the plural of radius.

Swarf – the metal debris produced by the machine.

The **tailstock** is mounted on, and can slide along, the lathe bed. It is used for mounting drills and reamers, and for supporting the end of a long workpiece.

The **toolpost** is mounted on the cross-slide and holds the lathe tool.

Turning is the name given to the process of machining a component on a lathe.

Risk Assessment Subject:	**Operation of a Lathe – Workshop Practice Lab**				
Site, Building & Location:	Staff/Student Workshop – Thom Building			Review Date :	21-Aug-2023
Assessment undertaken by:	Paul Bailey	Signed:	[signature]	Date :	21-Aug-2021
Assessment Supervisor:	Bob Scott	Signed:	[signature]	Date :	21-Aug-2021

Assessing the Risk*

You can to this for each hazard as follows:

- Consequences: Decide how severe the outcome for each hazard would be if something went wrong (i.e. what are the Consequences?) Death would be "Severe", a minor cut to a finger could be regarded as "Insignificant".
- Likelihood: How likely are these Consequences to actually happen? Highly likely? Remotely likely, or somewhere in between?
- Risk Rating: Start at the left of the coloured Matrix. On your chosen Consequences row, read across until you are in the correct Likelihood column for the hazard in question. For example, an outcome with Severe consequences but with a Low probability of actually happening equates to a Medium risk overall. In this case "Medium" is what should be written in the Risk.

RISK MATRIX		LIKELIHOOD (or probability)			
		High	**Medium**	**Low**	**Remote**
CONSEQUENCES	**Severe**	**High**	**High**	**Medium**	**Low**
	Moderate	**High**	**Medium**	**Medium/Low**	**Effectively Zero**
	Insignificant	**Medium/Low**	**Low**	**Low**	**Effectively Zero**
	Negligible	**Effectively Zero**	**Effectively Zero**	**Effectively Zero**	**Effectively Zero**

Hazard *(potential for harm)*	**Persons at Risk**	**Risk Controls In Place** *(existing safety precautions)*	**Risk***	**Future Actions identified to Reduce Risks** *(but not in place yet)*
Contact with cutting tool. Possible entanglement from contact with revolving chuck and/or work piece.	**User**	The Lathe is fitted with an interlocked chuck guard and can be fitted with magnetic based Swarf/coolant splash guards when required. Training, in the form of a video and verbal instructions, will be given regarding safe operation of the lathe, including use of start, stop and emergency stop controls.	**Medium Low**	

Hazard *(potential for harm)*	Persons at Risk	Risk Controls In Place *(existing safety precautions)*	Risk*	Future Actions identified to Reduce Risks *(but not in place yet)*
		Inappropriately dressed students will not be allowed to take part in the lab. Students will not be allowed to use a lathe if they have not viewed the safety video and have not had instruction in safe operation		
Ejection of material	Users, others	The Lathe is fitted with appropriate guarding e.g. magnetic swarf guards, chuck guards and clamping systems used to prevent entrapment and ejection. All users to wear safety glasses when working on the Lathes. Inappropriately dressed students will not be allowed to take part in the lab.	**Medium Low**	
Contact with oil and grease on components, lathe surfaces, tools, etc.	Users	The use of gloves is discouraged except for medical reasons. The use of barrier cream is recommended. Students to wash hands after finishing the lab.	**Low**	