

CL500M Metal Lathe

Online Training

https://wiki.hackhitchin.org.uk/index.php?title=CL500M_Lathe

Table of contents

1. [Overview, or what you will get from this training](#)
2. [Safety](#)
3. [Preparation, Set-up and Operation](#)

CL500M Metal Lathe

What you will get from this training

Scope of the training

These online materials are designed to get you ready to operate the Hackspace's CL500M Lathe.

No prior knowledge of how to use a metal lathe is assumed.

If you already know how to use metal lathes, this material has been designed to get you up to speed with our particular CL500M quickly. Please be patient with the process and if you have any tips to improve this guide, [let us know!](#)

This guide covers what all the metal lathe users need to know in the Hackspace.

Learning objectives

- How the CL500M lathe works
- How to inspect the equipment before use
- How to use it safely
- How to machine metal using the metal lathe
- Cleaning-up after use

Training: What is expected of you

This training material gives you a complete overview of the knowledge we expect all users to be familiar with.

It also gives tips and suggestions on how to get good results. Read this document, including the linked videos and documents to clarify understanding

It's preferable to have a project in mind BEFORE you start the practical training

Once you have read and taken in the training material, you can arrange to have an in-person session. Only once you have been assessed person-to-person can you use the equipment.

PRACTICE on the machine as soon as possible after you have finished the training – ideally within a week - **expect to commit ~ 8 hours to this if you are new to machining**

CL500M Metal Lathe

Safety

How to use the CL500M metal lathe safely

A lathe is potentially one of the most dangerous machines in a workshop, however if correctly used it is extremely safe.

It is you that makes the difference.



Operator safety rules

- Always wear eye protection - Sharp edged chips can be thrown off the workpiece at high speed;
- Make sure to not use anything that can get stuck in the machine.
This includes:
 - Ties and scarves;
 - Bracelets, necklaces and rings;
 - Long sleeves;
 - Gloves;
 - Wired headphones;
 - Long hair **must** be tied up or securely held back.



CL500M Metal Lathe safety features

Off switch

E-stop



Tailstock support

CL500M Metal Lathe safety: Setup

The safe operation of a metal lathe is all down to the preparation and setup of the machine.

- Do not adjust the machine if it is capable of starting to move, or already moving.
- Rigidity, rigidity, rigidity: The limitations of the lathe will always be due to unwanted movement of the work or the cutting tool.
- Always be prepared to abandon an operation if it is becoming difficult to setup with rigidity, or the lathe starts making strange noises.

CL500M Metal Lathe safety: Operation

- Inspect the lathe for cleanliness and damage
- Set up the chuck and verify that it is secure
- Install your work into the chuck
- Check your cutting tools and set the correct tool height
- Verify that no part of the lathe, carriage, or tools will interfere with the chuck
- Use the lathe!
- Shutdown
- Clean up the lathe

CL500M Lathe safety: Additional checks & tips

- The most common problem is the possibility of crashing the cutting tool, or some other part, into the lathe chuck. *This can destroy the machine instantly.*
- You can always check for problems by powering off and rotating the chuck by hand.

The Six absolute No-Nos of machining

- Never let your chuck come loose, always check it is on tight before use, also check the rest of your lathe as you don't know how competent the previous user was
- Never start your lathe whilst your stock material is loose in the chuck, always check
- Never leave your chuck key in the chuck
- Never allow your cutting tool to hit the chuck jaws – always check your dead-stop setting after making adjustments
- Never allow the carriage to hit the dead-stop whilst cutting using the power-drive – keep your hand on the power-drive lever and your eye on the dead-stop gap
- Never retract the tailstock shaft beyond the 0 mark or you might eject the tool whilst in contact with the job and shatter either the tool or the job.

CL500M Metal Lathe

Preparation, Set-up, and Operation

Metal lathes have a lot of levers, buttons, and dials! It can be a bit overwhelming at first, so it's good to spend some time getting to know the machine. Note the milling head is not functional on the Hackspace's lathe



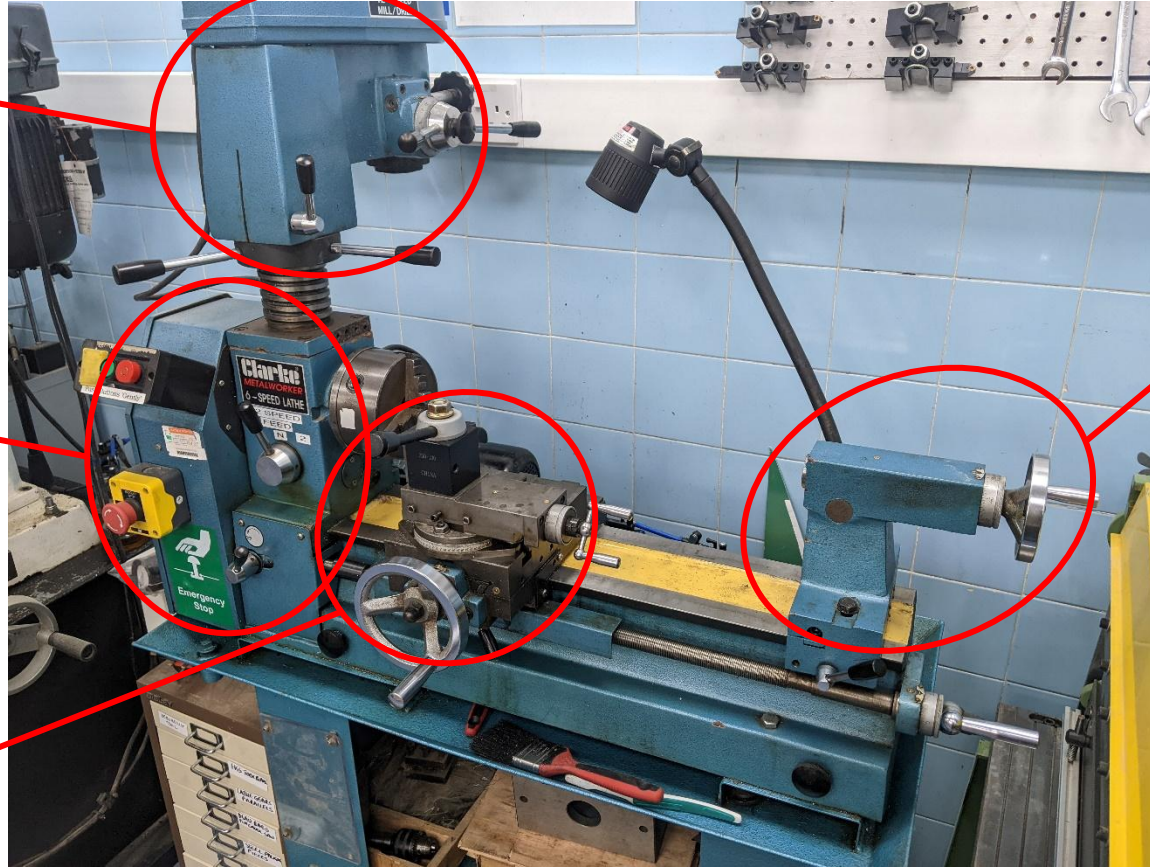
- | | | | |
|----|----------------------------|----|-------------------------------|
| 1 | Mill Head | 17 | Compound Slide Feed Handle |
| 2 | Mill Head Locking Lever | 18 | Cross Slide |
| 3 | Mill Head Elevating Lever | 19 | Saddle |
| 3a | Mill Head Elevating Collar | 20 | Cross Slide Feed Handle |
| 4 | Pulley Cover securing Knob | 21 | Leadscrew |
| 5 | Spindle Cover (2-part) | 22 | Leadscrew Locking Lever |
| 6 | Spindle Micro Feed Knob | 23 | Saddle Feed Handle. |
| 7 | Spindle Feed Clutch | 24 | Tailstock |
| 8 | Drill Chuck | 25 | Tailstock Spindle Feed Handle |
| 9 | Drill Chuck Guard Support | 26 | Tailstock Spindle |
| 10 | Chuck Guard | 27 | Tailstock Centre |
| 11 | Headstock | 28 | Tailstock Locking Lever |
| 12 | 3-Jaw Chuck Guard | 29 | Saddle Auto Feed Lever |
| 13 | 3-Jaw Chuck | 30 | 2-Speed Lever |
| 14 | Motor | 31 | ON Button |
| 15 | Compound Slide | 32 | OFF Button |
| 16 | Tool Post Locking Lever | 33 | Forward/Reverse Switch |

Getting to know your lathe

Millign head
(unused))

Headstock
(contains motor,
gears, chuck and
spindle)

Carriage (moves
along the lathe
bed)



Tailstock (for
drilling or
supporting your
work)

Getting to know your lathe: Gearboxes

Power feed
speed/pitch
selector

Power feed
engage lever



Belt and pulleys
set chuck speed

Gears set power
feed speed/pitch

Getting to know your lathe: Saddle or Carriage

Cross slide feed handle
(moves tool across the
lathe bed)



Compound or
top slide



Saddle feed handle
(moves tool along
the lathe bed)

Personal Protective Equipment (PPE)

Goggles or safety specs are required.

Other people working in the workshop space should also have eye protection if you are using this equipment because razor sharp metal chips will be flung across the room.

Do not use hearing protection.

Gloves are not advised when operating the machine because if your hand catches on a moving part, gloves will catch and drag you in.

Tie back any loose clothing, and especially long hair or long sleeves, etc. because these cause fatal accidents when they are caught/entangled.



Lathe Safety Hazards

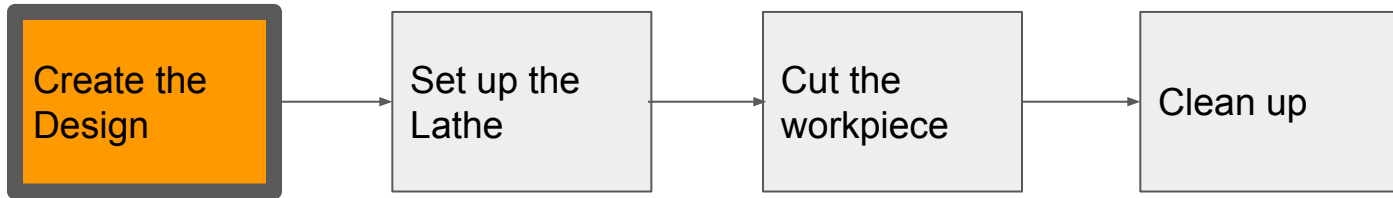
As a trained user, you should be very aware of the following risks and how to deal with them:

- **Fire** - Cutting with the wrong speed or pressure could result in the material igniting.
- **Moving Parts** - keep clear of the moving parts of the machine
- **Sharp Edges** - Take care installing and removing cutting tools, and when cleaning up swarf
- **Dust** – If dust is being created during cutting, run the workshop air cleaner throughout the job and regularly stop the lathe and use the vacuum to remove dust.
- **Noise** - Ensure that you wear the correct PPE when working with the machine.
- **Projectiles** - Poorly clamped work or snapped tools can be ejected from the lathe

The risk assessment can be found here:



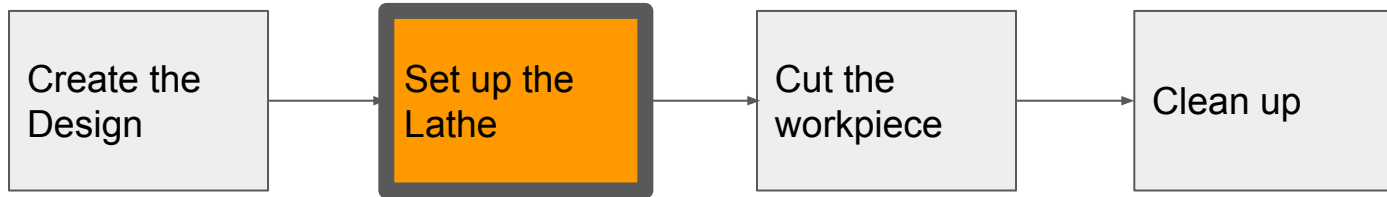
Turning Workflow



Designing for Turning

- Features parallel or perpendicular to the axis are easier to setup and machine than tapers
- Very deep, narrow grooves can be challenging (parting/grooving tool rigidity)
- Long slender parts are challenging as the work deflects under cutting forces
- Thin walls are challenging (vibration and deflection)
- Undercuts are possible provided the tooling (e.g. boring bar) geometry is compatible
- Internal holes don't need to match drill diameters, boring bars allow any diameter above ~6mm to be created
- It's generally worthwhile to produce a drawing, even if the design is simple
- Consider the order of operations and how the material will be held whilst cutting

Turning Workflow



Inspecting the Lathe before work

Never skip a thorough inspection of the Lathe before switching its power on:

- Check the general area is clean and clear
- Check that the chuck is clear of any entanglement
- Make sure the lathe bed is clear, and that nothing is in the way of the moving carriage
- Inspect the oil level indicators are OK.

Keep the equipment owners informed if you do find a problem, as this helps the Hackspace keep an eye on whether the equipment is working optimally. Please email maintenance@Hackspace.org with any concerns.

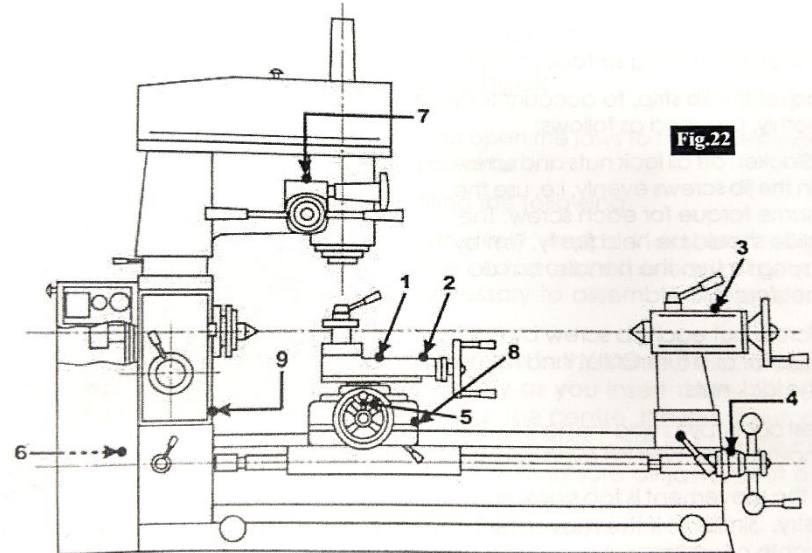
Inspecting the Lathe before work

Lubrication/oil checks

There are is an oil window under the chuck which should have oil halfway up the glass. If it does not then please report this.



Inject a few drops of oil to the oilways 1 - 8 Fig. 22.



Setting up your lathe

To get power to the machine:

1. Switch on at the wall
2. Release the E stop

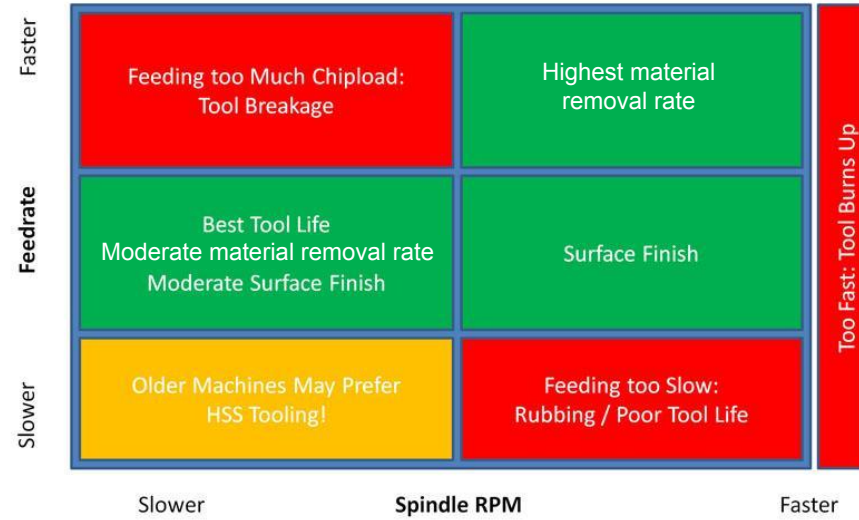


Getting to know your Lathe: Cutting speed

- The chuck rotation speed is set by the position of the belts in the headstock
- The belts will need adjusting for the material or drill size and the material being cut. The speed will need to be lower for larger diameters, particularly in steel.
- Too much speed will generate excess heat which will soften the tool and blunt it faster
- Reduce your cut depth and feed rate if the workpiece is getting too hot

Suggestion: use the speed chart on the following page (and also on the wall in the hackspace) to select the speed for cutting

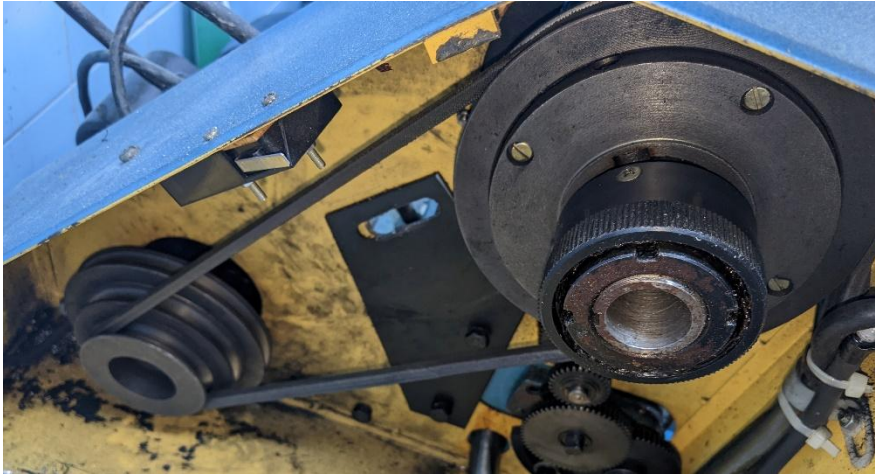
Sweet Spots for Feeds and Speeds



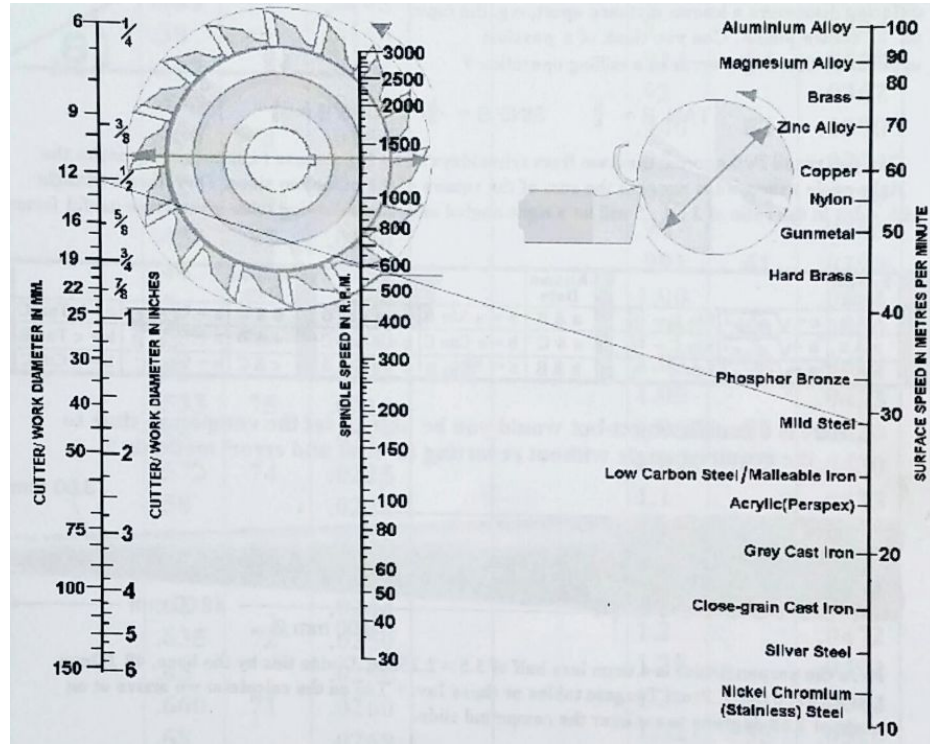
Setting the spindle speed for optimal cutting

The spindle **MUST** be stopped before changing the belt. Release the belt tension by adjusting the motor mount, then move the belt onto the appropriate pulleys.

The belt speed chart on the wall shows what speed will be achieved with which belt combination. Note some combinations require the idler pulley to be removed



Cutting speed lookup chart



Preparing your work: The 3-jaw chuck

The first step in preparing your work is to have the right chuck. We have a 3-jaw chuck and a 4-jaw chuck.

The 3-jaw scroll chuck is a simple and fast way to hold round, or hexagon-shaped material, with reasonable accuracy.

The 4-jaw independent chuck can hold any shape of material, even unbalanced and off-centre pieces, with high accuracy. We will cover this in later training.

Always leave the 3-jaw chuck on the lathe when done, some people cannot mount and de-mount the 4-jaw safely as it is very heavy. Later training will cover changing chucks.

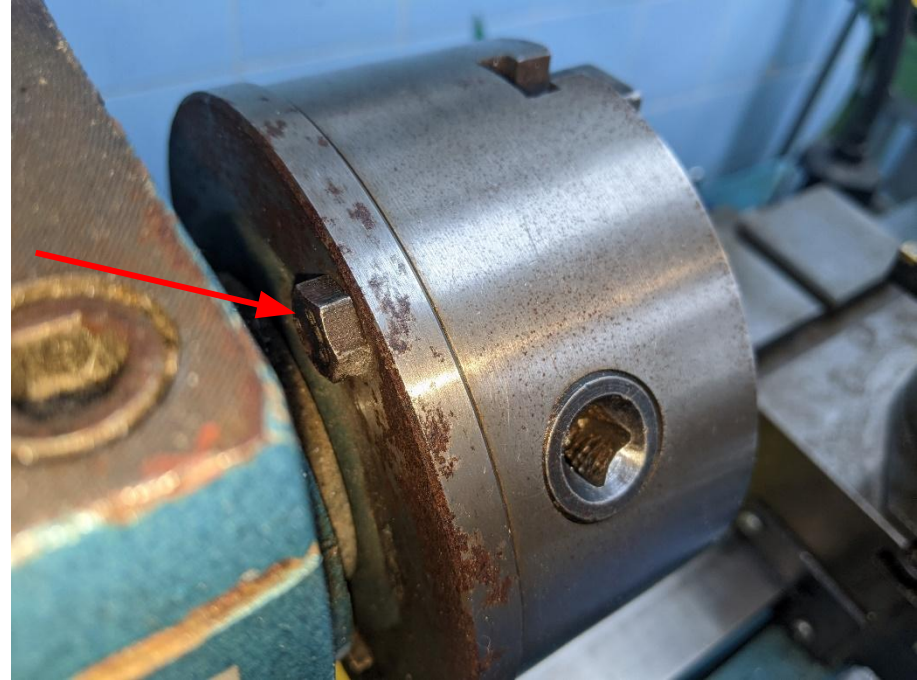


Safety: Check the chuck is secure!

You must **always** check the chuck is secure before running the lathe.

There are three hex bolts on the back of the chuck, as shown on the right

ALL THREE MUST BE SECURE BEFORE THE LATHE IS RUN. Use ring spanner to secure them.



Safety first: The chuck key

This key is used to loosen and tighten the chuck.

One of the most dangerous things that you can do on a lathe is to leave the chuck key in the chuck.

It is good practice to only ever have the chuck key in the chuck if your hand is on it. Never leave it in the chuck.

It is dangerous because it can either be thrown by the chuck, or jam between the chuck and something else and with the large forces involved cause a lot of damage



Place your work in the chuck

Insert the chuck key into the spigot on the side of the chuck as shown on the right.

Turning the handle clockwise will move the jaws towards the centre.

You can grip the work with either the inside of the jaws, or the outside, but you must always check it is very securely held.

Put as much of the workpiece in contact with the jaws as you can while leaving enough room to comfortably get the cutting tool in position while being clear of the chuck.

Tighten the chuck and **always remove the chuck key**



Cutting tools

May be right-handed or left-handed (approach from right/left).

Parting off tools: Feed in gently so it doesn't dig in.

Gold inserts give the best finish on Steels.

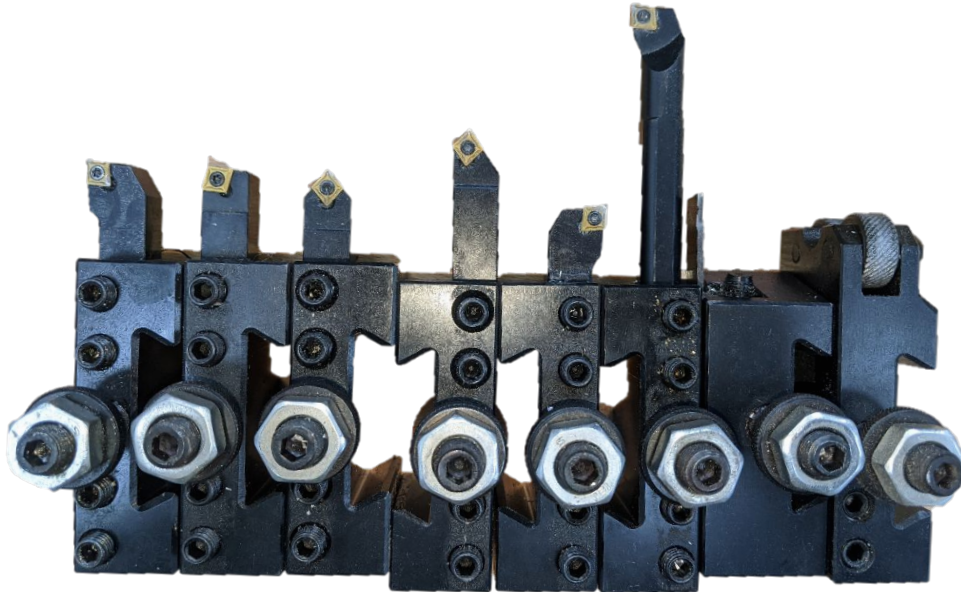
Silver inserts give the best finish on Aluminium and can be used on plastic

Spare inserts are in the drawer labelled “Deburring Tool” in the Bisley drawers between lathe and mill. Inserts can be swapped between holders or replaced if chipped or blunt.

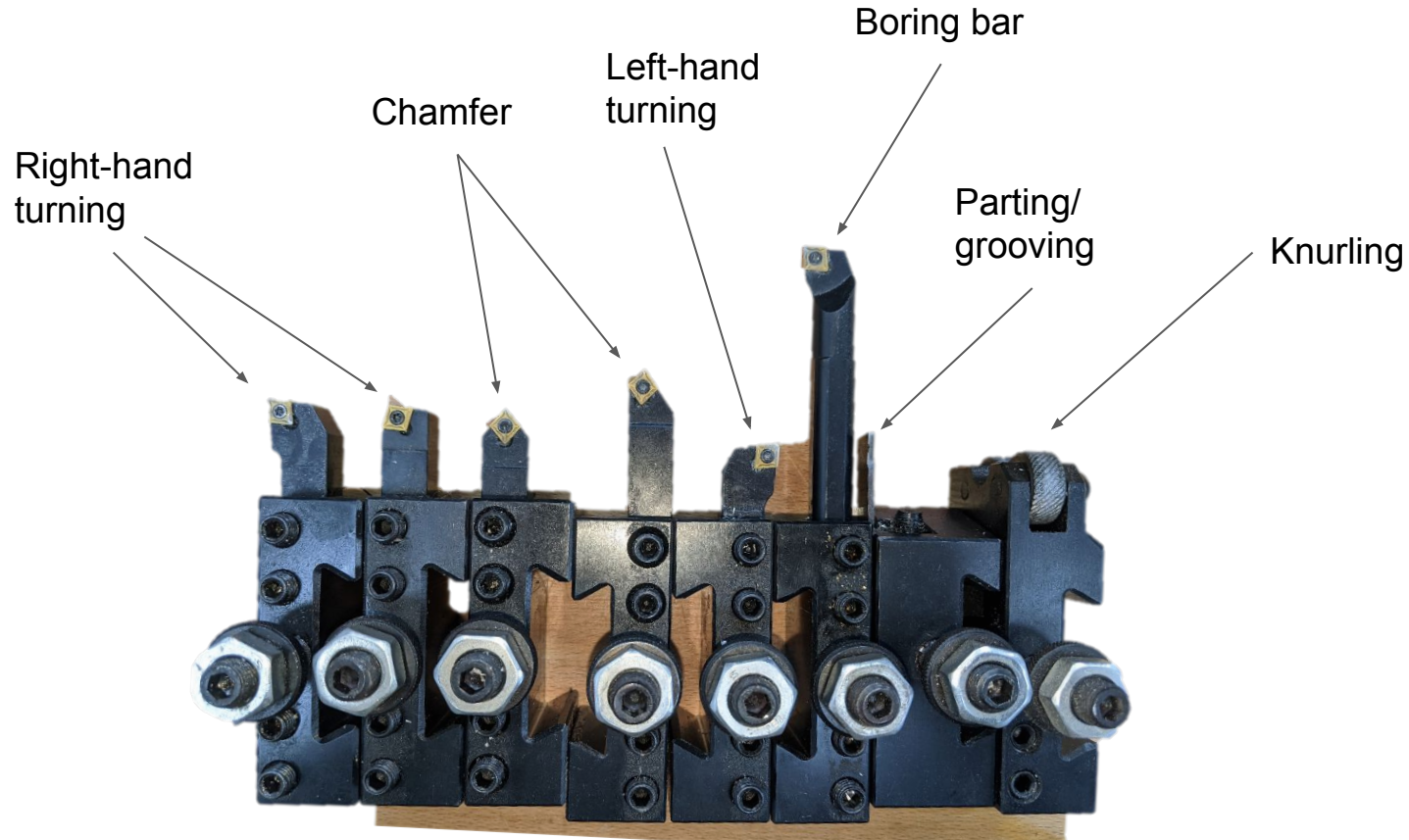


Cutting tools - Hackspace's collection

We have a selection of lathe tools that cover most typical lathe work. The most common tools are stored on the pegboard behind the lathe, but more (HSS) tools are in the Bisley drawers.



Cutting tools - Hackspace's collection

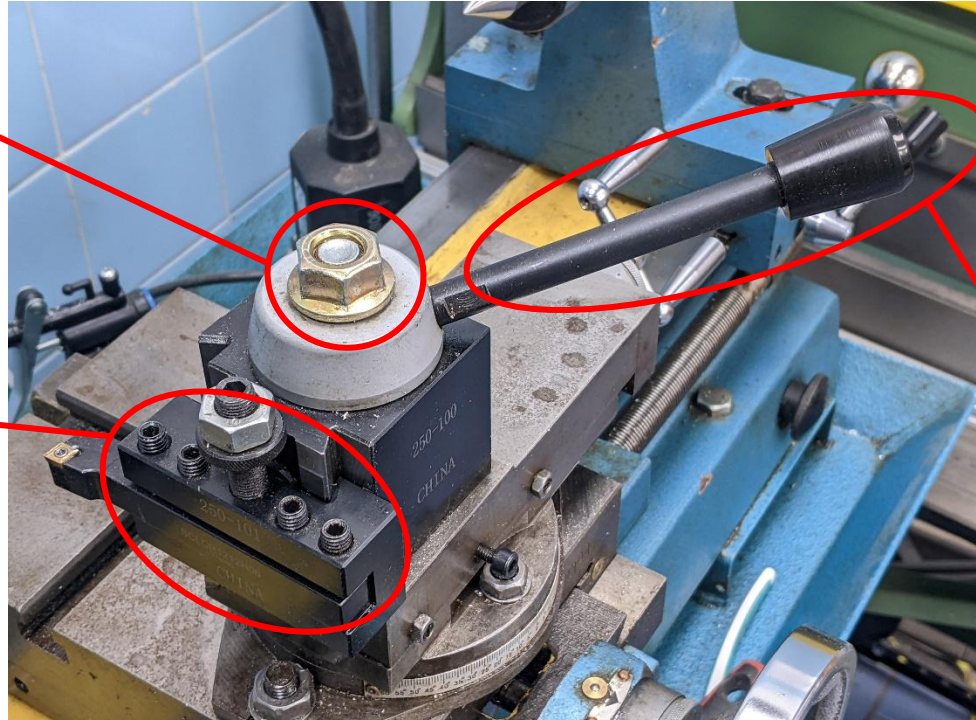


The quick-change toolpost

This toolpost holds the cutting tool and allows you to quickly and easily change between tools.

Toolholder
hold-down nut (for
setting tool angle)

Tool holder



Tool release handle

Quick-change tool, setting tool angle

The big spanner is used to loosen the quick-change tool and rotate it. You can re-align it by bringing it up to the chuck and checking it is square to it and tighten it again.

- The tool holders are “drop in and tighten type” and normally give you the correct height, but it's best to check
- Being square is absolutely vital with parting-off tools. Again, make sure all is tight here
- Its quite rare to need to rotate the head, even for taper turning the toolpost will rotate with the compound. The cutting tools have the correct geometry for when the toolholder is perpendicular to the face of the work

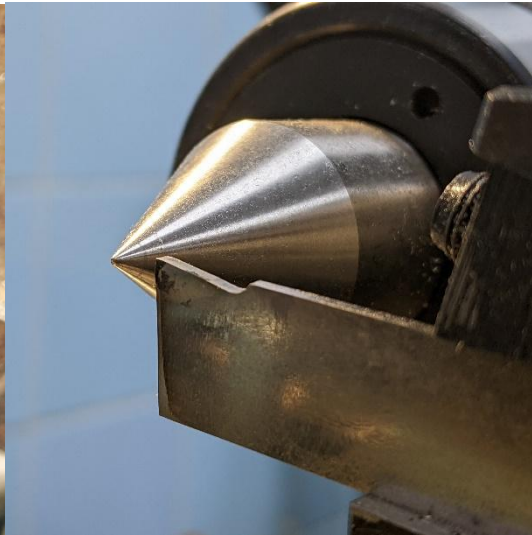


Setting the tool height

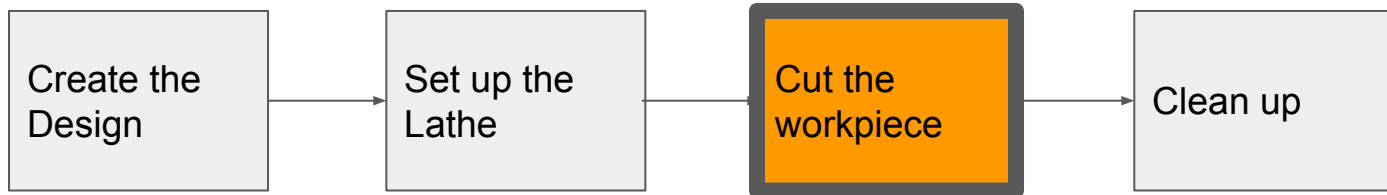
Use a height reference such as the tip of a live centre or the cut pattern of a face to check the cutting edge height. The tip of the tool should be exactly on centre.

To adjust the tool height:

1. Loosen tool release handle
2. Loosen the locknut
3. Rotate the black knurled height adjuster
4. Re-tighten the locknut
5. Re-tighten tool release handle



Turning Workflow



Safety before Starting – each and every time

Always make sure of two things when using a lathe:

1. That the work area is safe, there is nothing lying on the lathe that shouldn't be, especially the chuck key, more on that later. Also check before starting the lathe drives are not engaged that the chuck will not collide with anything.
2. You have nothing on you that can get caught in the mechanism of the lathe. Beware of loose clothing, long sleeves, jewellery and especially long hair. All of these are a total no-no. Whilst eye protection is mandatory do not wear anything that will impair your hearing – if you listen to the lathe while it cuts the lathe will tell you how well you are doing. Do not use gloves as they impair the physical feed-back from the lathe.

You are also responsible for the safety of all others around you, check them every time before you start the lathe and ensure that they know you are starting.

Working with the graduated hand wheels

If you want two features to be accurately positioned relative to each other, using the calibrated graduations on the hand wheels is one of the best ways to achieve this.

The process generally involves establishing a datum, then winding the hand wheel whilst counting the turns, and finishing on the correct graduation. Care needs to be taken to account for backlash and cutter width.

A datum can be established through many methods, common approaches are by “touching off”, taking a skim cut or using the calipers to set a position.

Cutting notes

- Square inserts are for heavy rough cuts and don't go right up to a shoulder.
- Chamfer bits exist, and so do internal/external cutting bits (more on later training)
- The tools that are on the pegboard should be kept there when not on the toolpost.
- Replacing tools in tool holders means you will have to adjust the height nut on each cutting tool. Lock and then re-test.
- All tools have a tiny radius at the end, so if you are cutting up to a shoulder you can either undercut a little and sink the radius in, or you can undercut the shank. A lot of times it doesn't matter, until you need to fit a bearing.
- Plan to cut slightly larger than your final cut and measure prior to cutting the last cut and do a very fine cut.

Making the part match the drawing

There are a number of methods to ensure the part you make meets your design. The most common are:

1. Mark the design onto the material before turning, using engineers blue and marking equipment such as scribes, height gauge or calipers.
2. Establish a datum position then use the dials on the hand wheels to position the tool according to the design.
3. Measure the part as you go, and creep up on the final dimension.

All these methods have limitations. 1) is generally ok for cosmetic parts but is challenging to be more accurate than $\pm 0.1\text{mm}$. 2) & 3) can achieve $\pm 0.01\text{mm}$ with care. 2) can be challenging to keep track of the number of turns. 3) is tricky with one-shot operations like the position of a drill or a cutter-width groove.

Method 1: Marking a scribing lines to machine up to: <https://youtu.be/ltXn8o52GCo?t=35>

Method 2, Backlash, touching off and using hand wheels: <https://youtu.be/1IsG8vIXA8k?t=180>

Method 3: Machining to a target diameter by measuring: <https://youtu.be/-dyO4PEkEkc?t=170>

Types of lathe machining operations

This part of the training covers the following operations:

- Facing / cross-cut
- Turning / long-cut
- Cutting at an angle
- Chamfering

Further operations can be covered in later training.

Facing / cross-cut

Face Cutting is done by cutting across the end of the metal. This movement is known as “feeding in” or “infeed”.

The Cross feed is marked in DIAMETER: For example .5 mm on the dial moves the cutter by .25mm. This is called a “direct” dial.

Your instructor will demonstrate a cut to you then you can do one, try both a manual cut and then a power feed one.

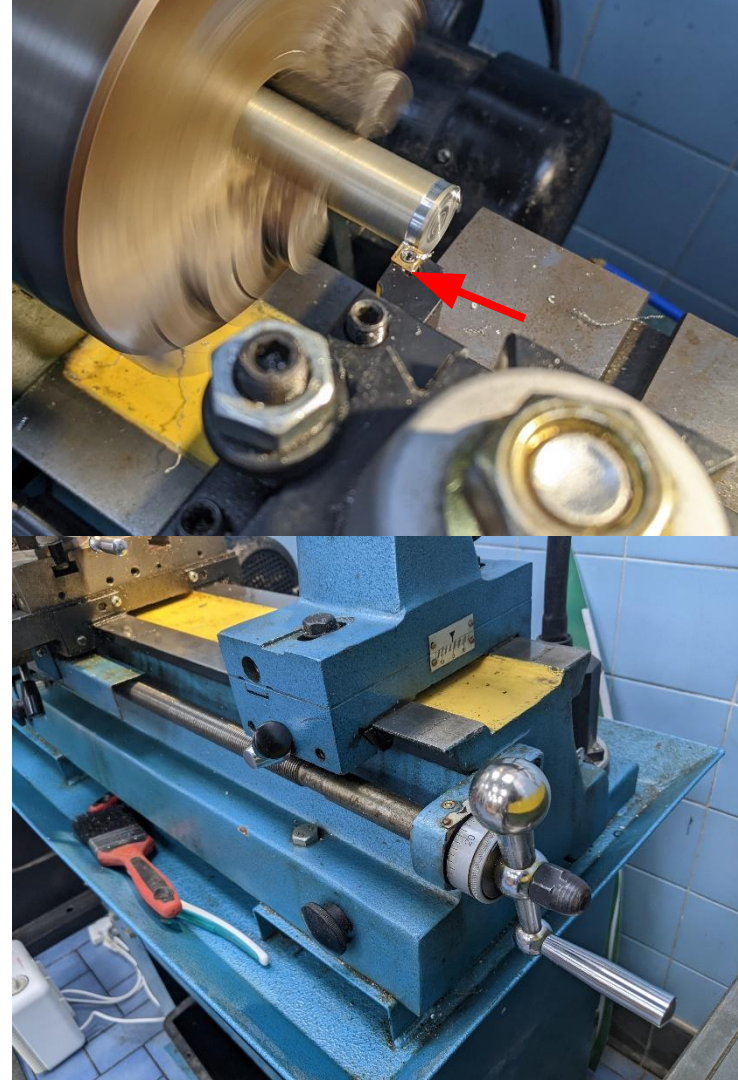


Turning / long-cut

Turning is done by cutting down the rounded side of the metal and using the longitudinal wheel.

Your instructor will demonstrate a cut to you then you can do one, try both a manual cut and then a power feed one.

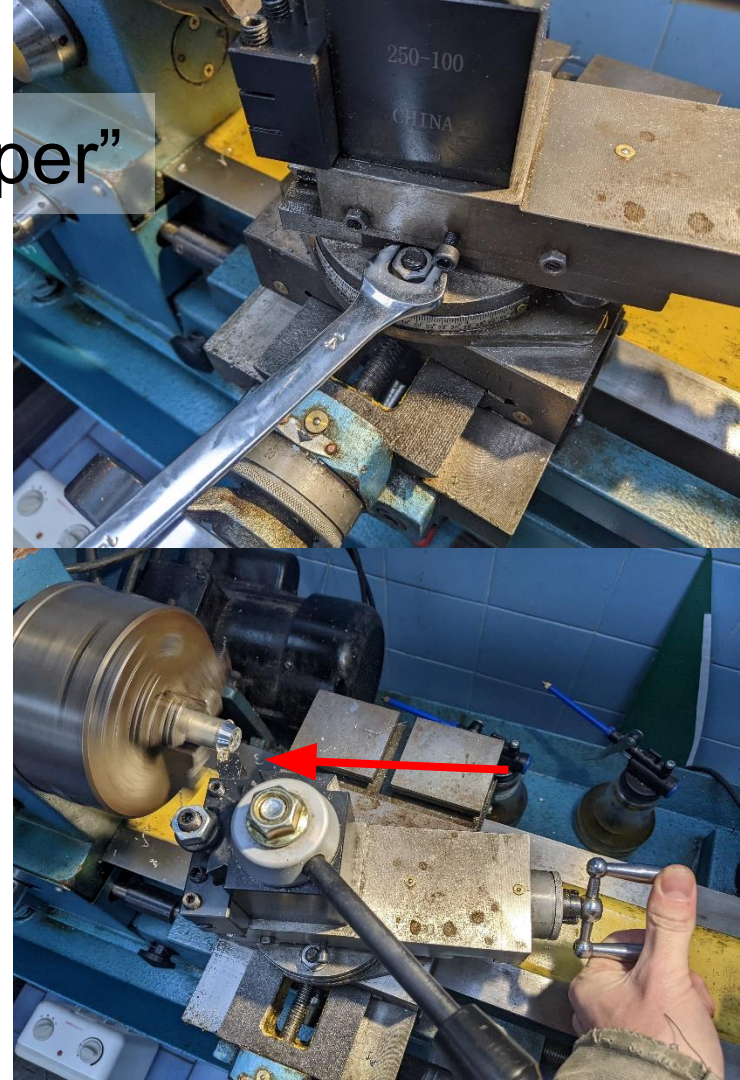
Always be careful that you do not drive the cutting tool into the moving chuck, particularly when using the power feed.



Cutting at an angle / “turning a taper”

The top slide on a lathe, also referred to as a “compound”, can be rotated and used to cut at a precise angle.

Keep track of any movements using the dial, or by attaching a dial indicator. Be careful about moving the cross feed or longitudinal feeds whilst set up for taper turning, as you may lose your reference position.

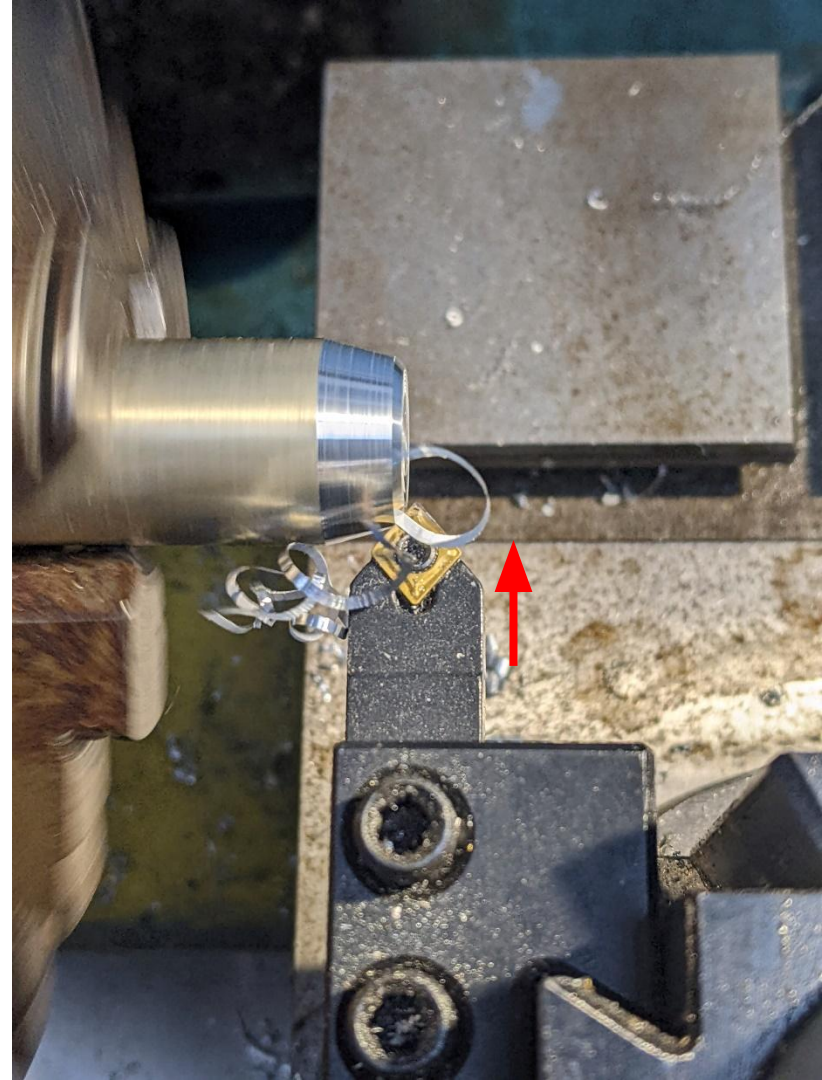


Chamfering

Chamfering is done by cutting down the rounded side of the metal and using the longitudinal wheel.

Your instructor will demonstrate a cut to you then you can do one, try both a manual cut and then a power feed one.

Always be careful that you do not drive the cutting tool into the moving chuck, particularly when using the power feed.



Tailstock

The tailstock can be used to drill concentric holes in your work, or to support your work using a tool called a centre.



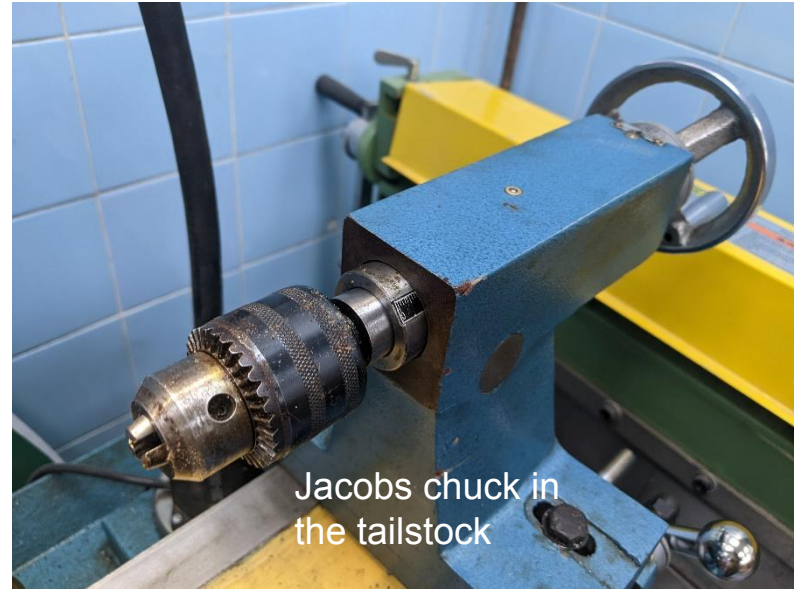
The tailstock can be locked in place with its lever.

The tool can be moved along the axis of the lathe with the wheel at the back.

To remove the tool, retract the tool beyond the zero position and it will be ejected. **Be careful not to do this when the lathe is running!**

Tailstock for drilling

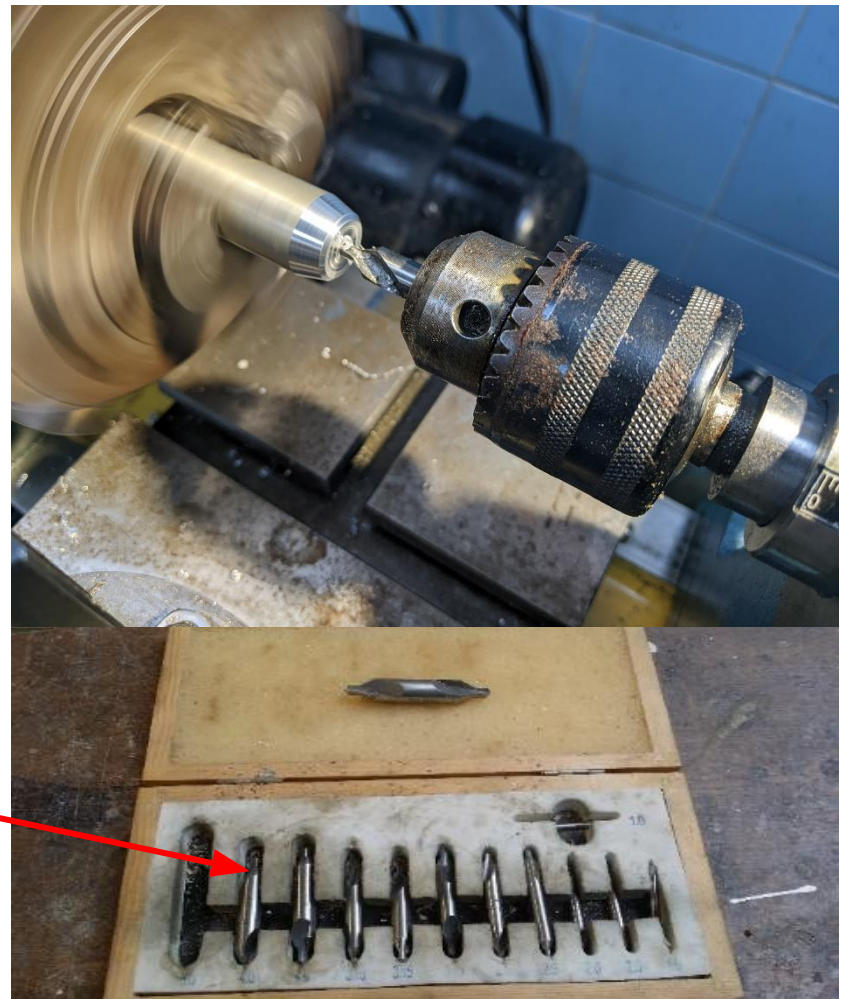
To fit the chuck wind the tailstock quill inwards past zero and insert the taper of the chuck by pushing it in sharply, and then check it is secure by trying to pull it out again. Remember it will eject if you wind out past zero



Tailstock for drilling

Centre Drill

- To ensure that you are commencing the hole dead centre, and to stop the drill bit wandering, use a centre drill to start the hole
- Choose the appropriate size bit for the hole you are drilling



Tailstock for support

- You can use the tailstock for supporting your work.
- To do this you first centre drill your work, then you replace the chuck with either a “live centre” or a “dead centre”.
- Most people prefer a live centre, which rotates with the work.
- A dead centre does not rotate and requires lubrication
- Slide the tailstock close to your work and engage and put pressure on with the tailstock handle, then lock the tailstock



Powerfeed

- Take the tool well clear of the work and make sure the lathe is working correctly before you start to cut, you can even practice away from the chuck
- Check you have set the correct direction – make sure you know which way the lever goes for longitudinal drive
- It's always better to run the drive (not the chuck) slower and a better surface usually results
- Cross feed or transverse-feed drive is not selectable on the CL500M lathe
- Never remove your hand from the feed lever – in an emergency using it is quick and can avoid a situation from becoming worse extremely fast
- **NEVER** allow the carriage to hit the end stop or chuck whilst under power.

Tapping pt.1

- Always drill deeper than the required to allow for the fact that the tap does not completely reach the bottom of the hole
- Use through-holes for threads wherever you can in your design
- Use the live centre in the dimple in the rear of the tap to hold the tap straight
- Never tap under power
- *Use cutting compound*
- Start with the first tap and turn 180° then back 90° when you will feel the right spot where the swarf comes loose



Tapping pt.2

- Be ready for the moment that the tap reaches the bottom of the hole, it will suddenly become much tighter.
- Forcing it further in will most likely break the tap in the hole with no chance of removing it
- Then use the second tap (*don't forget the cutting compound*) and repeat the process.
- When you get to the bottom, carefully remove the tap
- Clean out any swarf and JOB DONE!



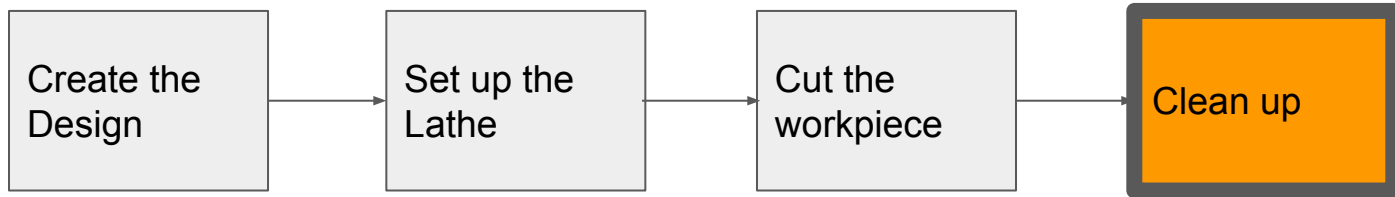
Video clip: <https://youtu.be/-dyO4PEkEkc?t=576>

Shutdown at end of work

- Hit e-stop and then turn off at wall.

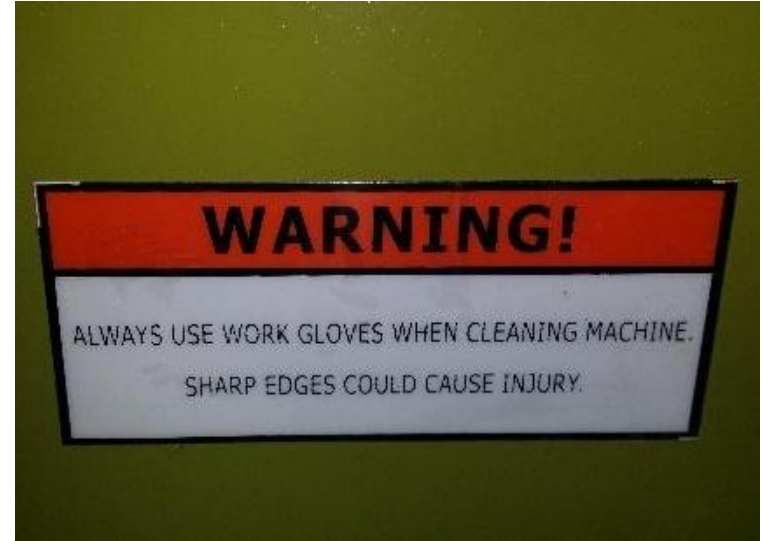


Turning Workflow



Cleaning the lathe: keep it clean!

- Take work out, replace all the bits you may have changed/removed, brush off the swarf from slides and other surfaces with the paintbrush.
- **For cleaning up gloves are mandatory.**
- **Swarf is razor sharp and can go septic if it gets under your skin.**



The six absolute No-Nos of machining

- Never let your chuck come loose, always check it is on tight before use, also check the rest of your lathe as you don't know how competent the previous user was
- Never start your lathe whilst your stock material is loose in the chuck, always check
- Never leave your chuck key in the chuck
- Never allow your cutting tool to hit the chuck jaws – always check your dead-stop setting after making adjustments
- Never allow the carriage to hit the end stop whilst cutting using the power-drive – keep your hand on the power-drive lever and your eye on the gap
- Never wind out the tailstock quill past the zero mark whilst the lathe is running

Summary

- Introduction of the CL500M Metal Lathe
- How to inspect and start the lathe
- Setting up your work and tools
- Different types of tooling
- The fundamental lathe operations:
 - Facing
 - Turning
 - Chamfering
 - Cutting at angle, “turning a taper”
 - Tapping threads
- Switching off
- Cleaning up after finishing



Further reading

- This introductory series is a good primer on all aspects of lathe work:
<https://www.youtube.com/playlist?list=PLY67-4BrEae9Ad91LPRIhcLJM9fO-HJyN>
- "Workshop Practice Series" from specialinterestmodelbooks.co.uk/ - very cheap at ~£7 each

