UNSW SYDNEY
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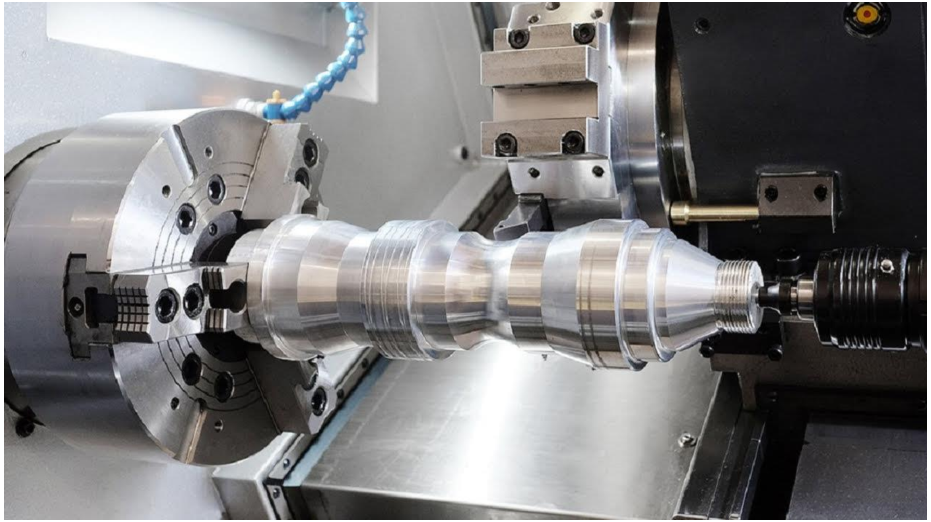
Turning Processes



Week 4 Test

- The test paper and submission boxes will become available **in Moodle** at 3pm, Week 4 Friday.
  - The submission boxes will close at 5pm that same day!
- The test should take approximately 60-90 minutes to complete. However, you will have the full two hours to complete the test and submit your files.
- The topics covered in this test will be:
  - Engineering standards
  - Engineering drawings
- There will be a mix of short answer questions as well as a practical drawings component that must be completed using Solidworks.
- <u>You will not be required to create 3D models for this test.</u>

Week 4 Test

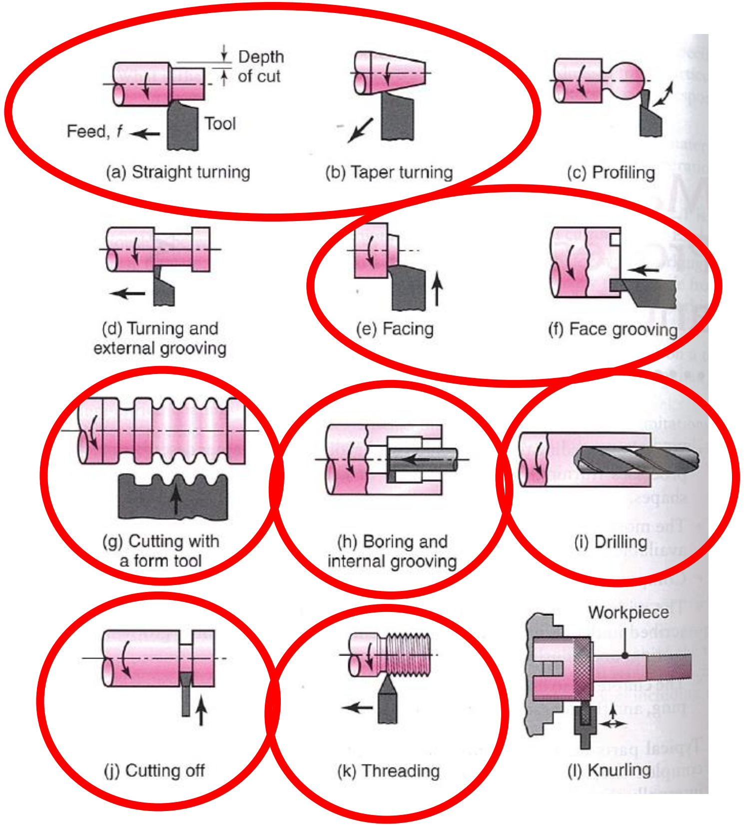
- You will need to submit two types of files:
  - Short answers must be typed using a wordprocesser and submitted to the Turnitin submission box.
  - Your engineering drawing file must be submitted to the File submission box.
- I have created some practice submission boxes.
  - This will let you go through the required submission processes before the test in Week 4.
- Please ensure that you have attempted this before next Friday to avoid submission problems on the day.
  - The last thing you want to be stressing over is submission procedures when the clock is running out.

Topics

- Turning Processes
- Cutting Parameters
- Material Removal Rate
- Roughing and Finishing Cuts
- Cutting Fluids
- Lathes
- Design Considerations
- Thread Cutting
- Boring

Turning Processes

- Turning is a fundamental machining process where the part is rotated while it is being machined.
- Turning is typically carried out on a lathe. Lathes are capable of a range of processes:
  - Turning
  - Facing
  - Forming
  - Boring and internal grooving
  - Drilling
  - Parting
  - Threading



Turning Processes

- Let’s have a look at some of the various processes we just outlined
  - https://www.youtube.com/watch?v=8EsAxOnzEms

Cutting Parameters

- The majority of parameters that affect the quality of the machining have been discussed in Week 1.
- Remember, always adjust your cutting parameters for the material!

General Recommendations for Tool Angles in Turning

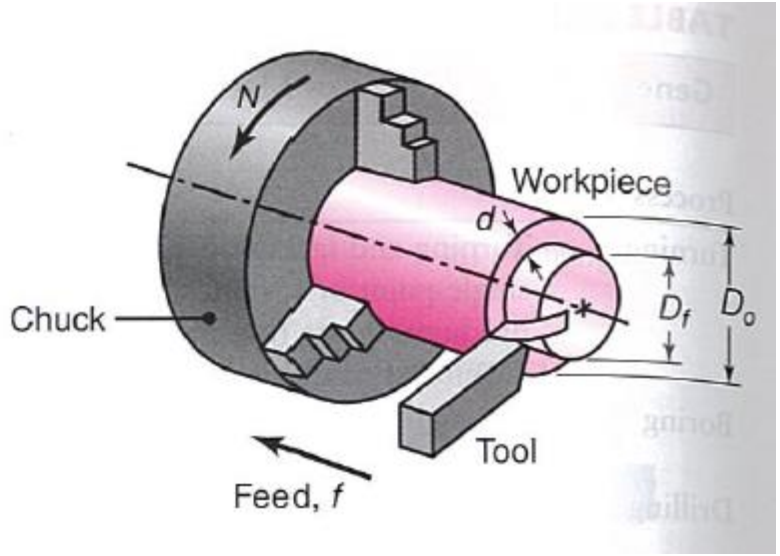
	High-speed steel					Carbide inserts				
Material	Back rake	Side rake	End relief	Side relief	Side and end cutting edge	Back rake	Side rake	End relief	Side relief	Side and end cutting edge
Aluminum and magnesium alloys	20	15	12	10	5	0	5	5	5	15
Copper alloys	5	10	8	8	5	0	5	5	5	15
Steels	10	12	5	5	15	−5	−5	5	5	15
Stainless steels	5	8–10	5	5	15	−5–0	−5–5	5	5	15
High-temperature alloys	0	10	5	5	15	5	0	5	5	45
Refractory alloys	0	20	5	5	5	0	0	5	5	15
Titanium alloys	0	5	5	5	15	−5	−5	5	5	5
Cast irons	5	10	5	5	15	−5	−5	5	5	15
Thermoplastics	0	0	20–30	15–20	10	0	0	20–30	15–20	10
Thermosets	0	0	20–30	15–20	10	0	15	5	5	15

Material Removal Rate

- We can quantify the amount of material removed in a similar manner to what we did for hole making.

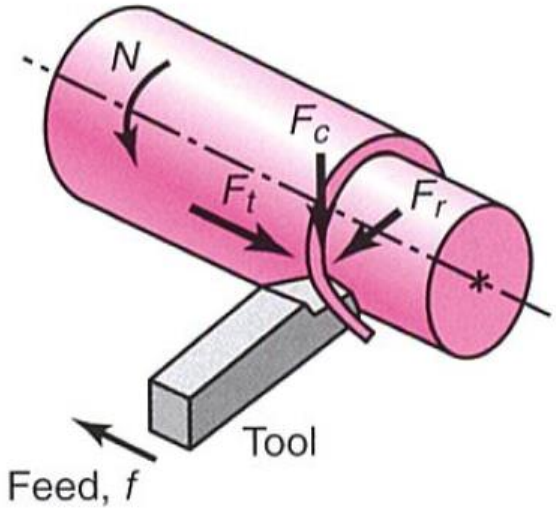
$$MRR = \pi D_{avg} d f N$$

- D – average diameter of workpiece [mm]
- d – depth of cut [mm]
- f – feed speed (linear speed of tool along workpiece) [mm/rev]
- N – rotational speed in RPM [rev/min]

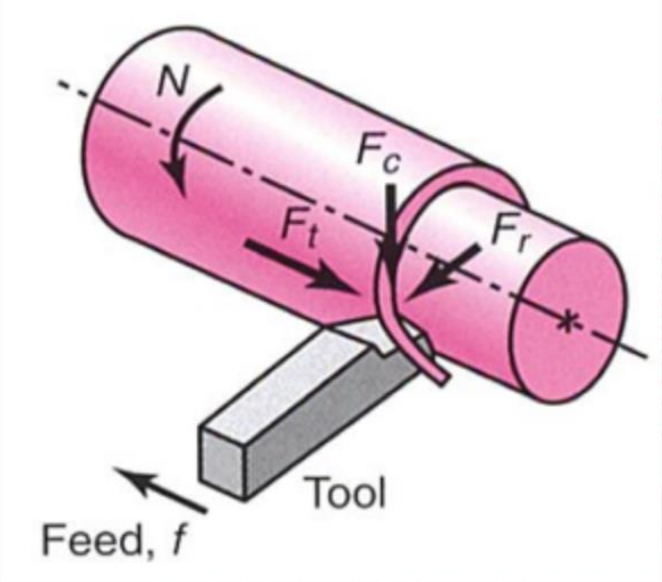


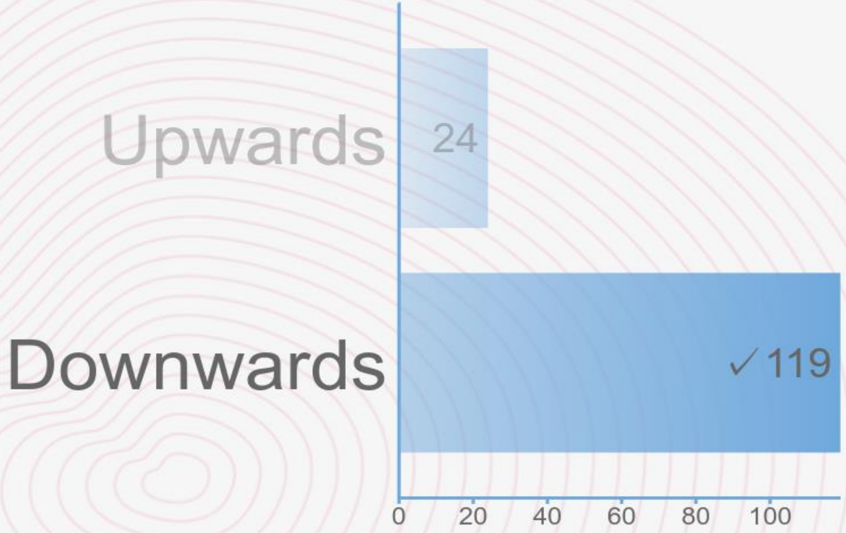
Cutting Forces

- It is important to think about how the cutting forces affect the machining job.
- When moving the cutter through the workpiece, three forces are experienced:
  - Radial force
  - Cutting force
  - Thrust force
- How do these forces impact the cutter?



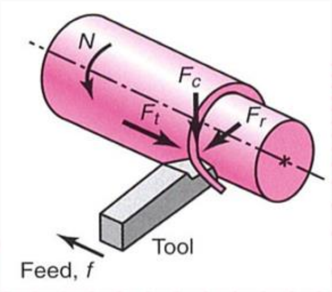
Which direction would the cutting tool deflect due to the cutting force Fc?

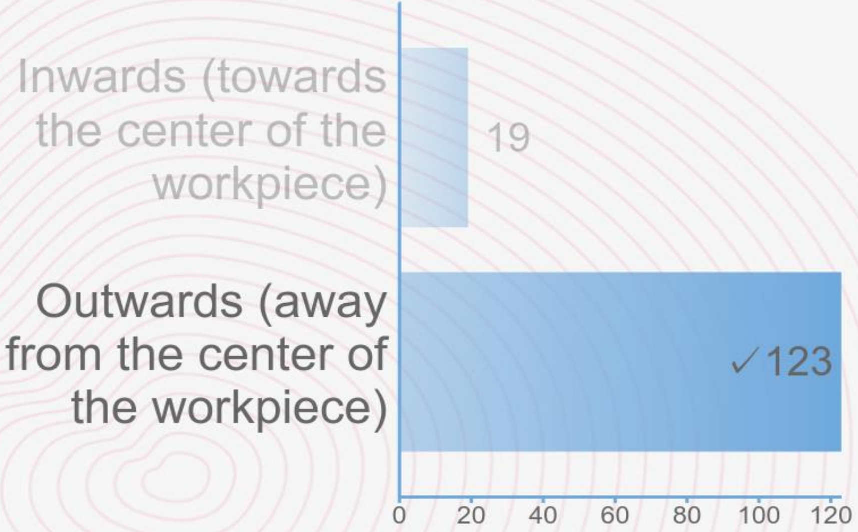




Total Results: 143

Which direction would the cutting tool deflect due to the radial force Fr?





Total Results: 142

Why is it important to understand how the forces affect the cutting tool during turning operations?

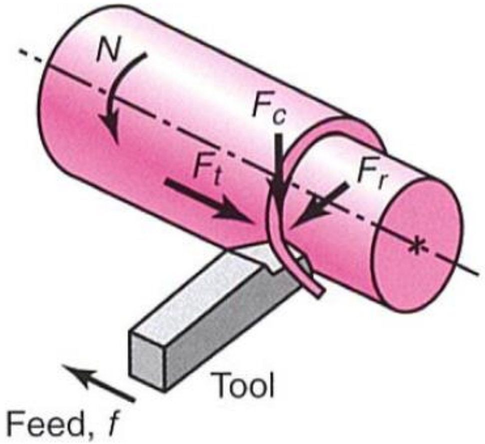
“ ensure the cutting tool not damaged ”

“ to avoid excessive distortion of workpiece and improve accuracy when cutting ”

Total Results: 154

Roughing and Finishing Cuts

- This gives us a strong understanding for the typical machining procedure and approach.
- Roughing cuts
  - High feed rates
  - Large depth of cuts
  - Little concern for dimensional accuracy/surface finish
- Finishing Cuts
  - Low feed rates
  - Shallow depth of cuts
  - Strongly concerned with dimensional accuracy/surface finish



Cutting fluids

- Turning is not considered a severe machining process but can still benefit from cutting fluids depending on the material and required process.

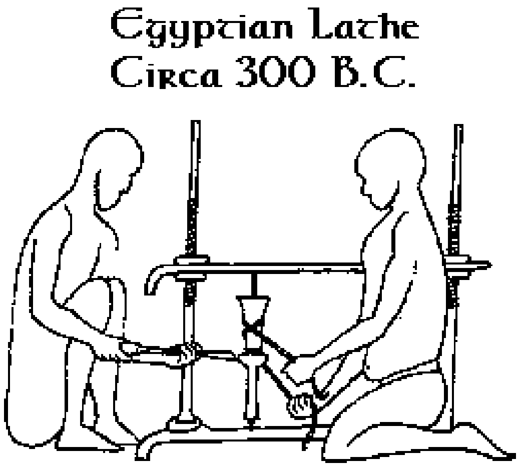
General Recommendations for Cutting Fluids for Machining (see also Section 33.7)

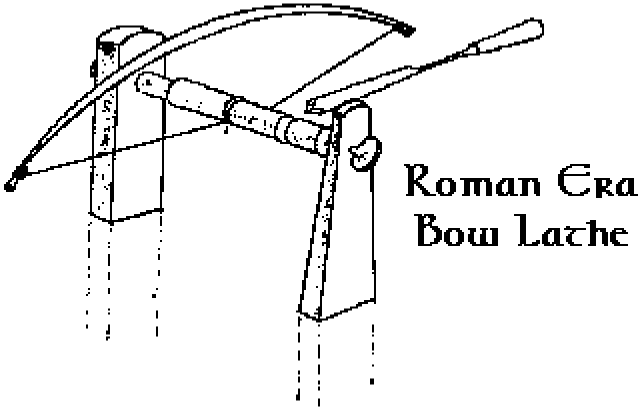
Material	Type of fluid
Aluminum	D, MO, E, MO + FO, CSN
Beryllium	MC, E, CSN
Copper	D, E, CSN, MO + FO
Magnesium	D, MO, MO + FO
Nickel	MC, E, CSN
Refractory metals	MC, E, EP
Steels	
Carbon and low-alloy	D, MO, E, CSN, EP
Stainless	D, MO, E, CSN
Titanium	CSN, EP, MO
Zinc	C, MC, E, CSN
Zirconium	D, E, CSN

Note: CSN = chemicals and synthetics; D = dry; E = emulsion; EP = extreme pressure; FO = fatty oil; and MO = mineral oil.

Lathes

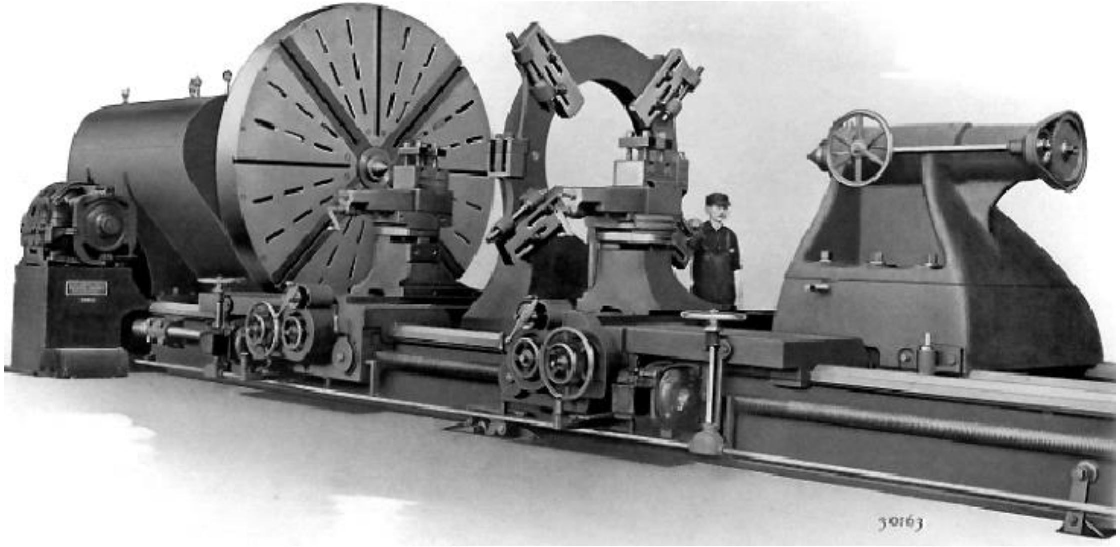
- Lathes are considered to be the oldest machine tools.
- Woodworking lathes were developed as early as 1000 B.C. by the Egyptians.





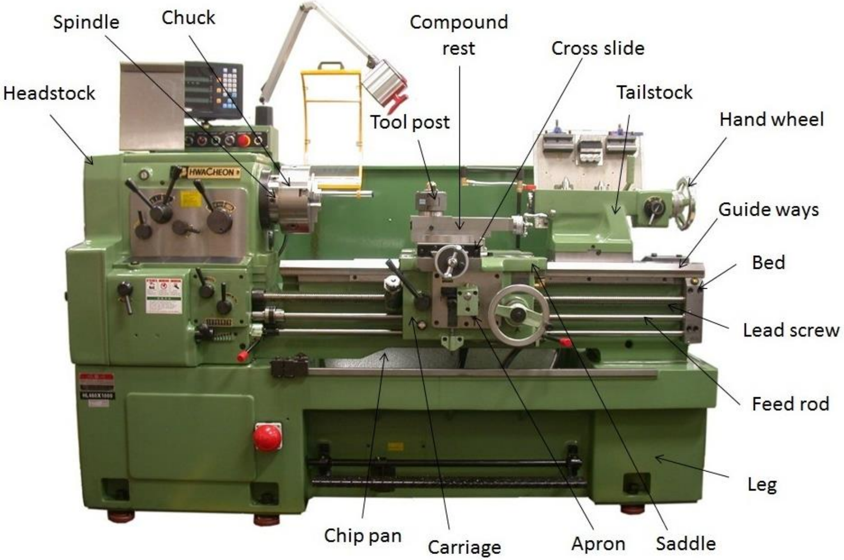
Lathes

- The metalworking lathes that we know and love weren’t invented until the late 1700s.
- The most common lathe was called an engine lathe.
  - This is due to the fact it was powered from engines on the factory floor via belts and pulleys.



Lathes

- All modern lathes are mercifully equipped with electric motors.
- Lathes are specified by the following parameters:
  - Swing: the maximum diameter of the workpiece that can be machined
  - The distance between the headstock and the tailstock centers.
  - The length of the bed
- E.g. 360mm swing by 760mm between centers by 1800mm length of bed.



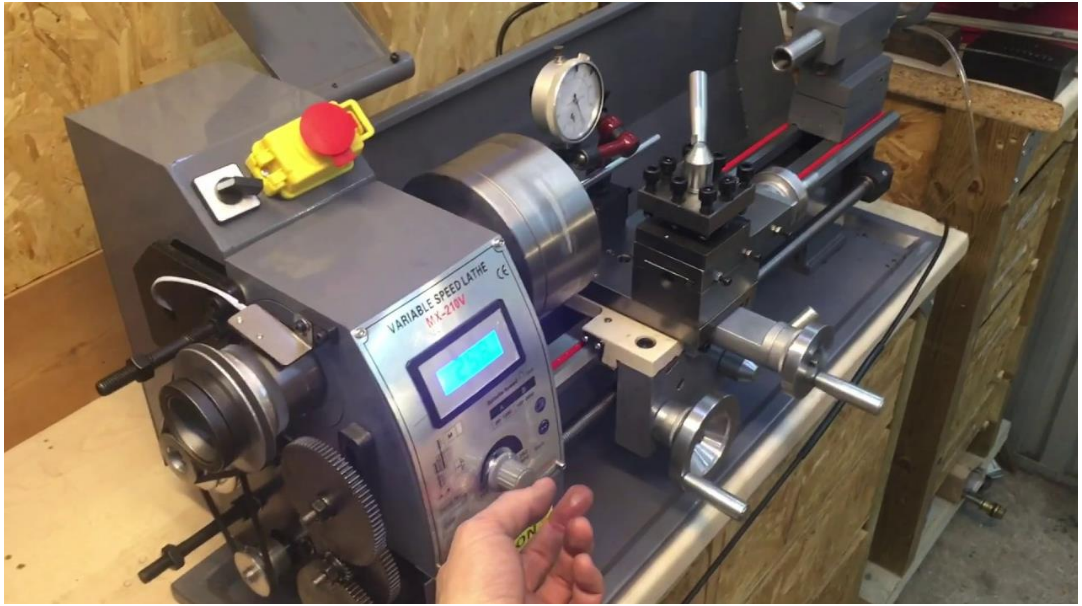
Lathes

- There are a variety of methods for securing the workpiece to the lathe:
  - 3-jaw chucks are used for round workpieces and are self-centering
  - 4-jaw (independent) chucks are used for square or odd shaped workpieces
  - Power chucks are actuated pneumatically or hydraulically, great for high volume manufacture
  - Faceplates are used for clamping irregularly workpieces not suited to 4-jaw chucks



Other Types of Lathes

- Bench lathes
  - Low powered lathes capable of being place in smaller spaces.
  - Usually operated by handfeed and only suitable for small workpieces.



Where is the carriage?

Total Results: 128

Powered by Poll Everywhere

Where is the spindle and chucks?

Total Results: 129

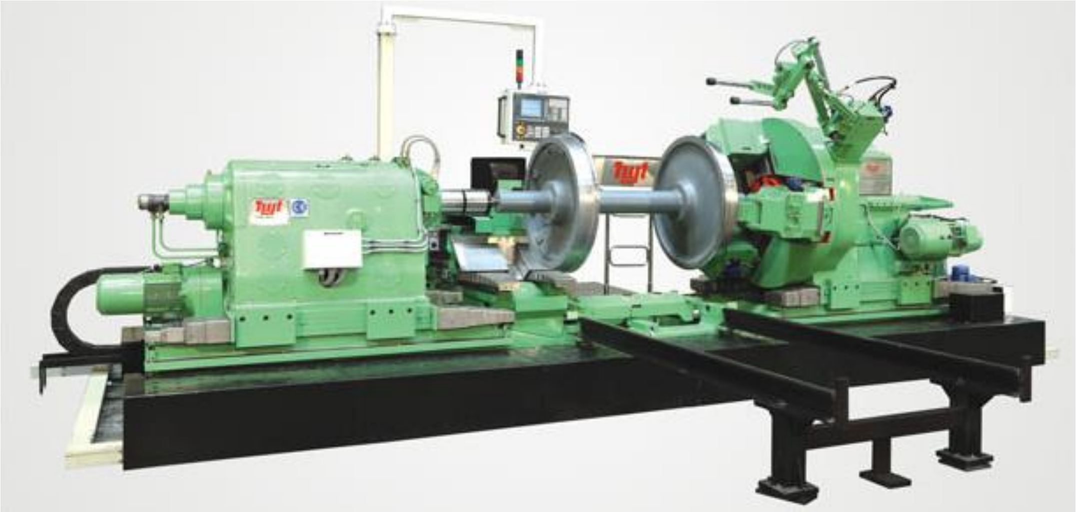
Where is the lead screw?

Total Results: 128

Powered by Poll Everywhere

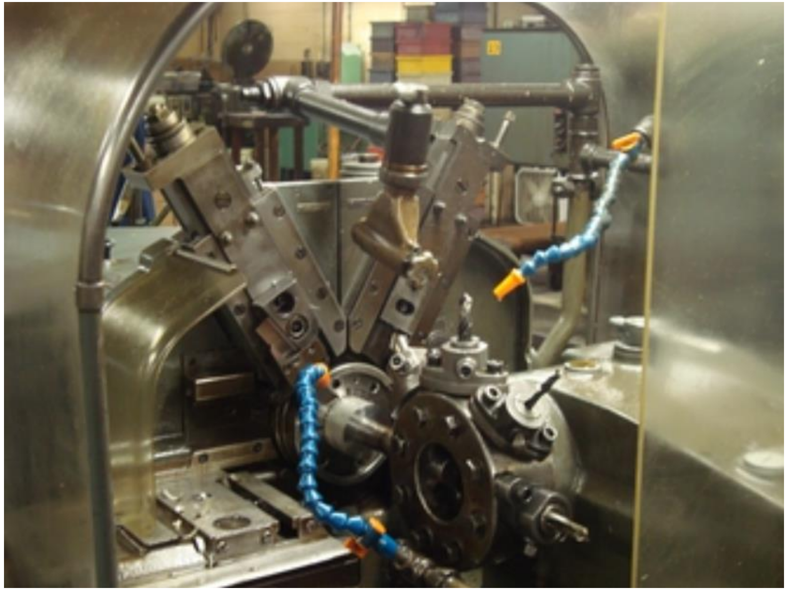
Other Types of Lathes

- Special-purpose lathes
  - Only used for specific applications. The below example is for creating railroad wheels.
  - Workpiece size could be as large as 1.7m to 8m in diameter.



Other Types of Lathes

- Automatic bar machines
  - Designed for high-production rate machining of screws and other threading parts
  - After machining is complete, the parting of the completed part as well as feeding in the new stock is automated.
  - https://www.youtube.com/watch?v=nZtfW2e2Cp0
  - https://www.youtube.com/watch?v=vvCIb2NLODo



Other Types of Lathes

- Computer numerical control (CNC) lathes
  - These lathes contain automatic tool changers (ATCs). These are turrets capable of swapping the required cutting tools needed for multiple processes.
  - Reliably repetitive, maintain desired dimensional accuracy, requires less skill to operate.
  - Hilariously expensive
  - https://www.youtube.com/watch?v=lcGHtI9Lql4

Design Considerations

- Although we won’t typically be manufacturing the part, we will be designing it. Some important considerations to factor in are:
  - Parts should be designed so that they can be fixtured and clamped into work-holding devices.
  - Sharp corners, tapers, steps in the part should be avoided. Why?

When designing parts, why should sharp corners, tapers and steps (jumps in dimensions) be avoided?

“ They are difficult to machine generally. ”

“ Dangerous ”

“ Safety reasons ”

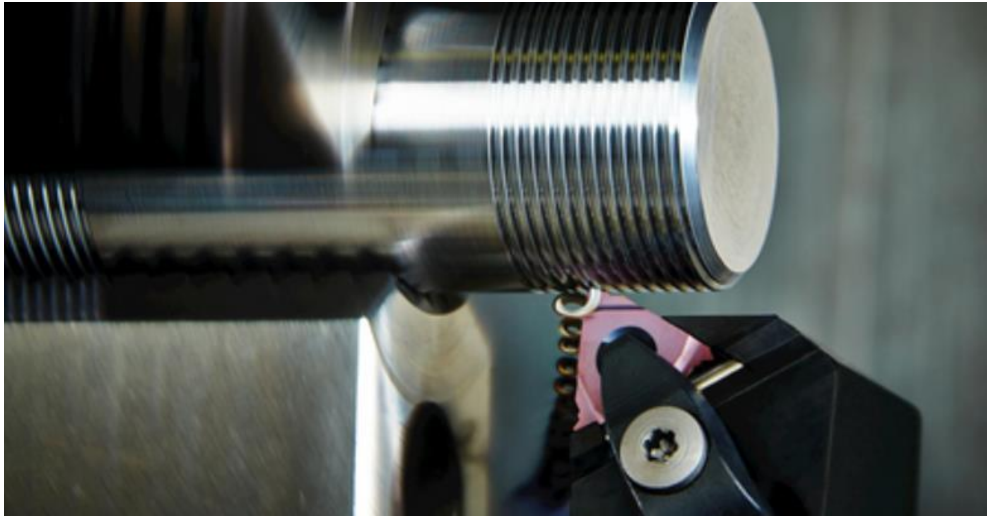
Total Results: 152

Design Considerations

- Although we won’t typically be manufacturing the part, we will be designing it. Some important considerations are:
  - Parts should be designed so that they can be fixtured and clamped into work-holding devices.
  - Sharp corners, tapers, steps in the part should be avoided. Why?
  - Blanks should be as close to final dimensions as possible to minimize production time.
  - Parts should be designed so that cutting tools can traverse the workpiece without obstruction
  - Design features should avoid requiring bespoke tooling, inserts and toolholders.
- CNC Fails: https://www.youtube.com/watch?v=PsFNeiAu04M

Thread cutting on a lathe

- We learnt about tapping and threading in hole making.
- It is also possible to cut threads using a lathe.
  - Cutting threads on a manual lathe required considerable skill.
  - These days, if a thread is to be cut using a lathe, we take advantage of CNC.
  - https://www.youtube.com/watch?v=alqa7qf81OA



Boring

- Boring is a machining process that enlarges a previously made hole.
- It is also used to create circular internal profiles.
- Whilst the tools used are similar to that employed in turning, we must use a boring bar.
  - This minimizes tool deflection, vibration and chatter and maintains dimensional accuracy.

Boring

- Bores of small diameter are capable of being conducted on lathes.
  - https://www.youtube.com/watch?v=i1bhiX1ldnE
- If a large bore diameter is required, we need to utilise a specialist machine called a boring mill.
  - https://www.youtube.com/watch?v=xzsqWscLfbA