Brunsfield Basic Lathe Training Notes

General Rules and safety

1. Following the *completion of basic training*, students will be permitted to use the Brunsfield Centre's workshop, and only those whom have already completed basic training will have access. Basic training will however grant limited access to the space as students will not have access to the mill, lathe, and welding area without having completed subsequent trainings for the respective equipment.

2. It is important to never work alone in the shop and to always have a supervisor on duty in the space. If working alone there is no one to help in the case of an accident or injury which makes it very dangerous.

3. Safety glasses must always be worn within the workshop. Safety glasses must be worn even if a face shield or welding helmet is being used overtop of them. Never approach anyone actively working the workshop without wearing safety glasses.

4. Proper footwear must be worn when working in the workshop to avoid hazardous situations (e.g. sparks, sharp metal, hot chips from operations) where the inappropriate footwear would cause greater levels of risk/harm. Closed-toed shoes must be worn. Not flip flops, crocs, mesh-toed running shoes or and similar style or type of footwear. Steel-toed or similar footwear is recommended when working on larger, heavier projects.

5. Clothing that is long, baggy and/or loose must be rolled up. Strings on the front of a hoodie and hanging jewelry must be tucked under a shirt or taken off. Rings must not be worn inside of the machine shop. Long hair must also be tied back and up. These rules are in place to avoid the danger of having machinery grab and pull you into them causing severe harm.

6. No food or drink should be brought into the workshop. There are many chemicals, coolants and other contaminants that can be harmful if ingested.

7. The Brunsfield centre is a serious workspace and must be treated as one. Pranks, rough-housing, and general fooling around while within the workshop will not be tolerated. Any behavior deemed unprofessional and to this way by a supervisor will be met with an immediate suspension of shop privileges.

8. All persons within the MTC and Brunsfield Centre must always be of good health both physically and mentally as well as not being under the influence of any drugs and or alcohol.

9. A first aid kit is located within the Brunsfield office (Room A139). Any injury severe or small should be reported to a supervisor and an incident report should be

filled. In the case a supervisor is not present, contact the nearest designated first aider (a list of first aiders can be found on the main door).

10. An emergency spill kit is available in the Brunsfield Centre. The spill kit can be used to clean and or contain hazardous materials that get spilled in the shop. A supervisor must be advised whenever the spill kit is used.

11. There are fire extinguishers and emergency stops located throughout the Brunsfield Centre. There is one fire extinguisher located at each of the main entrance doors, and one near the designated welding area. There are three emergency stops located at the main entrances and in the office. Students should be familiar with the location of each fire extinguisher. If an individual is not familiar with these locations, they should request the information from a supervisor their first time in the workshop.

12. Students are responsible for knowing their own limited knowledge of facilities and equipment, and to ask for assistance from a supervisor when encountering any unfamiliar equipment or processes (i.e. if you're not sure: Ask). Supervisors are there to help with any matter pertaining to the workshop and would much rather taking the time to explain something many times then having someone get injured or equipment break because of improper use of the space.

13. Before working with unfamiliar materials and chemicals, become familiar with the product's handling procedures. MSDS (Material Safety Data Sheets) info can be obtained by using the Google search engine and typing "MSDS" followed by the product name and/or asking a supervisor to see the MSDS.

14. Students as well as supervisors are entitled to a safe working environment. Safety is everyone's responsibility, thus anyone witnessing any unsafe behavior or working practices must advise a supervisor immediately.

15. Any damaged equipment must be reported to a supervisor immediately to ensure shop safety and that the issue related to the equipment is correctly addressed. A supervisor must also be notified in the case of a broken tool to ensure that the tool was being used properly as to avoid the breakage of future tools.

16. Students are responsible for keeping the workshop clean and tidy. It is required that students clean up any work areas or machines that have been used after you have finished. The floor must be kept free of debris and tripping hazards. All tools must be put back in their proper places after use. Unplug all power tools while not in use.

The Brunsfield Centre is a joint workspace for all students and a certain respect must be held for the space. It is important to treat the equipment and tools properly and with care so that everyone can have a better-quality work experience. The Brunsfield staff reserve the right to revoke shop privileges of anyone within the shop who does not respect the tools and equipment of the space as well as the rules listed above.

Notes

Turning Operations - Cutting speeds

When performing any kind of machining process where you are removing material the speed at which you remove that material is of utmost importance. End mills, drill-bits and other cutter-based tools are only made to withstand certain cutting conditions. As such it is critical for the life of the tool and the efficiency of the machining process that the tools are run within their working parameters. When turning with a standard cutting tool for the lathe, the variables surrounding the operation are as follows.

The main variables to consider when turning are:

- Desired Diameter and Depth of Cut
- The type of material – For specific properties and tool selection
- The coolant selected – Specific to the type of material and tool
- Machine and work-holding – Setup rigidity
- Tool Type and Material

Considering these factors, there is still a level of understanding that is required before the correct values can be found. This comes with experience, however there is a simple equation that may be used as a starting guideline for the correct rotation speed of the workpiece.

$$RPM = \frac{4 \times CS}{Dia.}$$

This starting formula takes into consideration the surface removal rate for a specific material/tool combination (denoted as **CS**) and the outmost cutting diameter of the tool (denoted as **Dia.**), and returns the recommended basic rotational speed of the tool (**RPM**). With a starting value an operator can begin the process and use their judgement to adjust the speed of the machine relative to the feedback encountered.

In general it is hard to list specific cutting speeds for each material in each situation. Some tools will contain information on their specific recommendations, however for general purpose work this is not usually obtainable. As a starting point, bellow are some recommended surface removal speeds which may be used in the general equation above.

Typical Values for SFM when using High Speed Steel (HSS) cutters are:

Steel	80 SFM
Stainless Steel	40 SFM
Brass	250 SFM
Aluminium	300 SFM
Plastics	100 – 200 SFM

With cutting tools made of carbide it is usually appropriate to run the workpiece with 2 - 3 times the recommendations above. Insert carbide tooling will usually have a specific set of values with the packaging that are optimal for the tool.

Examples

Turning a ½" steel rod in the lathe

CS (steel) =80 SFPM
Piece Diameter = ½"

RPM = 4 x CS/ DIA.
= 4 x 80/.5
= 640 RPM

Turning a 2" Piece of aluminium in the lathe

CS (Aluminium) = 300SFPM
Piece Diameter. =1/4"

RPM = 4 x CS/DIA
= 4 x 300/.25
= 4800 RPM

Since this equation provides only an approximate value for the maximum speed for a process, the feedback given from the tool and machine is the best source of understanding for what is happening (for good or for bad). The ability to interpret the feedback and the "feel" from a machine is what separates good machine operators from those with little to no experience. For example, a turning process being performed at too high of an RPM, and/or at an incorrect depth of cut, will in some cases cause a lot of "chatter". Chatter is the machining terminology for vibration. That is, chatter is used is because as the tool will vibrate a loud chatter-like noise. Turning operations with a significant amount of chatter can yield, in most cases, a poor surface finish or surface markings. Audible feedback is one of the best forms for understanding how the machining process is performing. If something does not sound right, then there is a good possibility that the tool is not performing within its working parameters. This skill is developed over time and it is therefore recommended to always inquire with a supervisor before performing a machining process about the recommended cutting speeds and setup.

Lathe

The metal lathe is a machine tool that has been used in industry since the time of the industrial revolution over 200 years ago. The material removal process of turning on a lathe is accomplished by revolving a mounted workpiece at high speeds against a movable and hard cutter which cuts away the material it touches. The tool bit can be precisely controlled allowing the operator to cut the workpiece into the desired shape.

Lathes are produced in a variety of sizes and formats ranging from those that are used by jewelers and instrument makers, to machines that turn large cylindrical shapes, such as shafts used in heavy industries such as mining and marine. The size of a lathe is specified by the maximum diameter that it can turn (**Swing**) and the maximum length of workpiece that can be accommodated between centers (**Distance Between Centers'**). Other important specifications include HP of motor, Spindle Bore, Spindle Taper, Tailstock Taper, Cross Slide Travel, Tailstock Quill Travel, Spindle Speeds, and Threading ranges.

Parts Of the Lathe

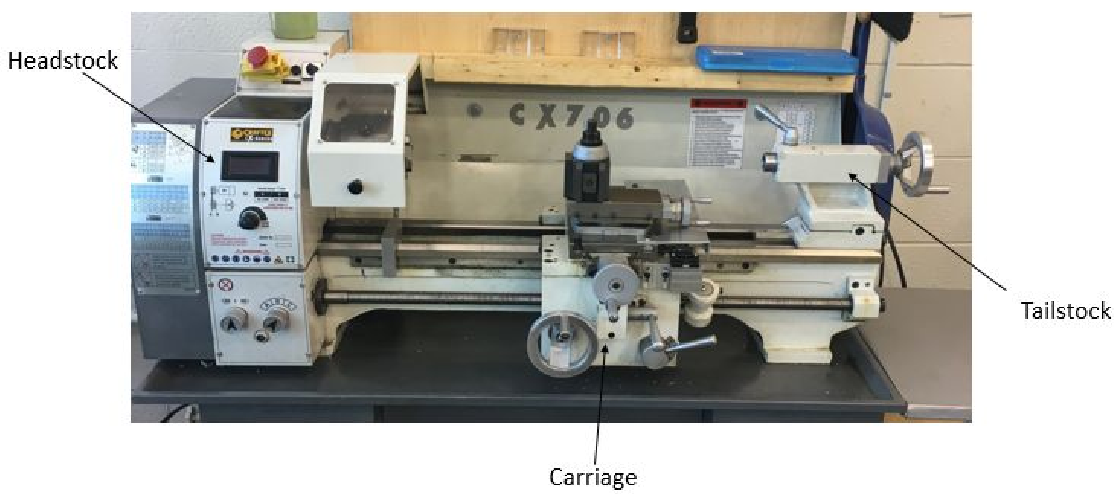

Figure 1: MTC Lathe

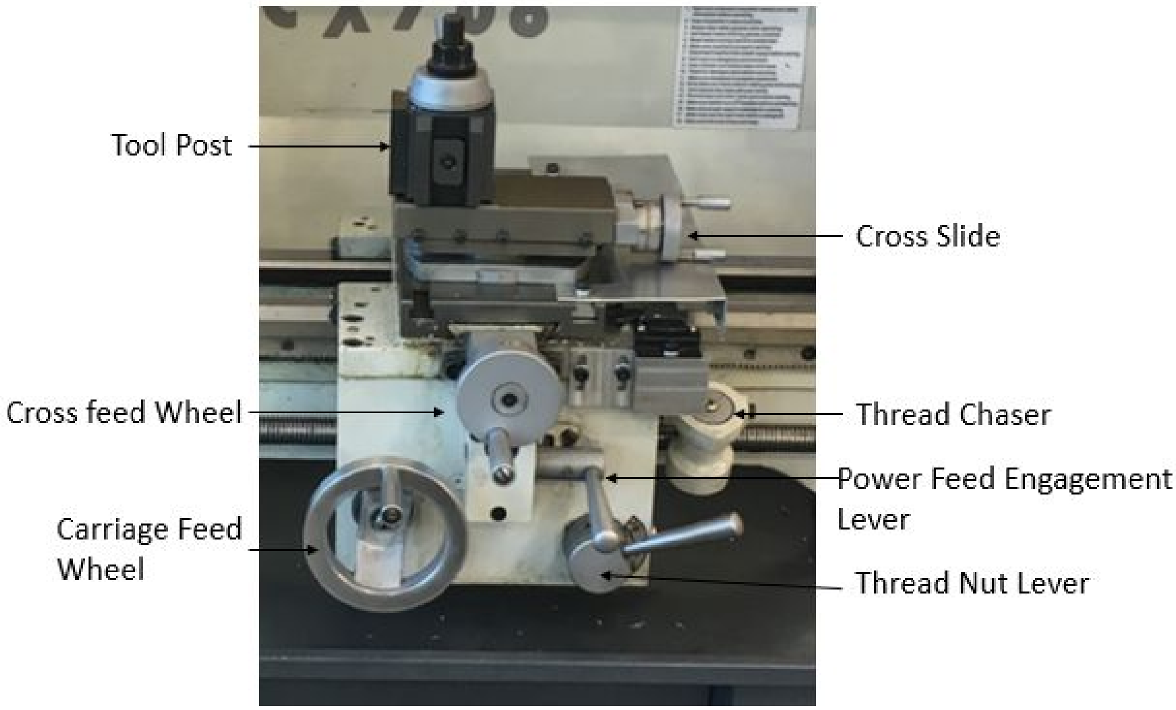

Figure 2: MTC Lathe Carriage

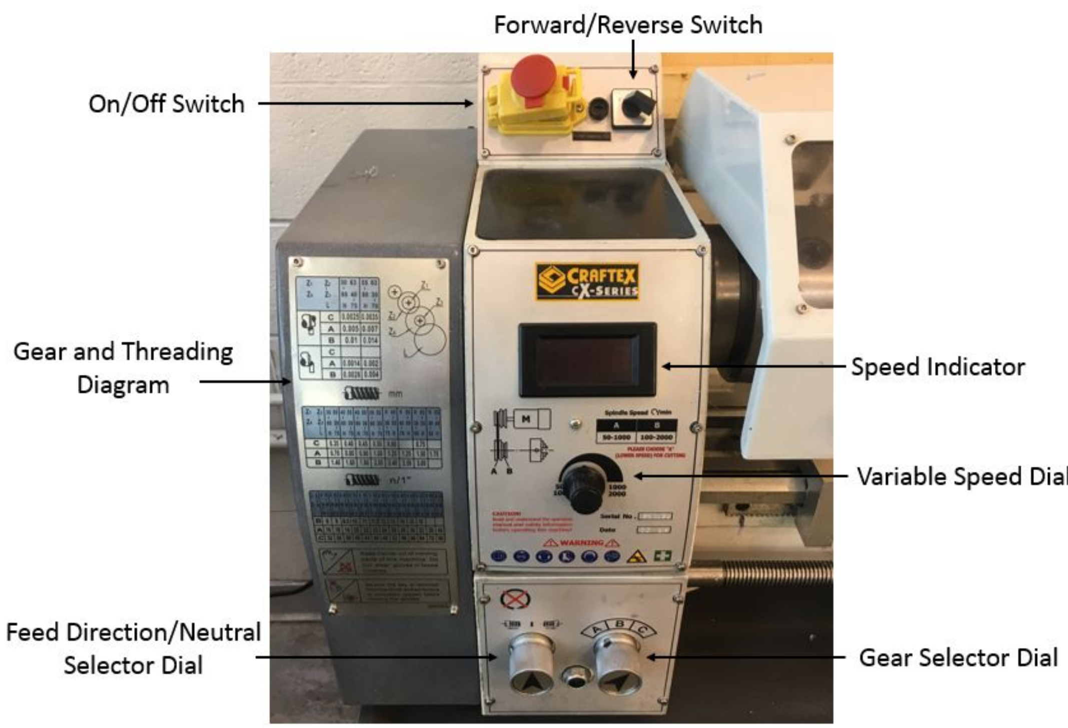

Figure 3: MTC Lathe Headstock

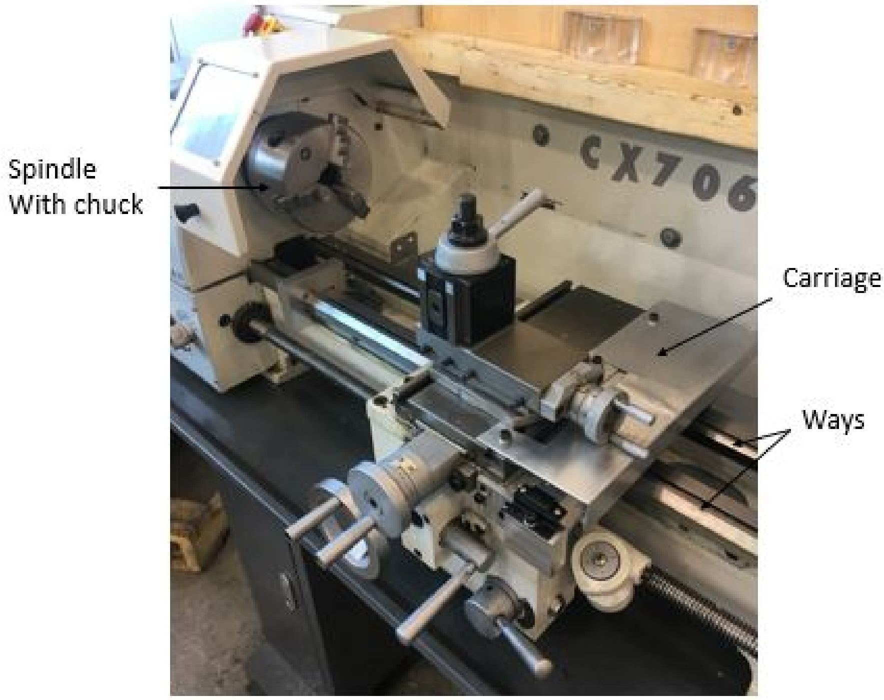

Figure 4: MTC Lathe Bed

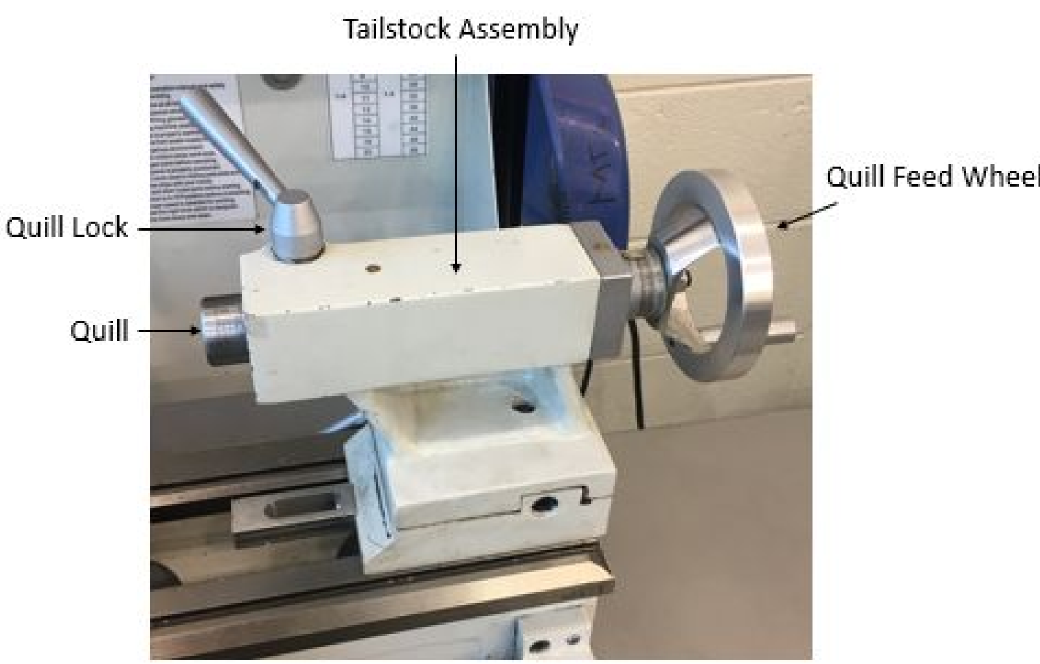

Figure 5: MTC Lathe Tailstock

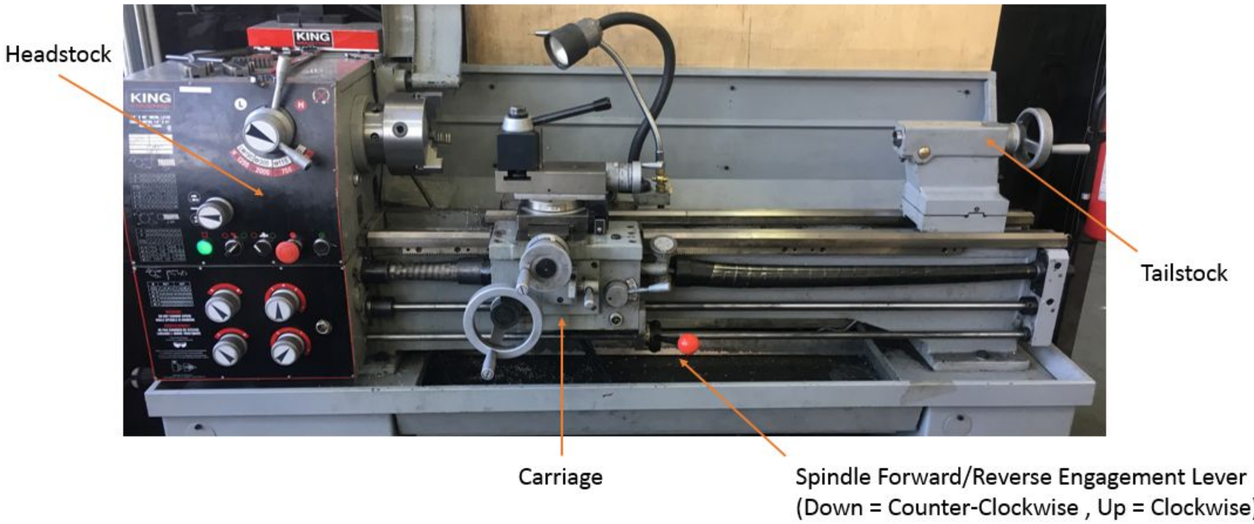

Figure 6: Brunsfield Lathe

Figure 7: Brunsfield Lathe Headstock

The following definitions will be in reference to the Figures above.

Lathe Bed: The bed of the lathe is the main foundation of the lathe that supports the other parts of the lathe. It must be rigid and precisely machined to achieve proper accuracy while working.

The Ways: The Ways are the precision finished bearing surfaces of the bed on which the Headstock, Tailstock and the Carriage are mounted and aligned parallel to the axis of the spindle through the length of the bed. The *Outer Ways* are the bearing surfaces on which the carriage rides and the *Inner ways* are used to align the tailstock and the headstock.

Headstock: The headstock is an assembly that consists of the headstock casting, the main spindle, the drive and speed selection mechanism and the gears to drive the **leadscrew**. The **main spindle** provides the mounting for a chuck or a faceplate. Its center is bored out through its length to allow a workpiece to pass through and the end where the chuck is mounted has an internal taper in which to insert a center. The main spindle controls the speed of the workpiece when it revolves.

Tailstock: The tailstock is a cast and machined unit that provides bearing support for longer workpieces or with a drill chuck, may be used for drilling. The tailstock consists of a mounting base that aligns it with the main spindle axis, a movable spindle and locking mechanisms.

Tailstock Quill: The tailstock spindle has a tapered hole on its end to receive a center for workpiece support or a drill chuck for drilling the workpiece. Its movement is controlled with handwheel with a micrometer ring and can be locked in position with a locking lever.

Carriage: The carriage of a lathe is an assembly that is moved along the ways of the lathe to control the position of the tool bits. These movements, powered either by hand or using the power feeds of the lathe, advance the toolbit into the workpiece to remove material. The carriage has the following parts; the Apron, the Saddle, the Cross Slide, the Compound Slide, and the Toolpost.

Apron: The apron is the front section (overhanging the bed of the lathe) where the carriage handwheel, the cross slide handwheel and the levers for the power feed engagement and threading are located.

Saddle: The saddle is the H shaped piece with the bearing surfaces that rest on the ways of the bed. It also has the dovetails that the cross slide runs on.

Cross Slide: The cross slide moves perpendicular to the axis of the lathe bed on ways on the saddle. A handwheel with a micrometer collar allows for precise movements (to .001”) of the tool

Compound slide: The compound is mounted on the cross slide and can be rotated to any angle to allow the tool to advance at any angle.

Toolpost: The toolpost is mounted on the compound rest and holds the tool bit holders.

Quick Change Gearbox: The quick-change gearbox allows the various feed rates to be quickly set up for the carriage and cross slide power feeds and the feeds for thread cutting.

Lead Screw: This is the threaded shaft that runs along the bed of the lathe on the operator's side from the headstock to the end of the bed. This shaft, when rotating, is engaged by *half-nuts* to drive the carriage when cutting threads. A *thread-chaser* is used to indicate when the *half-nuts* are to be engaged for cutting a particular thread. The leadscrew only rotates when the main spindle is turning, as it is connected to the main spindle through the change gears and the quick-change gearbox. Charts on the headstock indicate the threads/inch screw threads or the pitch in metric that various gear combinations produce, the proper gear combinations can then be determined.

Power Feed: This is a slotted shaft that runs along the bed of the lathe from the headstock to the end of the bed, usually below the leadscrew. When rotating, will transmit the power to drive the carriage feed and the cross feed. It only rotates when the main spindle is turning. The rate of feed is set by the change gears/ quick change gearbox. Feed rates are expressed as inches/revolution of the main spindle (or mm/rev. in metric)

Terminology

Backlash: Backlash is a term used to identify the space of no contact on a gear train when switching from reverse to forward. As a general rule the more backlash a system the harder it is to control the precision of the instrument and therefore is something to be avoided.

Chatter: Chatter occurs when the tool bit or the workpiece is vibrating during machining leaving a patterned finish rather than a smooth finish and making a loud "chattering" noise. The simplest and usually most effective way to remove chatter is to make the tool clamping or piece clamping more rigid to try and mitigate vibration. Chatter is bad because the constant vibration of the tool will significantly decrease tool life as well as affect the overall precision of the work.

Coolant: Coolant is a liquid that is applied either as a light mist or a flow of liquid at the area of contact between the tool bit and the piece. It performs several functions, the primary function being to dissipate the heat generated from the cutting. Coolant also cools the workpiece and provides lubrication during cutting to reduce tool wear. Coolant is not required on all materials and the type of coolant varies depending on the material being machined. It can produce a better surface finish on some materials.

Machining Operations

Facing Cut: A facing cut is a cut that is done across the face of the workpiece using the cross slide to move the tool bit either using the power feed or by hand feeding.

Turning Cut: Turning is a cut made parallel to the axis of the bed of the lathe using the carriage power feed or by hand using the carriage handwheel.

Boring: Boring is an internal cut that hollows out the end of the workpiece and can be a very precise cut

Drilling: Drilling is done by using drill bit held in a drill chuck inserted into the tailstock spindle or using taper-shank drill bits inserted either directly into the tailstock spindle.

Parting: Parting separates the workpiece from the stock. It is used when repetitive parts are made or for parts that would be difficult to hold by conventional means during machining. It is usually the last machining operation that is performed on the part. When parting the piece must always be supported with a live center and the speed must be dropped drastically.

Grooving: This type of cut leaves a groove in the part and is performed using the cross slide of the lathe to move the tool bit in to the required depth of cut.ie; an O ring groove or a groove for a retaining ring (circlip).

Threading: Threading is done by taking a series of cuts using a thread form tool to reach the final depth and profile of the thread required. The turning speed is usually reduced to less than 120 RPM and lighter cuts are taken, with the compound used to advance the toolbit on each successive cut. Threads may be inch or metric, internal or external, left hand or right hand depending how the lathe leadscrew is set. Tapered threads such as pipe threads require the use of a taper turning attachment.

Knurling: This operation puts a patterned roughness into a round workpiece to provide a raised gripping surface. The knurling tool is rolled against the workpiece as it slowly revolves and is fed along the length to be knurled using the leadscrew. The federate is set by the selection of the screw pitch set on the quick-change gearbox.

Work Holding

When using a lathe, the workpiece is rotated by the main spindle in the headstock and must be attached somehow to this spindle. There are several common methods used to do this. The most common method is using a self-centering **3 Jaw Chuck**. Other methods include: the **4 Jaw Independent Chuck**, **Mounting between Centres**, **Faceplate Mounting**, and **Collets.** Longer and or slender workpieces may be supported by a *Steady Rest* or a *Follower Rest*. The following section will go into detail about the previously mentioned work holding methods.

3 Jaw Self Centering Chuck

This chuck has 2 sets of 3 jaws that can grip a round workpiece either on the inside or from the outside. The three jaws have a specific serial number and are numbered from 1 to 3. When changing sets of jaws, they must be installed in the proper 1 to 3 sequences in order to fit properly and achieve self – centering. The jaws, being self-centering automatically align the center of the workpiece to the axis of the lathe main spindle, so it is a very fast chuck to use for machining. However, unless a precision chuck is used, the chuck may have an eccentricity of up to 0.005”. knowing this lack of precision, it is to be noted that If a workpiece is machined, removed and then reinstalled into the chuck it may not run true and further cuts will not be concentric to previously machined sections of the part.

The jaws of the chuck are opened and closed with a chuck key. The key must never be left in the chuck after using it to install or remove a workpiece as it will become a very dangerous projectile if the machine is turned on.

4 Jaw Independent Chuck

The four-jaw chuck is very similar to the three-jaw chuck in function. However, the four-jaw chuck allows each jaw to be individually adjusted. The individuality of each jaw permits the user to hold non-circular pieces or hold a piece of center. The four-jaw chuck is also used when precision and repeatability are required as it can be fine-tuned to be within a desired tolerance.

Turning Between centers

To machine between centers both the lathe and the workpiece must be prepared. The type of work piece that is often machined this way is shafting or a longer type of piece. Both ends of the piece must first be drilled with a center drill. These holes will determine the axis of rotation and may be concentric with the shaft center or eccentric. The chuck of the lathe is removed and replaced with either a drive plate or a faceplate. A dead center is inserted into the taper of the headstock spindle and a live center is inserted into the tailstock to support the outboard end of the piece. The tailstock must be aligned with the axis of the headstock spindle or a tapered cut will result, unless of course, that is the desired result.

Face Plate

When using a faceplate, the part to be machined is either bolted or clamped directly to the faceplate or to a fixture mounted on the faceplate. The part must be centered to where the machining is to be done and the assembly may have to be balanced prior to turning.

Collets

Collets are usually made to hold specific sizes of round stock and are tightened with a drawbar running through the center of the main spindle or they are used with a collet closer. They can be fast to use and are accurate for aligning the work to the spindle axis.

Tools

Cutters

There are several types of cutters, however, for the basic portion of the lathe training they will be generalized here. See Figure 8

Cemented Carbide: Cemented carbide cutters are made of steel and have a slab of carbide cemented onto the end of the cutter. These cutters don't have replaceable tips and must be reground when they become dull.

Insert Cutters: Insert cutters have a steel shaft that is outfitted to hold an insert. Inserts usually made out of tungsten carbide can be replaced easily and can be bought for very specific operations.

High Speed Steel Cutters: High speed steel cutters (HSS) are a solid chunk of steel that can be ground or bought to any desired cutting-edge. A more old fashioned practice as it demands a lot of time and skill to get the desired shape HSS cutters can be quite effective when used properly.

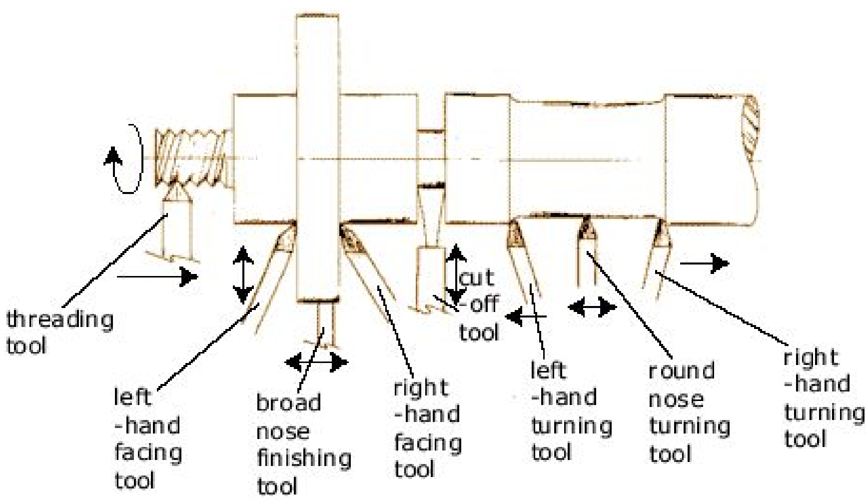

Figure 8: Different Types of Cutters and Their Preferred Direction of Travel

Left-Handed and Right-Handed Cutters: The cutting points on cutters will generally be pointed in a certain direction, in order to provide a relief angle to the cutter. A relief angle is the angle at which the cutter is offset from the 90° degree line of the workpiece. The relief angle is important because it dictates the way the chip will form. A bad relief angle can lead to the tool rubbing against the surface of the workpiece which in turn will create a lot of heat damaging the tool and giving a poor surface finish.

Left and right-handed cutters are made to perform better going in a certain direction due to the geometry of the tool providing that needed relief angle. Left-handed cutters perform better going from right to left to right while right-handed cutters perform better in the opposite direction.

Straight Cutters: Cutters with a straight edge are usually meant for threading or grooving, however can be used to turn the workpiece if the point is rounded

Cut-Off Tools: Cut off tools are used when the piece being machined is finalized and ready to be separated from the rest of the stock or excess length of stock is to be removed completely. Cut off tools must always be ran at very slow speeds as the material removal rate is very high and the generalized speed equation given in the machining 101 section cannot be applied. They must also be used at an exact 90º degree angle from the workpiece to avoid force concentration on one side of the tool. If a long workpiece is being separated with the cut-off tool then both ends of the piece must be supported, one in the chuck and the other with a live center in the tailstock.

Boring Bar: Boring bars are long and slender usually with an insert protruding from the side of the tool. Boring bars are used to cut internally and with higher precision than other cutters.

Lathe Safety

1. Ensure that you are familiar with the lathe, the controls and its operation prior to using it.

2. Users operating any rotating machinery must not wear any rings, necklaces, neckties or wristwatches. Avoid loose clothing: if you have loose fitting sleeves, roll them up or cover them with a lab coat. Long hair must be tied back securely. Safety glasses must be worn at all times. Do not wear gloves, as they can get caught by the workpiece or spinning entangled swarf. Do not use rags or cloth wipes near or on the rotating work or rotating parts of the lathe.

3. Do not touch the tool bit or other rotating parts when the lathe is operating. If you have to clear chips from the bit use a brush. Never attempt to clear chips or oil using a wiper while the spindle is rotating - it could easily get caught in the lathe. Make sure that rags and debris are kept away from the bit.

4. Stop the lathe frequently to remove chips and debris as required before it can become entangled in the chuck or the work. If debris or chips becomes entangled and spins with the spindle, immediately stop the lathe to remove it. It is sharp and may be hot so use a metal rod to remove the entanglement rather than fingers.

5. Do not leave any covers of the machine open when operating the lathe.

6. Never leave the chuck key in the chuck, even if you are not going to turn the machine on.

7. Stand at all times when using the machine; do not ever attempt to operate it from a sitting posture. Do not leave the lathe running unattended.

8. Be aware at all times of the location of the switch and emergency stop buttons and make sure that you can always reach them easily.

9. Emergency stops must be used only in emergencies. They must never be used to turn the machine on and off. If the emergency stop is used, make sure the lathe spindle switch is in the off position and power feeds disengaged before pressing the start button on the panel.

10. Run the lathe only at speeds suitable for the diameters being machined and the surface cutting speed of the material being machined. The speed at which to run the machine can be found using the equation shown at the beginning of the notes. Use a lubricant on the tool bit when machining metals (except brass).

11. Make sure that the chuck holds the drill tightly. Do not allow the drill to jam and turn in the drill chuck, or the tailstock (if using Taper shank drill) or to spin the drill chuck as this will damage the drill shank and /or the tailstock taper. Be careful when the drill breaks through, especially in brass, as the drill can grab.

12. When drilling, start the hole with a centre drill first. Large holes are best drilled in steps.

13. When using the power feed be sure that the feed rate and direction are set correctly. Be sure which position of the power feed lever engages which axis of feed. When the feed is engaged, keep a hand on the lever at all times so that it can be disengaged quickly at any time. Do not take excessively deep cuts/ high feed rates with the tool bit.

14. Do not use a chuck alone to hold a tapered surface workpiece; it will not be held securely and could fall out of the chuck. Ensure that there is adequate material to be held securely in the chuck.

15. Do not leave tools on the ways of the bed. The ways should be covered when sanding to prevent grit from damaging the surfaces.

16. When removing/changing chucks etc from the spindle, protect the ways with a wooden board to prevent the chuck from damaging should the chuck be dropped. The changing of chucks should not be done without the supervision of the staff.

17. Long slender pieces must be supported properly.

18. Wash your hands thoroughly before going to the washroom, before eating and when finished working. Check your hands for any metal slivers and any adverse reactions or allergies to the cutting fluids.

19. If unsure of any procedure or safety related issue, ask one of the shop supervisors for assistance.

Screw Thread Systems

Thread Systems

Unified National threads

The designators are UNC (Coarse Thread), UNF (Fine Thread), and NS (Special Thread). Threads are designated by the nominal major diameter and the threads per inch (tpi) of the thread. The diameter may be either a fraction (as in ¼") or a Gage (000 to No. 14). No. 12 and 14 and 3/16 are not in common use and after No. 10 there are fractional values starting at ¼". The actual diameter may measure .005" under the nominal size.

ISO Metric threads

The metric threads have a crest and root of the thread that are slightly truncated. Metric threads are designated by the prefix "M" and the threads are designated by the basic nominal diameter and the pitch (distance between thread crests or roots along the axis) in mm. Examples are; M5 x 0.8, M6 x 1.0, M10 x 1.25 again, the measured diameter may be 0.1 mm or 0.005" under the nominal size. In the metric thread system, there is no designation in the thread designation for coarse, fine or others as there is in inch and thread charts may not list all of the metric sizes available.

Identification of Threads

The tools required to identify a thread are a precision measuring device such as a caliper or a micrometer to measure the actual outside diameter of the thread, pitch gages (inch and metric) to find the pitch, and finally a thread chart listing tap drill sizes. Once a thread has been identified, then the tap drill can be identified in preparation for drilling the tap hole and tapping the threads.

Tapping Threads

Taps

A tap is a tool for producing internal threads. Threads may be produced by either forming or by cutting. Cutting type taps may be designed for hand use or power. **Form taps** are designed for power tapping only. The size of the thread is marked on the shank of the tap. Tapped holes are either through or blind. A blind hole does not go through the workpiece, creating 2 potential problems; the tap will hit the bottom of the hole and the chips produced by cutting can accumulate in the hole causing the tap to bind. Either of which can result in a broken tap. Taps are designed for specific applications.

The entry end of taps come with 3 different lengths of tapered relief to permit easy entry into the workpiece. A **Taper tap** has an end that is smaller than the tap drill hole and has a tapered relief of 8° which helps when starting a tap as it allows a portion of the tool to go into the hole before the cutting commences leading to a straighter cut. A **Plug tap** has a tapered relief of 16° which makes it a little more aggressive to start but still provides some relief. A **Bottoming tap** has a tapered relief of 45 – 50° which provides no relief st at the start of the tap. A **taper** or a **plug tap** can be used to start a tapped hole. A **bottoming tap** is used to deepen the thread depth on a blind hole where there is a limited depth for the tapped hole, but the hole must be tapped initially with a plug or taper tap.

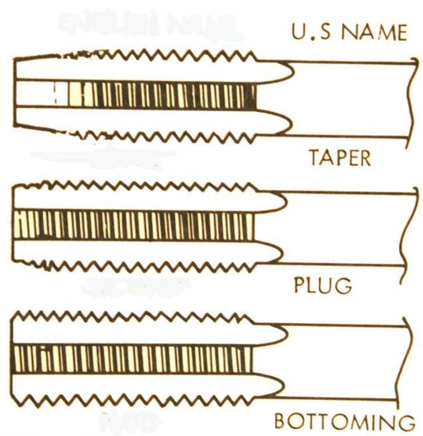

Figure 9: Examples of The Three Main Types of Taps

Once the thread for a location is known, then the tap drill must be selected. The tap drill is the size of drill for a particular size of thread that leaves enough material surrounding the hole in which to allow the threads to be cut or, in the case of form taps, to be deformed into the threads. Threads that are produced by form taps require larger holes than those produced by cutting. The internal threads that are produced are not 100% depth but usually, 70 to 75% depth to allow the fasteners to move freely during assembly

The tap drill size for a certain thread must be found using a thread chart. If there are any doubts on which tap drill size to use it is recommended that assistance from a supervisor must be requested.

When using a cutting tap to thread a hole it is very important to turn in reverse after a full turn forward. The act of running the tap in reverse will break any chips being created in the hole and will prevent them from binding. Taps have long channels cut into the sides of them to create cutting surfaces and help with chip evacuation, these channels however remove allot of material and make the taps fragile. This fragility makes them very susceptible to breaking and thus must be used with extreme care.