Basic Use of Workshop Tools
Handout 1

AERO1600

Workshop Technology

Aerospace Engineering Workshop Hand Tools Guide

The topic “hand tools” includes all hand held tools most commonly used during everyday maintenance or engineering work. Some of these tools can have very specialized purposes while other tools may be very common. No matter how common the tool is the correct usage is not always known. The following handout describes the correct usage of the most common tools used in the AERO1600 course. If you have any questions regarding tool use please do not hesitate to approach a staff member for correct instruction on how to use the tool. Students will receive another document during semester that covers more complex hand tools.

Hammers

Hammers come in many different sizes, shapes and weights, each with a specific purpose or job. Most hammerheads are made from cast steel with about 0.75% carbon, the face and pan are ground and carefully tempered. Hammer handles are made from Hickory Ash or Spotted Gum, these woods are chosen for spring and ability to absorb shock. The misuse of any hammer can lead to the damage of the work or injury to the operator, hence it is critical that hammers are used in a safe and correct manner.

Before using a hammer ensure you have the correct safety equipment and that the tool is in a satisfactory condition to be used. Before using a hammer you must inspect the tool and its pounding surface for flaws, cracks or damage, also inspect the handle for security. If you suspect that the hammer is not suitable to use please notify a staff member and it will be inspected and replaced if warranted.

Types of hammers:

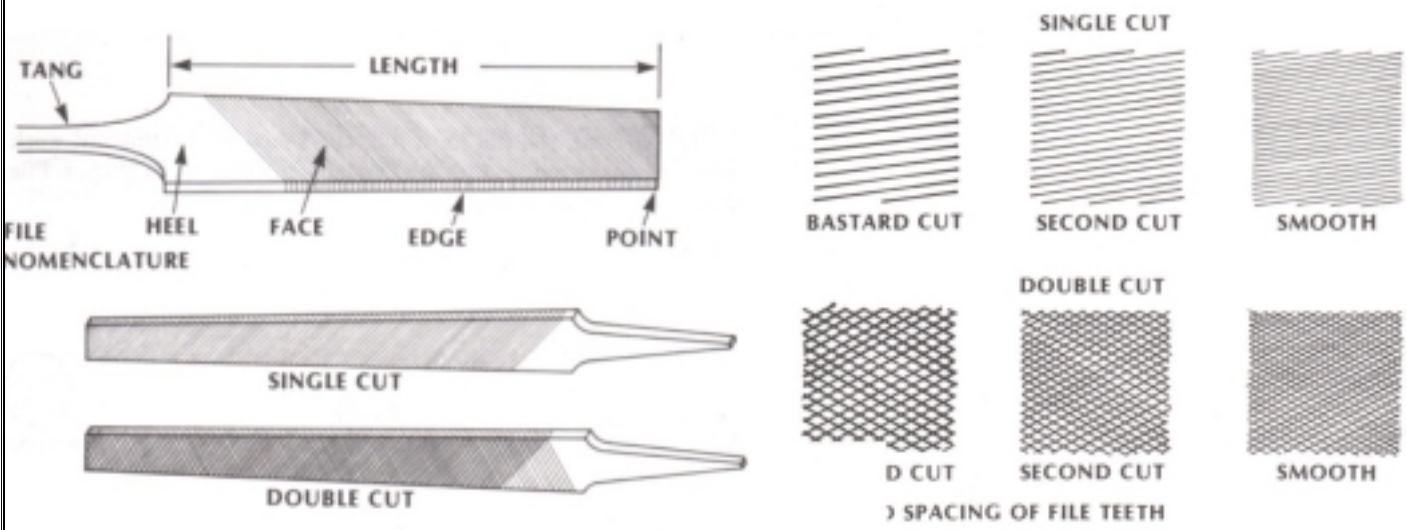
Hammer	Picture	Description	Use
Ball Peen		One flat face and one round face	Sheet metal use, rivet, not for nails. Used also for metal work.
Claw		Claw on one end and a slightly crowned end.	Typically for nails, not for metal work due to brittle head
Soft/ Mallet		Made from rubber, lead, plastic or hide, with a large crowned head.	Used for positioning, adjusting, fragile components that would be damaged with a normal hammer
Sledge		Long handle with flat hard heads	Used for jobs where a lot of force is required.
Body		Light weight sheet metal hammers	Used for smoothing sheet metal where little force is needed.

Files

The basic purpose of a file is to remove stock from a work piece, for aviation the files used are primarily designed for removing metal stock. Files are manufactured from high carbon steels that are heat treated to obtain a very hard cutting surface. The teeth of a file act as hundreds of small chisels, each removing a minute amount of stock. There are many types of files each with a particular purpose, files are graded according to the degree of fineness and whether they have a single or double cut teeth.

Single cut files are used for finishing a job or draw filing and are also used on sheet metal. A single cut file has teeth parallel to each other at an angle of approximately 65 degrees from the centerline of the file.

Double cut files have teeth that are crisscrossed on the blade. This forms diamond shaped teeth that are primarily used for rough work where quick removal of stock is required.



(*Jeppesen® Standard Aviation Maintenance Handbook)*

There are also many shapes of files, Jeppesson ® provides us with the most appropriate aviation standard description of these types.

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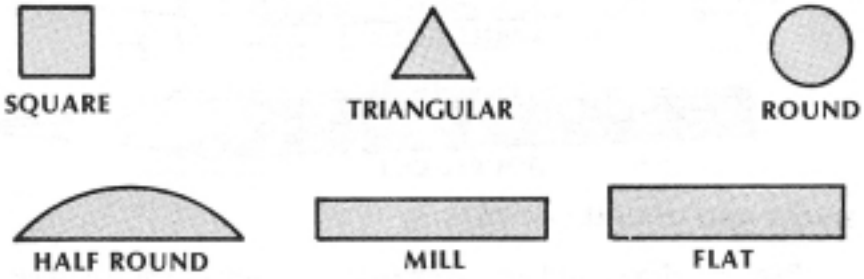

Square files are tapered on all four sides and are used to enlarge square or rectangular holes.

Triangular files are longitudinally tapered on all three sides and are used to file acute internal angles, and to clear out square corners.

Round files are also known as "rat-tail" files because of their similarity in appearance to the rodent's appendage. Their primary use is enlarging round or oval holes.

Half-round files provide a handy combination. The flat side may be used on flat surface and the rounded side for curved surfaces.

Mill files are tapered in thickness and width. One edge of a mill file has no teeth and is known as the safe edge. Mill files are always single-cut and are used for draw filing and other fine work.

Flat files are a general purpose file and may be single- or double-cut. The double-cut being used for rough work and the single-cut for fine work.

(*Jeppesen® Standard Aviation Maintenance Handbook)*

Whenever using a file ensure you have the correct file for the job, improper selection and use of a file can drastically reduce its life. The handle provides the operator with protection from being gouged by the job but also allows the user to guide the file to remove material where it is not needed. Files are not to come into contact with other files, this is a sure way to quickly blunt them.

When using a file the handle should be gripped in the left hand while the right hand rests on top of the end of the blade providing down force if required. Use slow even strokes utilizing the entire length of the file, ensure the work piece is securely clamped to avoid vibration and chatter. When using a round file, rotate it as it cuts the work piece, this will ensure there are no dips or hollows.

If filing aluminum or other soft metals the file should be drawn back to remove any filings lodged in the teeth, a stiff wire brush can also be used to remove the stock

from the teeth of a file. Ensure there are no chips lodged in the teeth of a file since this reduces the tendency of the file to scratch rather then cut, which can often damage a job.

Screwdrivers

The screwdriver is one of the most common tools, it is also one of the most commonly misused tools. The screwdrivers wide range of shapes and sizes often tempts us to use the one that is closest or available, not the one which is suited to the screw. Screwdrivers are designed to remove and insert screws, there are not designed for: being used as a chisel, punch or lever, this will damage the tool and most likely injure the user.

Screwdrivers can have long or short shanks, plastic or wood handles and various tips for differing screws. Below is a table with the various bits available:

(*Jeppesen® A&P Technician General Textbook)*

Bit Type	Picture
Slot / Flathead	
Phillips	
Reed and Prince	
Tri-wing ™	
Posidriv ™	
Torx ™	6-blade screwdriver

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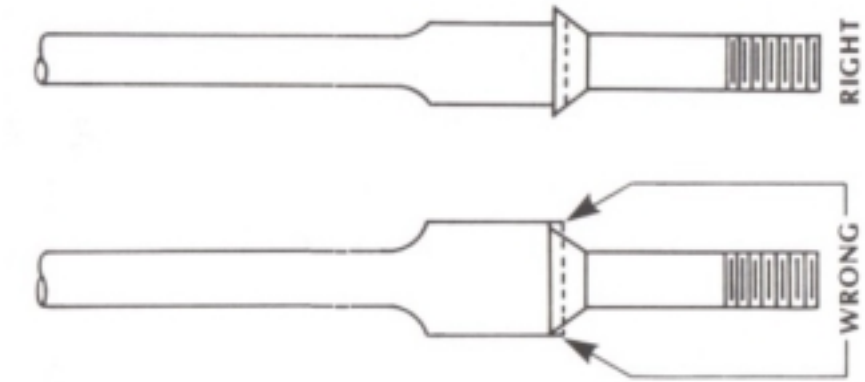
Using Screwdrivers:

- Ensure the correct sized tool for the screw.
- Check the tool is in good working condition
- Ensure the screwdriver fits correctly into the recess of the screw
- Keep hands free of tip when operating, the screwdriver may slip and injure.
- Keep axis of shaft aligned with the screw.

Example:



(*Jeppesen® Standard Aviation Maintenance Handbook)*

Spanners/Ratchets

There are two main types of spanners that we will use in this course, ring and open-ended spanners, these are the most commonly used spanners in the aviation industry today. There are also combination spanners that have one end open while the other is a ring style end. Most spanners have the head offset by ~15 degrees to provide clearance for other fasteners and the operators knuckles. There are various units of measure for spanners; metric, imperial, unified national, AF etc.

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Ring Spanners:

Offset Spanner

- Should be the first choice when selecting a spanner for a job. Ideal for light fasteners.
- Most ring spanners have 12 contact points, this requires only 30 degrees arc to operate while cheaper 6-point spanners require 60 degrees to move.
- These spanners come in 3 main offset types; 15-degree upward sweep, shallow offset and deep offset.

Open Ended Spanners:

- The standard open-end spanner has a length 10 times the width of the jaw opening.
- Heads of these spanners are also offset like the ring spanners.
- The open-ended spanner is only suitable for low torque applications.

Correctly using a spanner:

1. The spanner must be the correct size for the nut, do not use metric spanner on a imperial bolt, vice versa
2. The spanner must fit fully onto the head or nut.
3. The spanner must be in good condition with no cracks or worn jaws.
4. If possible pull the spanner towards your body. This way you are far more balanced then when pushing away, pulling the spanner will also prevent the nut from suddenly cracking open and injuring your knuckles.
5. If pushing the spanner is required, use the heel of your palm to avoid losing your knuckles!
6. If you are working in an area where the spanner could be dropped into a hazardous position use a wrist strap.
7. If requiring high torque on a fastener, firstly select a ring spanner over an open ended spanner.

Adjustable Spanner

Adjustable spanners should never be used for aircraft applications.

Sockets and Socket drivers

The main advantage socket wrenches hold over spanners is the wide variety of handles and adapters that are available, these include; ratchets, breaker bar, speed handles, universal joints and extensions just name a few. Below is a typical driver and socket and some of the common accessories:

Sockets typically have a square drive hole in one end and a 6 or 12 point opening designed fit various nuts at the other. In the aviation industry the most common size drivers are; ¼, 3/8, ½ and ¾ inch. For the AERO1600 course we will use ¼ inch sockets and drivers.

Using a socket and driver is very similar to the previous spanner section.

Torque Wrenches

Threaded fasteners generally have a better holding power when initially torqued to a greater value then the loads the fastener will be subjected to. This is achieved by precisely measuring the torque of a fastener as it is installed on an aircraft. Design engineers will provide the correct torque that the fastener must be set at. The amount of force required to turn a fastener is directly related to the tensile stress within the fastener. Torque is commonly measured in N/m, inch-pounds and psi.

There are several types of torque wrenches available in the aviation industry:

"Click" type torque wrench (clicks when the selected torque is reached)	
Dial type torque wrench (dial indicates the torque)	
Digital Torque wrench	Has a digital readout!

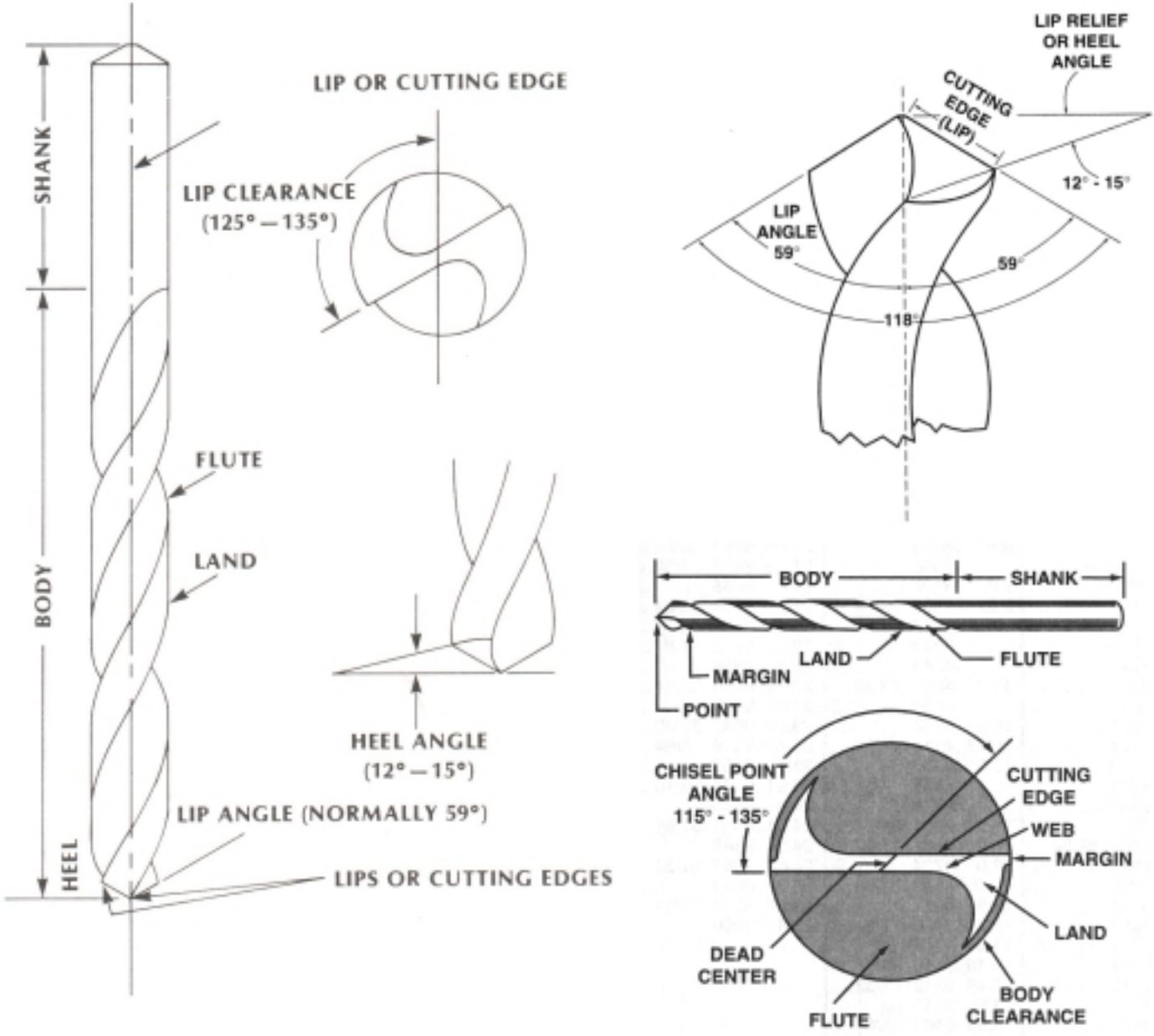
Using a Torque Wrench

If a fastener is under torqued then there is the danger that the part will be subjected to unnecessary loads leading to premature failure. If a fastener is over-torqued then there is a stress on the thread, also leading to premature failure of the fastener. Hence it is very important to ensure that the correct torque is applied to the correct bolt. Please follow these guidelines when installing a torqued fastener:

1. Ignore friction drag (this is where a self-locking nut is being wound onto a thread)
2. Never use impact type torque wrenches.
3. Ensure the thread and nut are clean and free of foreign particles.
4. If a nut is accidentally over torqued, it should be loosened and then retorqued to the correct value.
5. Never back off a nut leaving it under-torqued.
6. Ensure the torque wrench you are using is in good working order and is regularly calibrated to generate correctly installed fasteners.

Drill Bits

The twist drill is the aircraft technician's tool for originating or enlarging holes in various types of materials. Twist drills are the primary bit for metal work. There are other bits that are used for wood and other materials. There are also some specialty drills like the flat-bottomed drills, sheet metal drills, hole-cutters and fly cutters to name a few. The standard engineering twist drill has two flutes running the length of the bit to form the cutting lips of the bit (refer to diagram). Below is the basic outline of a twist drill bit.



(*Jeppesen® A&P Technician General Textbook)* (*Jeppesen® Standard Aviation Maintenance Handbook)*

Drill bits are made from either plain High Carbon Steel or High Speed Steel (HSS). High-speed steel is a steel alloy containing tungsten that retains its strength at high temperatures (usually high speeds). Drills that are heated treated to obtain hardness are subject to breakage through simple impact with a hard surface.

The Flutes:

The flutes (shown on previous page) are spiral grooves that are cut at an angle aligned with the drill centreline. The function of the flutes is:

- Provide an exit way for the swarfs (waste material)
- Form a cutting edge (lips)
- Allow lubricant to be supplied to the cutting edges.
- Provide the rake angle for the cutting lip of the drill

The Land:

The features of the Land are as follows:

- Guide the drill accurately.
- The land is kept to a minimum width to reduce friction and heat.
- The diameter if the land at the tip is larger then the land at the shank ends.

Drill Sizing

There are four common units of measure for drill bits:

1. Imperial Fraction Drill size. (Uses fractions of an inch)
2. Number Drill size. (Standard Wire Gauge {SWG} 80-1, 80 being small)
3. Letter drill size. (A-Z used for tapping, reaming and clearance holes)
4. Metric Drill size. (Millimeters, the smallest drill is 0.32mm)

Lubricant and Cutting Fluids

Drilling often generates a lot of energy, this is most likely to be dispersed through heat (some is removed through sound and momentum). As a result of this heat the drill bit may be affected, hence lubrication is required to reduce the friction that generates the heat. Lubrication performs two tasks; minimizes the friction that reduces heat and allows the heat to travel away from the job and the bit.

Lube Chart

Metal	Fluids
Aluminum Alloys	Kerosene, lard oil, soluble oil
Brass/Bronze	Dry/ Kerosene, lard oil, soluble oil for deep holes
Magnesium Alloys	Mineral lard oil, kerosene or dry
Copper	Mineral lard oil and kerosene, soluble oil or dry
Mild Steel	Mineral lard oil
High Tensile Steel	Soluble oil
Stainless Steel	Soluble oil
Titanium	Soluble oil
Plastics	Soapy water
Hard Rubber	Dry

Drill Speeds

When drilling various materials the drill must be set to the appropriate speed. The drill bit cutting edge has a variable speed, the outer corner moving the fastest. Hence any calculations performed for drill speed are done taking the corner as being the critical speed point. When RPM is set it should give the corner cutting point the optimal speed, since it does most of the work!

Cutting Speeds for HSS Drill Bits

Aluminum	200-300 ft/min	60-90 m/min
Mild Steel	80-100 ft/min	25-30 m/min
Cast Iron	60-100 ft/min	20-30 m/min
Brass	125-200 ft/min	40-60 m/min

And the RPM is calculated using the following formulae:

RPM (Imperial) = [4 x cutting speed (ft/min)] / [diameter of drill (Inches)]
RPM (Metric) = [300 x cutting speed (m/min)] / [diameter of drill (mm)]

Drill Feed

Drill feed is defined as the axial distance the drill penetrates the hole per revolution of the drill.

Slow Drill Feed:

- Causes the drill bit to scrape rather then cut.
- The bit may chatter.
- The drill will become blunt quickly.

Excessive Drill Feed:

- Cause overheating.
- Cutting edge to dull due to heat and excessive pressure.
- Cause cracking and chipping on the cutting edge.

There are several types of drilling devices, some of these are; hand drill, electric drill, drill press, pneumatic drill and the cordless drill. Below is a general guide to setting up a job to be drilled.

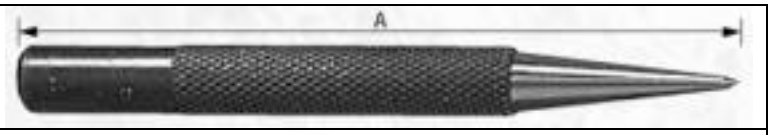
Drilling Process

The drilling process is pointless unless you have the hole in the correct position. Ensure you have correctly marked out your hole. OK, now check again.

1. Centre punch the desired location of the hole.
2. Use dividers to scribe a circle inside the final size of the hole.
3. Set-up the job on the drill table.
4. Secure the job to the drill table or vice
5. Ensure neither the table nor the drill vice can move.
6. Drill a pilot hole first. (Any drill size above 3/16 should have a pilot hole)
   Note: The pilot hole is made to ensure the final hole is on the center, it is difficult to center a large drill bit on a center punch mark. The pilot hole also reduces the load on the drill bit.
7. Ensure the drilling speed is correctly set.
8. Gently lower the drill and allow the bit to cut.
9. Raise the drill and ensure the cone drilled so far is centred correctly. (If the cone is not centred then, using a chisel, place a groove on the side that the drill needs to be closer to. This process can be repeated)
10. Complete the hole, raising the bit as required to remove swarfs.

Punches

There are many different types of punches available, each providing a specific purpose. Punches are made from high carbon steel, the ends are tempered to create very hard points. There are three types of punches that we are interested in:

Centre punch – Used to mark-out holes to be drilled	
Prick Punch – used to generate witness marks on marking out lines.	
Pin Punches – Used to remove locking pins, dowels and rivets.	

Safety:

Keep the head of the punch free from burrs and ensure punch is squarely hit with the hammer, wear eye protection if required. Obviously keep you fingers away from the striking and point areas!

Hacksaws

The hacksaw is the most commonly used metal cutting implement. It consists of a flexible hardened steel blade and a adjustable frame, the blade is held under some tension. Most blades are either carbon steel or high speed molybdenum (expensive), the teeth of the saw are hardened while the back of the blade is annealed. Hack saw blades are found in two lengths; 10 and 12 inches, the number of teeth per inch also varies for the application (18-32 teeth per inch).

To properly use a hacksaw long steady slow strokes are required, using as many teeth as is possible. Short, fast strokes with uneven pressure will result in a dulled or broken blade. The cutting is done on the forward stroke, NOT the backward stroke. When choosing what blade to use remember as a rule of thumb, you need to have a least 2 teeth in contact with the work at all times.

Safety:

1. Wear safety glasses to avoid chips entering eyes.
2. Ensure the blade is correctly tensioned and that the teeth point away from the handle.
3. Clamp the job close to the saw line to avoid excessive vibration.
4. Support the over-hang as the cut is nearly completed.
5. Do not continue an old cut with a newly replaced blade, it will jam.

References:

1. Jeppessen ® Sanderson 1997 A&P Technician General Textbook,
2. Jeppessen ® Sanderson 1985 Standard Aviation maintenance Handbook