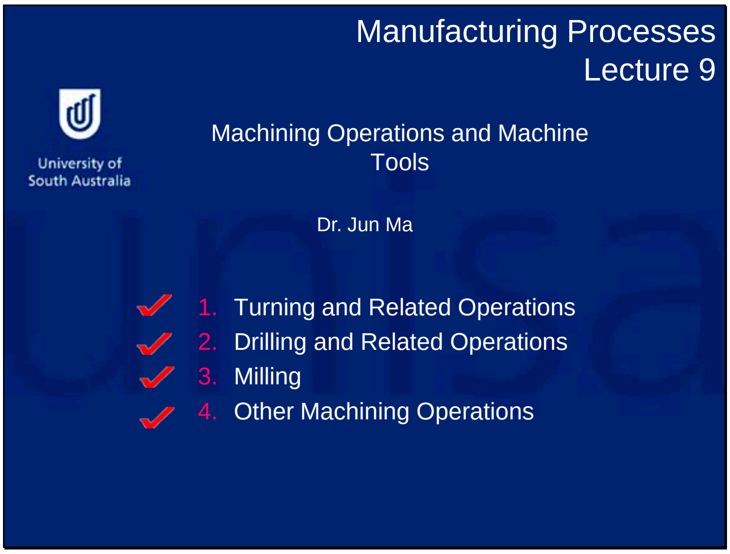
ENR212 Lecture 9 Slides and Notes

Slide 1



Hello everyone, and welcome to lecture summary 9. (This lecture works through material covered in Chapter 22 of the textbook.) This lecture introduces Machining Operations and Machine Tools. Major machining operations include turning, drilling and milling. There are also other machining operations such as shaping, planning, broaching and sawing.

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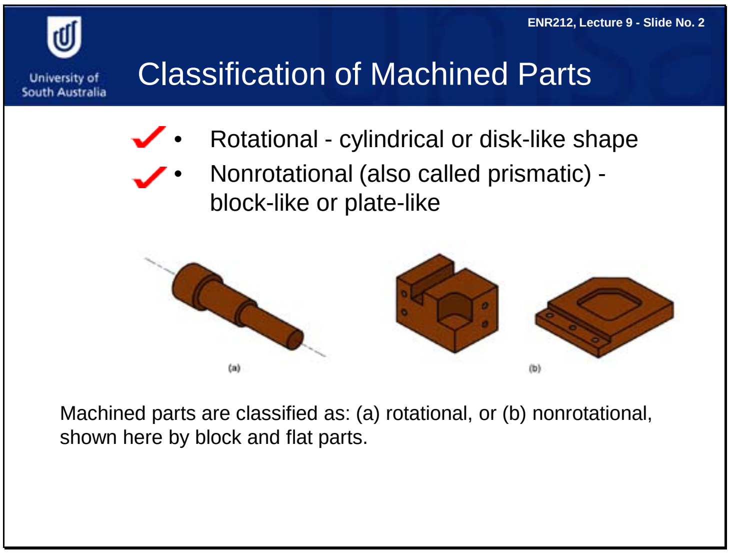
Slide 2



Machined parts are working pieces which have been processed by machining. There are two types of machined parts: rotational machined parts and non-rotational machined parts. Rotational parts are cylindrical or disk-shaped and are machined on a turning machine that is a lathe; non-rotational parts are block-shaped or flat, and are generally produced on a milling machine, such as a shaper or planer.

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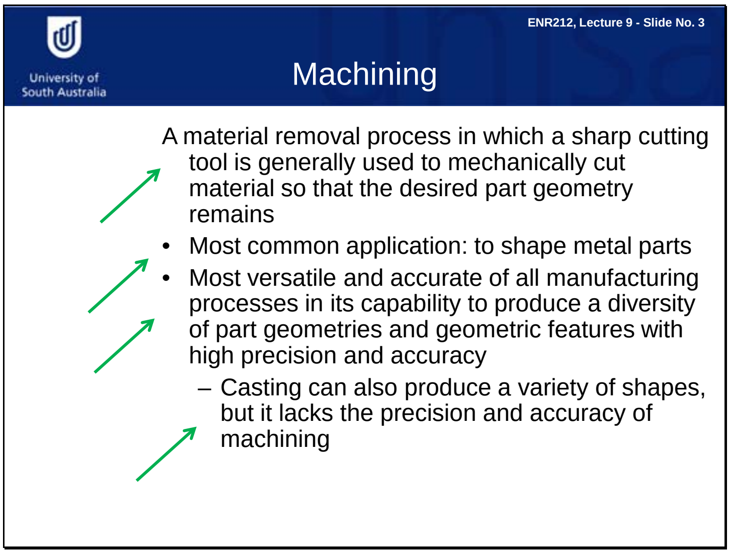
Slide 3



So, what is machining? Machining is a material removal process, in which a sharp cutting tool is generally used to mechanically cut material to produce a desired geometrical part. Machining is the most commonly used process in manufacturing. It is able to produce a very good surface finish with high precision and accuracy.

However, machining processes waste quite a lot of material. How can we prevent this? We can combine machining operations with other manufacturing processes, such as casting. For example, a primary shape can be produced by casting, and then processed by manufacturing and machining operations to produce good surface finish and high accuracy.

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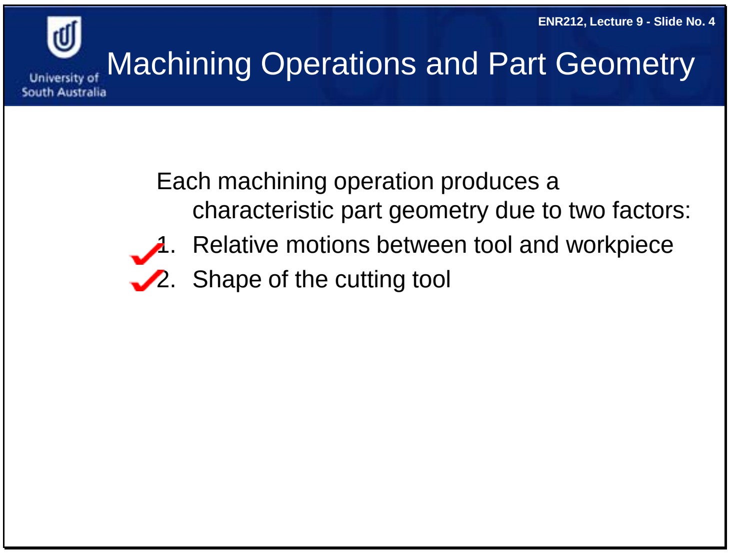
Slide 4



Part geometry is essential in machining operations. Different machining operations produce different part geometries. The two basic factors determining the part geometry in each machining operation are generating and forming. Generating refers to relative motions between the tool and the workpiece. Forming refers to the shape of the cutting tool.

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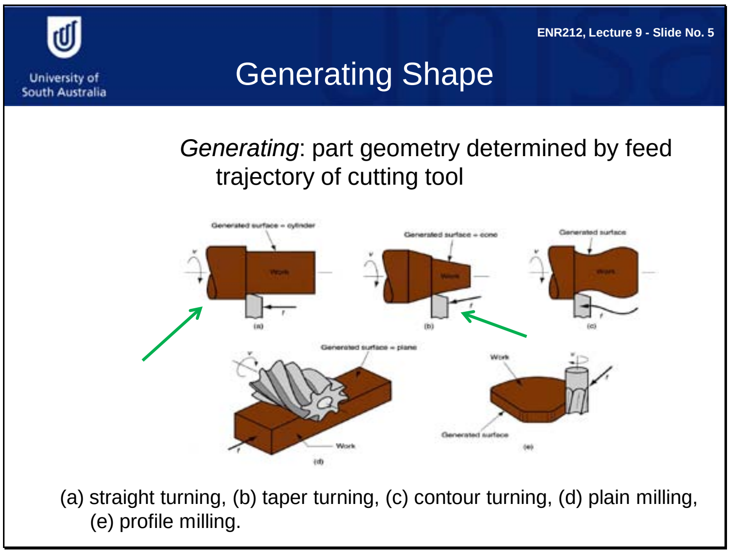

In generating, the part geometry is determined by the feed trajectory of the cutting tool. The path provided by the tool during its feed motion is imparted to the work surface in order to create the shape. In each of the operations shown in these figures, the speed motion in the operation removes the material, but the part shape is determined by the feed motion. For example, in figure a, the cutting tool moves in a direction parallel to the axis of the rotational work parts, so a cylinder is produced. In Figure b, the cutting tools move at an angle to the axis, so a cone is produced.

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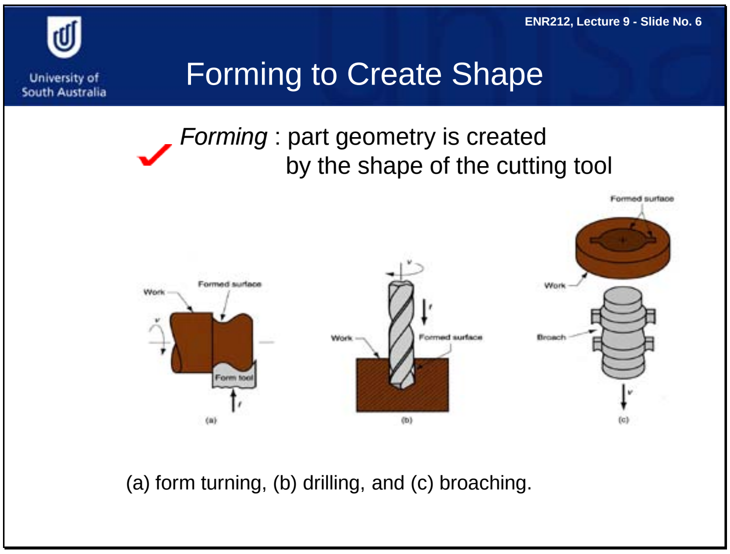

In Forming , the part geometry is created by the shape of the cutting tool.

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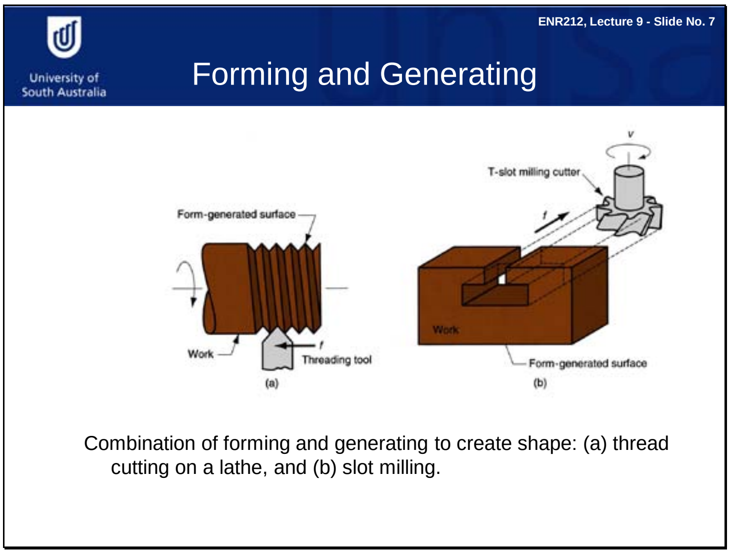
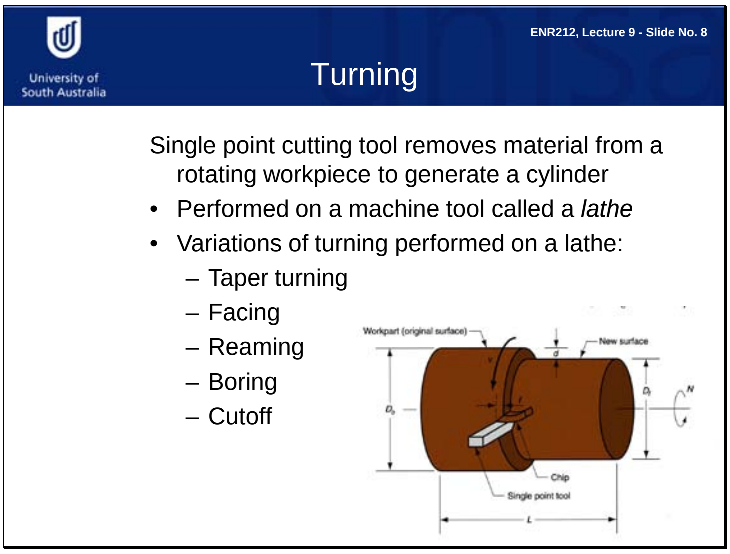


Forming and generating are sometimes combined into one operation, as you can see in the two operations shown in this figures. Figure a shows thread-cutting on a lathe, and figure b shows slot milling. Let's compare figure a, thread cutting on a lathe, with turning: what is the difference between the two operations? The only difference is the cutting tool. (We looked at how to produce thread using cold rolling in lecture 6, slide 12).

Slide 8



What is turning ? In turning, a single point cutting tool removes material from a rotating work piece to generate a cylinder. Turning is often performed on a lathe. There are five basic types of turning, which can be classified by the trajectory of the parts of the cutting tool. They are taper turning, facing, reaming, boring, and cutoff.

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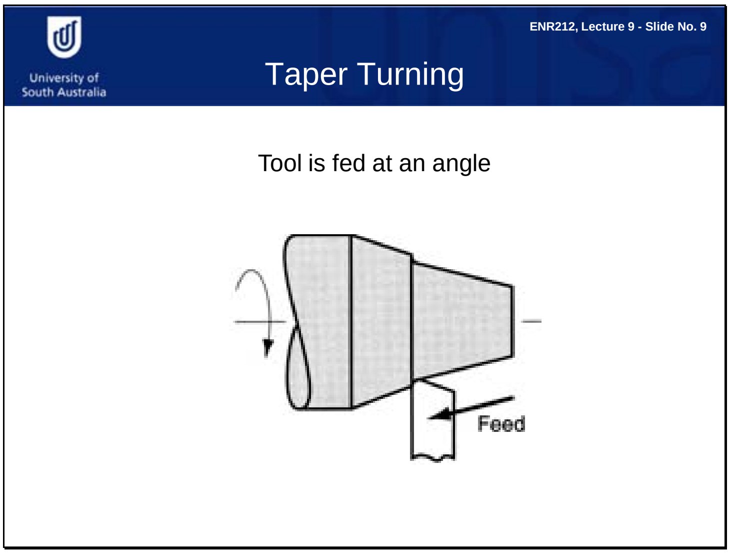
Slide 9



In taper turning, the tool is fed at an angle, so taper turning creates a tapered cylinder or conical shape.

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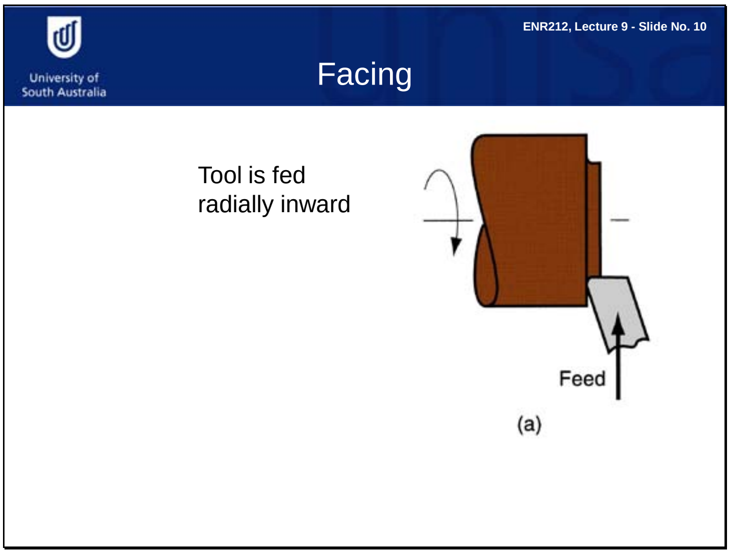

In facing, the tool is fed radially into the rotating work on one end, to create a flat surface on the end.

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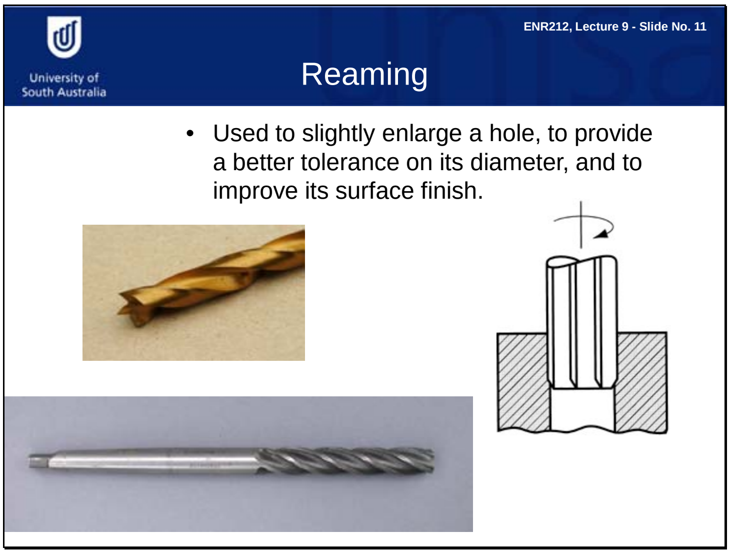
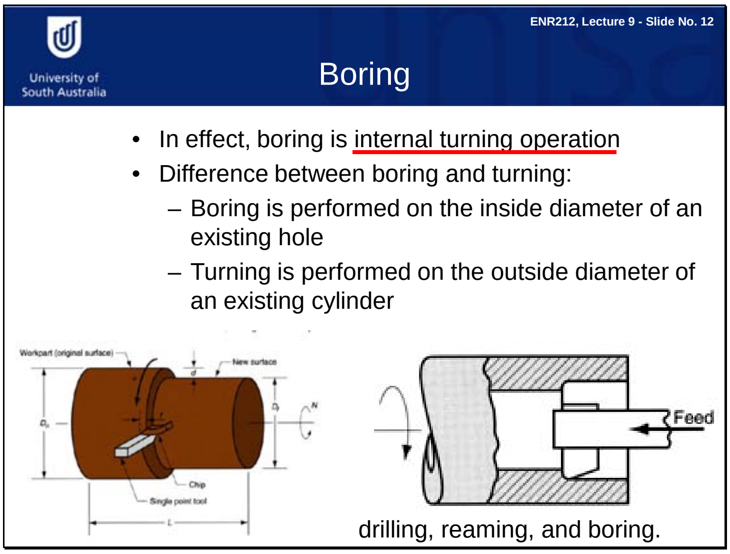


Reaming is used to slightly enlarge a hole, to provide a better tolerance on its diameter, and to improve its surface finish. The tool is called a reamer.

Slide 12



Boring is an internal turning operation similar to turning. Both operations use a single-point tool against a rotating work piece. The difference between boring and turning is that boring is performed on the inside diameter of an existing hole, while turning is performed on the outside diameter of an existing cylinder

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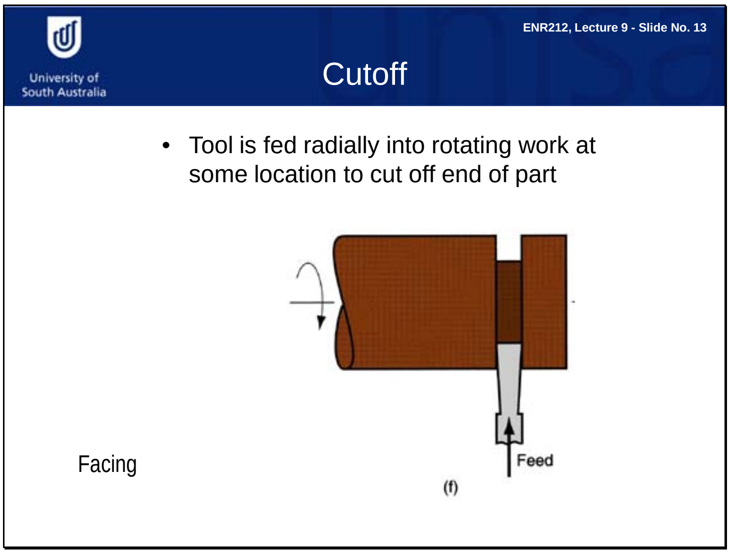
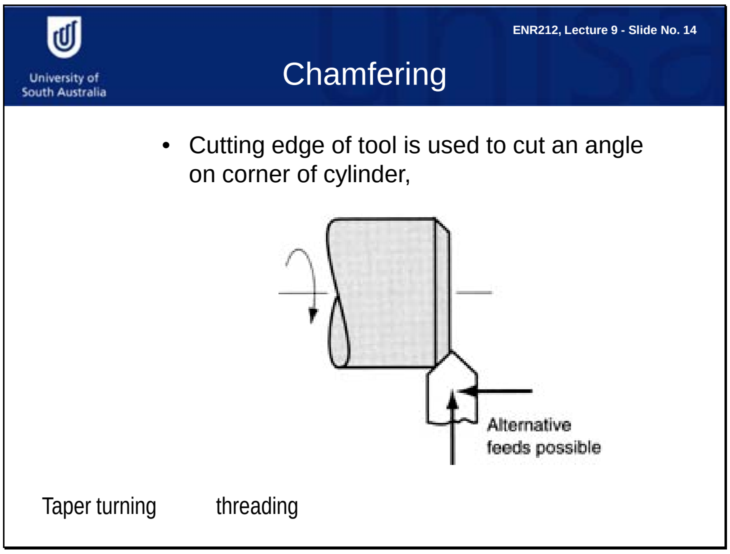


In cutoff, the tool is fed radially into the rotating work piece at some location along its length to cut off the end of the part. The cutoff is also called the parting.

Slide 14



In chamfering, the cutting edge of the tool is used to cut an angle on the corner of the cylinder, forming what is called “a chamfer”.

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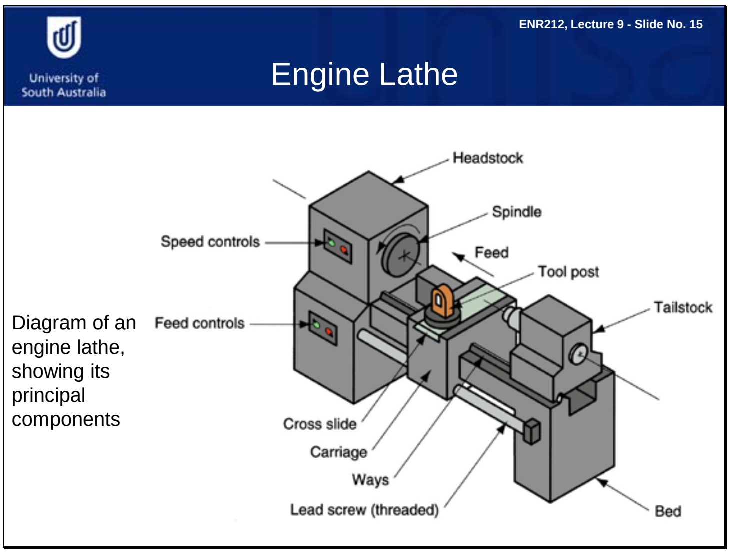

Turning is always performed on a machine called an Engine lathe. As shown in this figure, the headstock contains the drive unit to rotate the spindle, which rotates the workpiece.

Opposite to the headstock is the tailstock, in which a centre is mounted to support the other end of the workpiece.

The cutting tool is held in a tool post fastened to the cross-slide, which is assembled to the carriage. The carriage is designed to slide along the ways of the lathe in order to feed the tool parallel to the axis of rotation.

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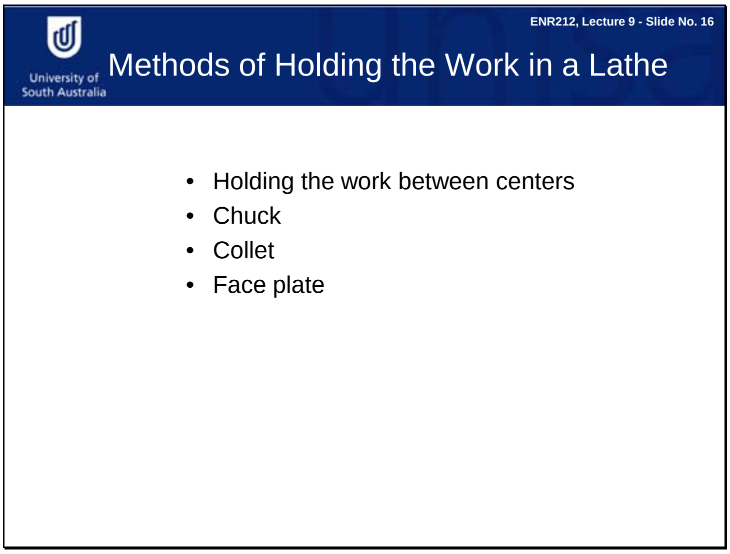

There are four methods of holding the workpiece in a lathe: holding the work between centers, using a chuck, using a collet, and using a face plate.

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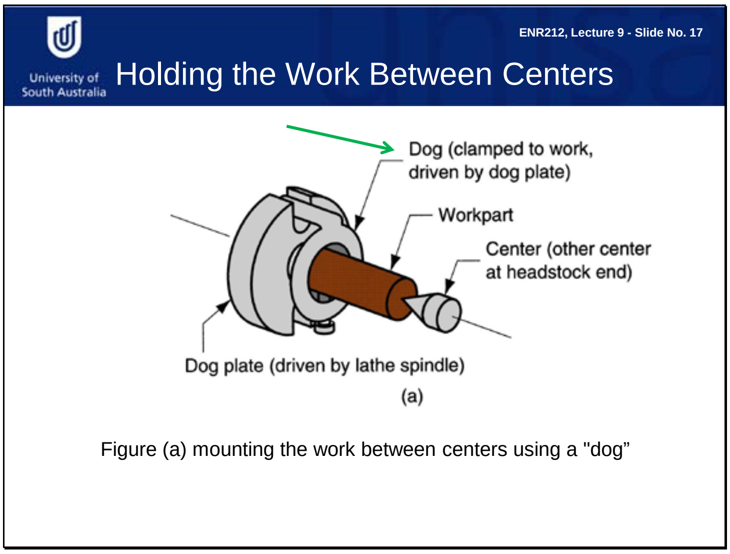

Holding the work piece between centres refers to the use of two centres, one in the headstock and the other in the tail stock. At the headstock centre, a device called a dog is attached to the outside of the work and is used to drive the rotation from the spindle. This method is used for large length-to-diameter ratios of workpiece.

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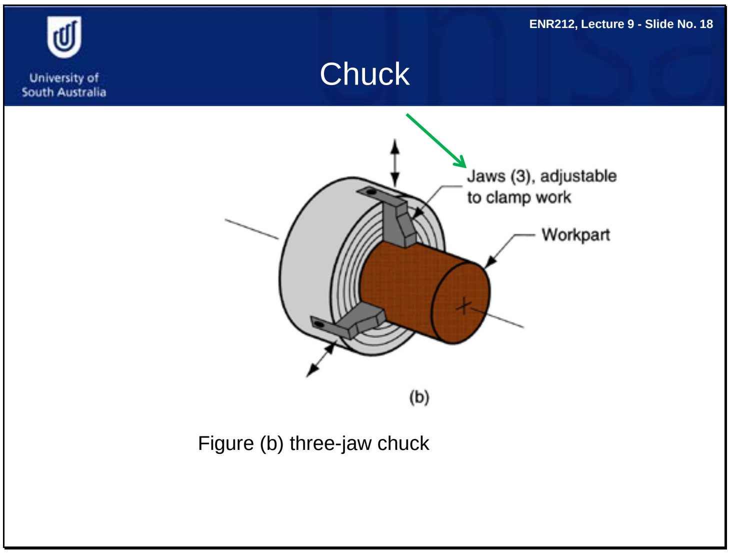

A chuck is a device which has three or four jaws to grasp the cylindrical workpiece on its outside diameter. This method is commonly used for low length-to-diameter ratio parts.

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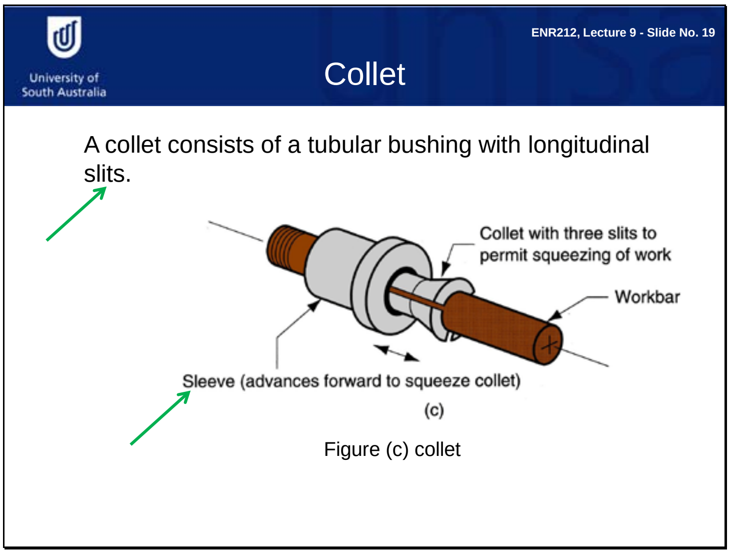

A collet consists of a tubular bushing with longitudinal slits. The inside end of the collet can be squeezed by a sleeve to provide a secure grasping pressure against the work piece. The limitation with this method is that you need different collets for different ranges of work pieces.

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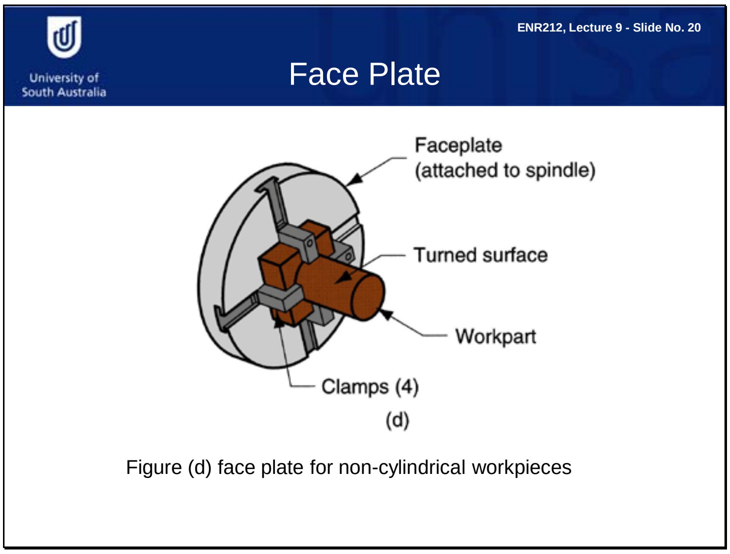
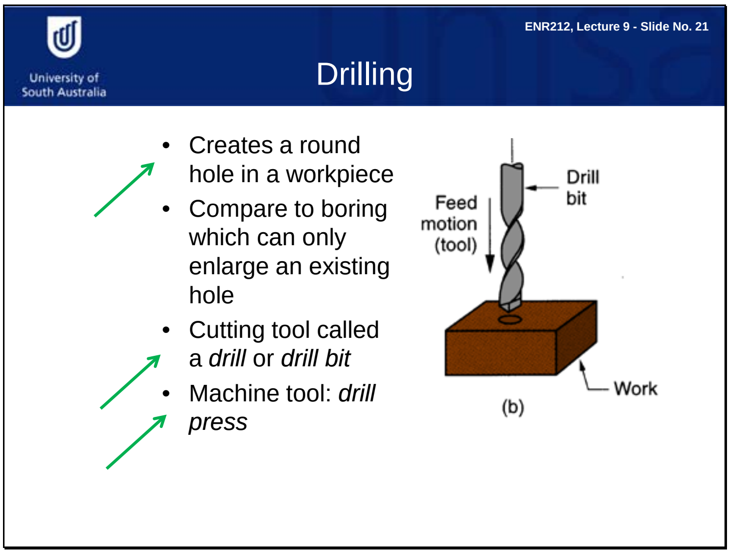


A face plate is a workholding device that fastens to the lathe spindle and is used to grasp parts with irregular shapes.

Slide 21



Drilling is usually performed with a rotating cylindrical tool that has two cutting edges on its working end. The tool is called a drill or drill bit. The rotating drill feeds into the stationary workpiece to form a hole whose diameter is equal to the drill diameter. Drilling is customarily performed on a drill press.

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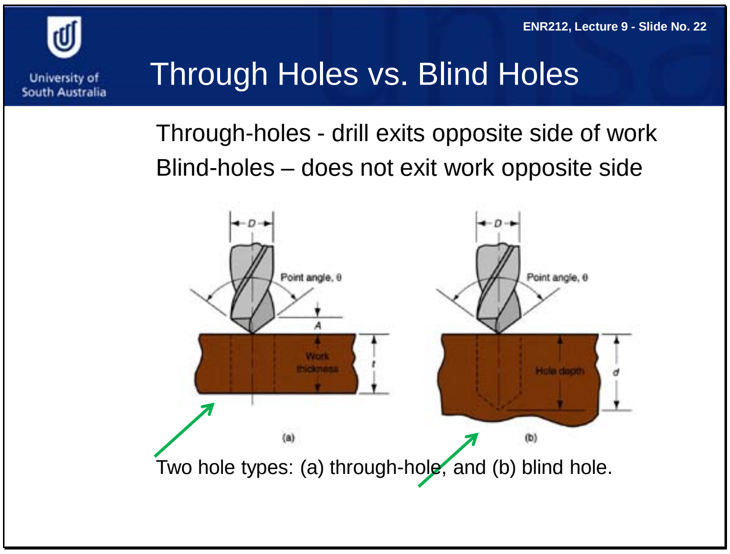

Drilled holes are either “through holes” or “blind holes”. In through holes, the drill exits the opposite side of the work; in blind holes, it does not.

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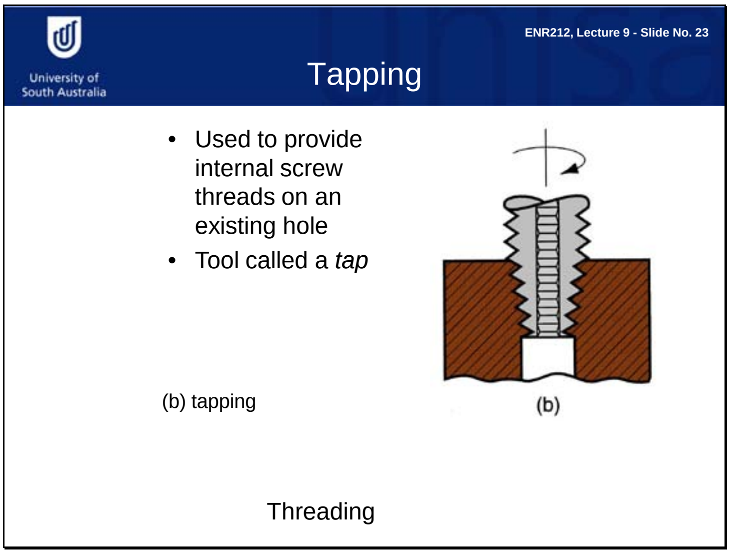

Tapping is used to provide internal screw threads on an existing hole. The tool is called a tap. What is the difference between tapping and threading? A threading operation is performed on a turning machine and produces an external thread, while tapping is normally performed on a drilling machine and produces an internal thread.

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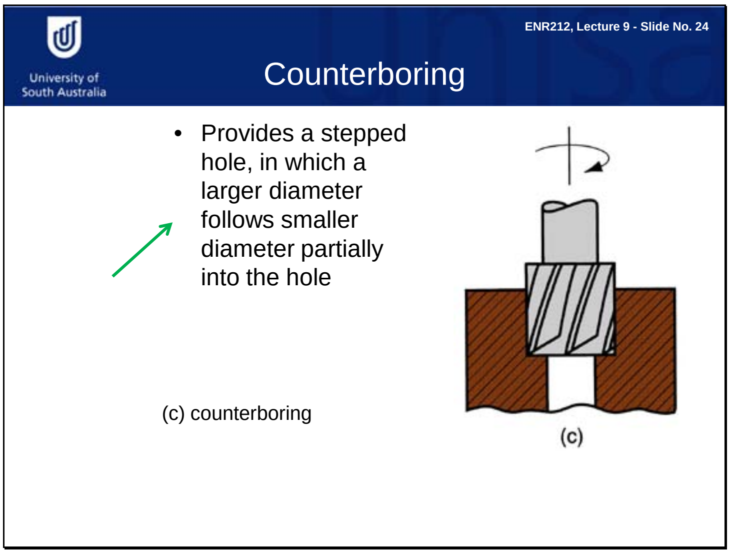
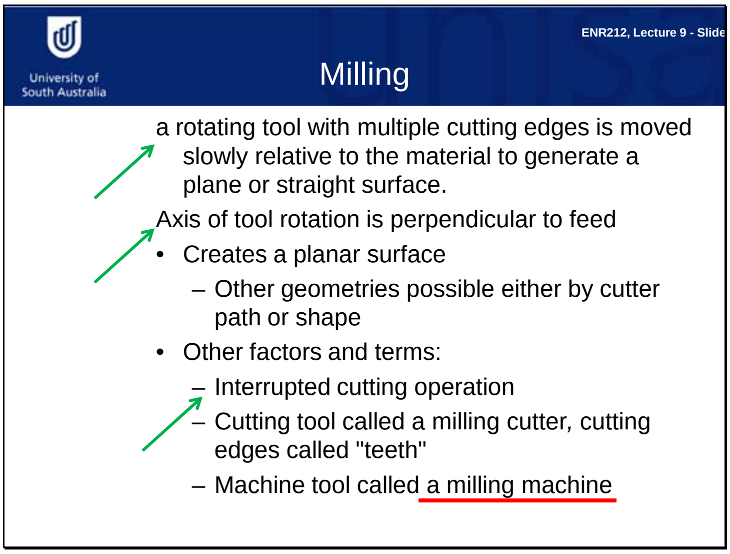


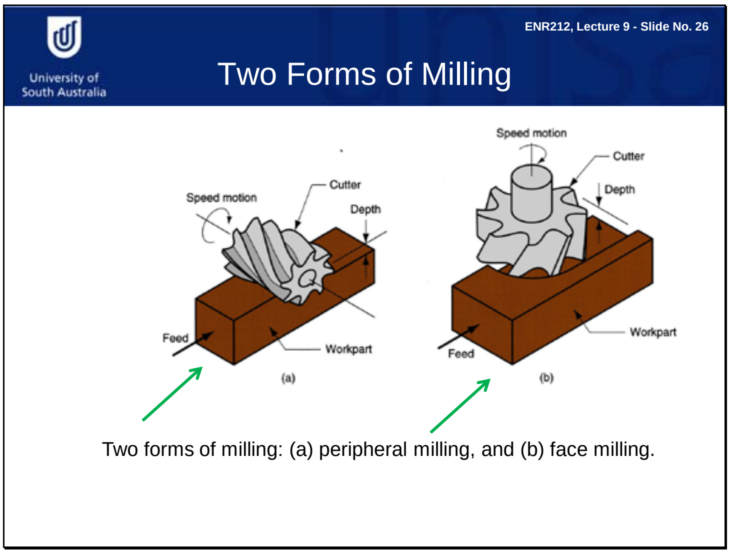
Counter boring provides a stepped hole. A larger diameter follows a smaller diameter partially into the hole.

Slide 25



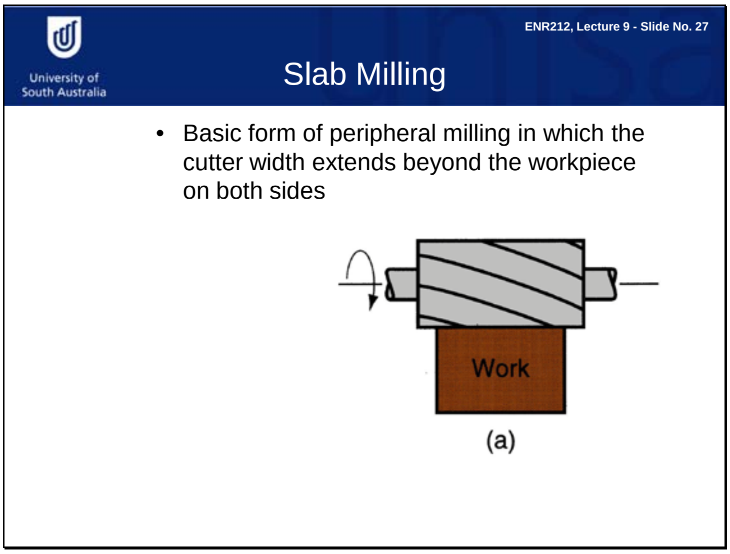
In milling, a rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The axis of rotation of the cutting tool is perpendicular to the direction of feed. Milling is often performed on a machine tool that is called a milling machine.

Slide 26



There are two basic types of milling operations: peripheral milling and face milling. In peripheral milling, also called plain milling, the axis of the tool is parallel to the surface being machined and the operation is performed by cutting edges on the outside periphery of the cutter. In face milling, the axis of the cutter is perpendicular to the surface being milled, and machining is performed by cutting edges on both the end and outside periphery of the cutter.

Slide 27



Slab milling is a basic form of peripheral milling. In slab milling, the cutter width extends beyond the workpiece on both ends.

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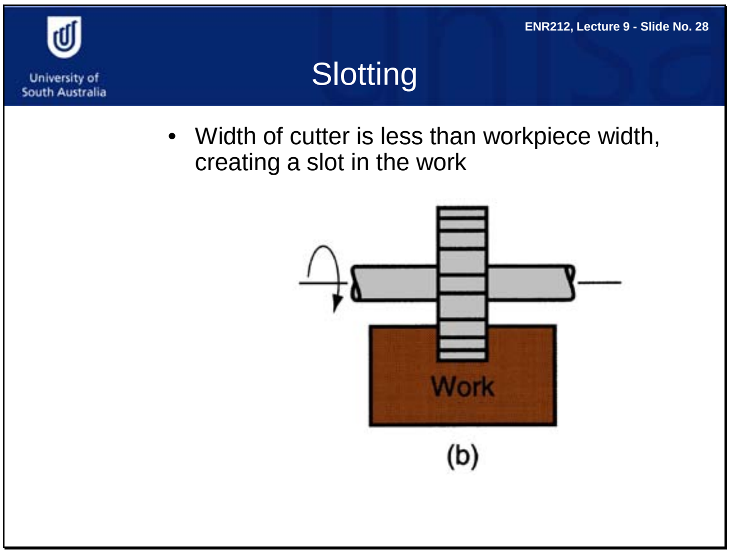

In slotting, the width of the cutter is less than the workpiece width, creating a slot in the workpiece.

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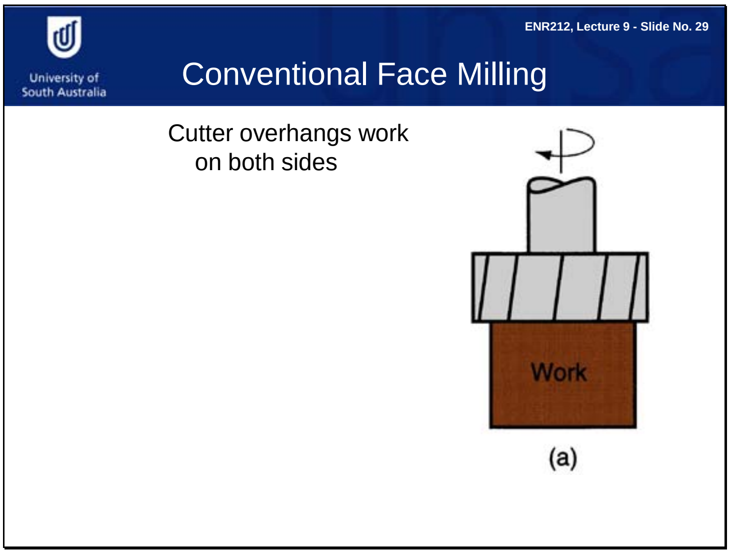

In conventional face milling, the diameter of the cutter is greater than the workpiece width, so the cutter overhangs the work on both sides.

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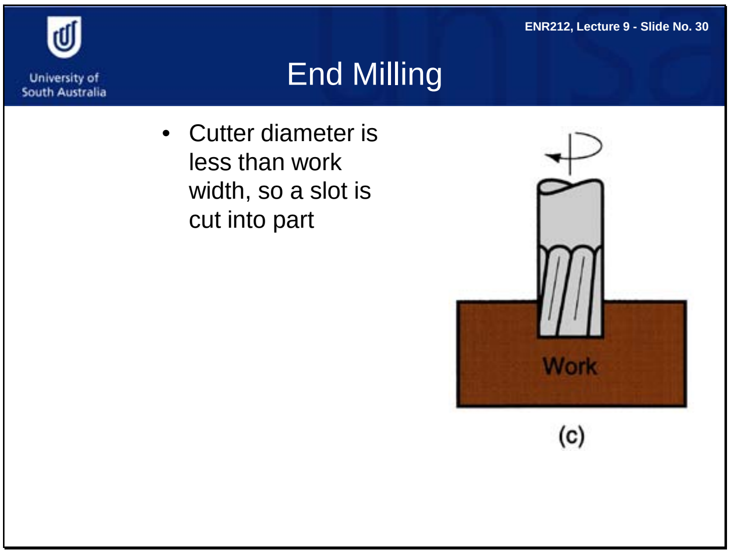

In end milling, the cutter diameter is less than work width, so a slot is cut into the part.

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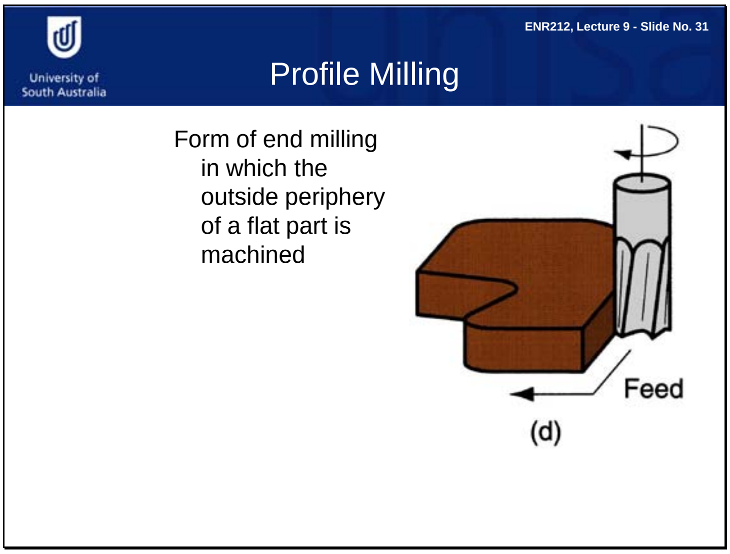
University of
South Australia
ENR212, Lecture 9 - Slide No. 31
Profile Milling
Form of end milling in which the outside periphery of a flat part is machined
Feed
(d)

Slide 32

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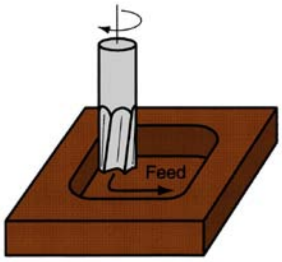
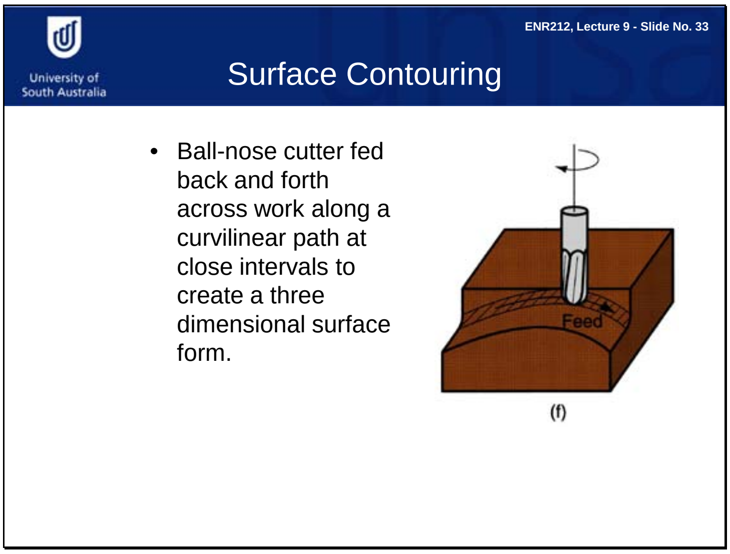
Pocket Milling

- Another form of end milling used to mill shallow pockets into flat parts



(e)

Slide 33



In surface contouring, a ball-nose cutter, rather than a square-end cutter, is fed back and forth across a work. It moves along a curvilinear path at close intervals, to create a three dimensional surface form. These figures and names from these slides are a potential exam topic for filling blanks or multi-choice questions.

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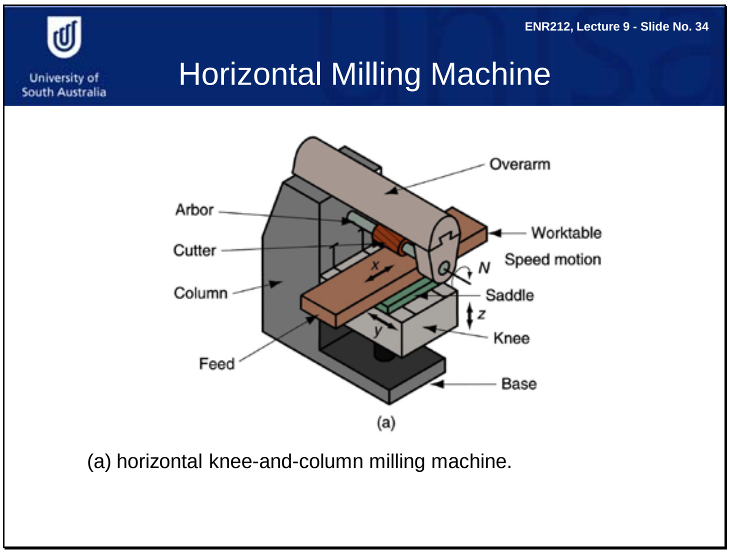

The machine used for milling is called a milling machine. Milling machines can be classified as horizontal or vertical, depending on the orientation of the cutting tool spindle. A horizontal milling machine has a horizontal spindle.

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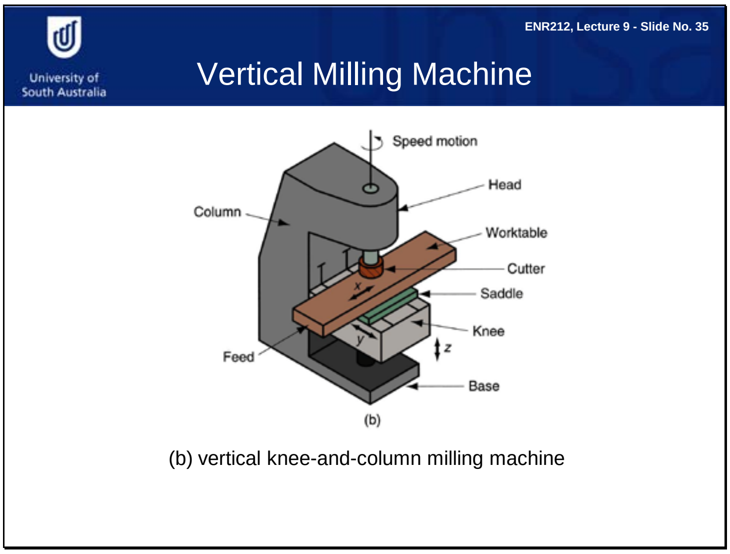

The basic milling machine is the knee-and-column milling machine, which means any milling machine whose x-y table rides up and down the column on a vertically adjustable knee. The universal milling machine has a worktable that can be rotated about a vertical axis to present the part at any specified angle to the cutter spindle.

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Machining Centers

Highly automated machine tool can perform multiple machining operations under CNC control in one setup with minimal human attention

- Typical operations are milling and drilling
- Three, four, or five axes

- Other features:
  - Automatic tool-changing
  - Pallet shuttles
  - Automatic workpiece positioning

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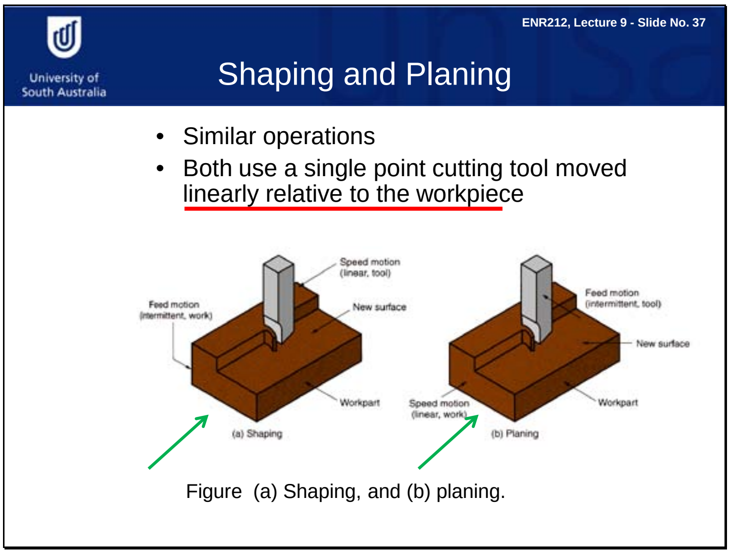
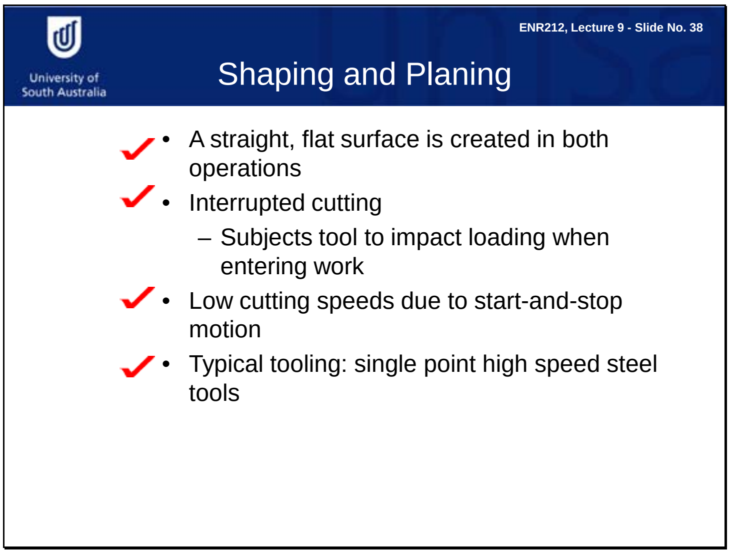


Shaping and planing are similar operations, both involving relative motion between the tool and the work part. The difference between the two operations is illustrated in this slide. In shaping, the speed motion is accomplished by moving the cutting tool, while in planing, the speed motion is accomplished by moving the workpiece. A planing operation is best described as moving a workpiece in a linear direction past a single-point tool.

Slide 38


University of South Australia
ENR212, Lecture 9 - Slide No. 38
Shaping and Planing
• A straight, flat surface is created in both operations
• Interrupted cutting
– Subjects tool to impact loading when entering work
• Low cutting speeds due to start-and-stop motion
• Typical tooling: single point high speed steel tools

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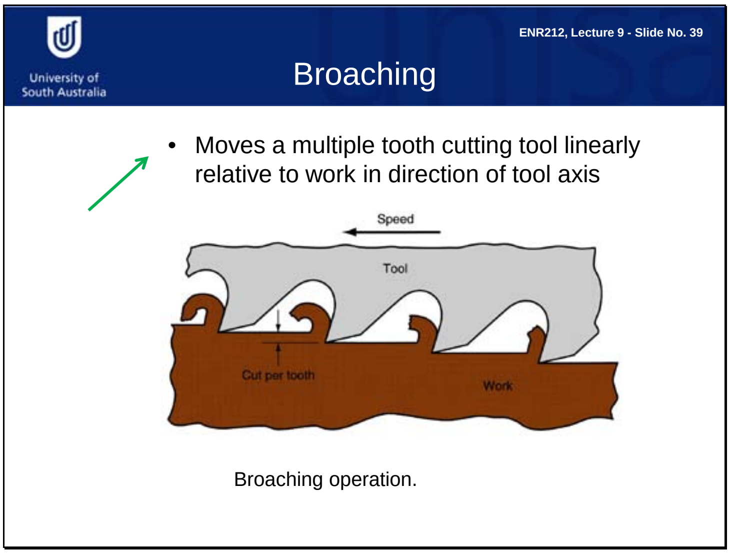

Broaching is performed using a multiple tooth cutting tool, by moving the tool in a linear direction relative to the work in the direction of the tool axis. The cutting tool is called a broach. The machine tool is called a broaching machine. A broaching operation is best described as moving a tool with multiple teeth in a linear direction past a stationary workpiece.

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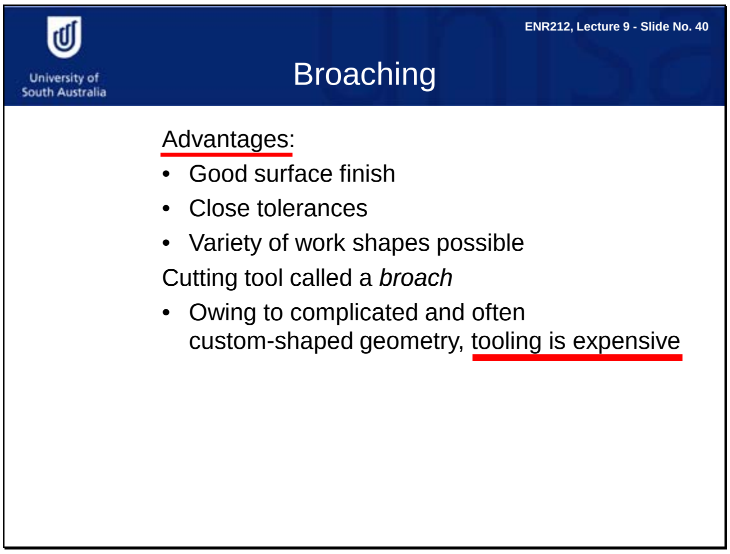

The cutting tool for broaching is called a broach, and the machine tool is called a broaching machine. Broaching is expensive.

Now let's look again at the advantages and disadvantages of machining. Machining gives a good surface finish, has close tolerances and can produce a variety of work shapes.
However, it takes a lot of time, so it is expensive. For this reason, machining is always combined with other manufacturing processes, such as metal casting. The metal casting produces a primary shape, and then this shape is further processed by machining to produce good surface finish with close tolerances.

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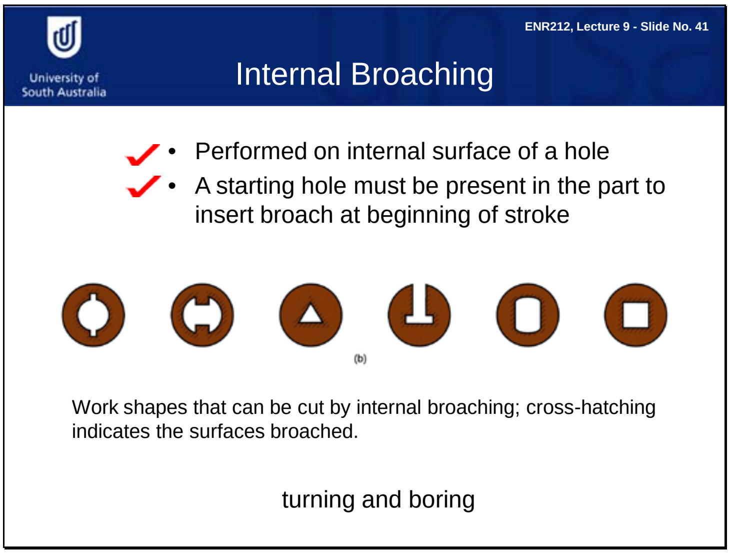

Internal broaching is accomplished on the internal surface of a hole in the part. Therefore, a starting hole must be present in the part so that the broach can be inserted at the beginning of the broaching stroke. This figure shows some of the common shapes.

What is the difference between internal broaching and external broaching? Internal broaching is accomplished on the inside surface (hole) of a workpiece, while external broaching is performed on one of the outside surfaces of the part.

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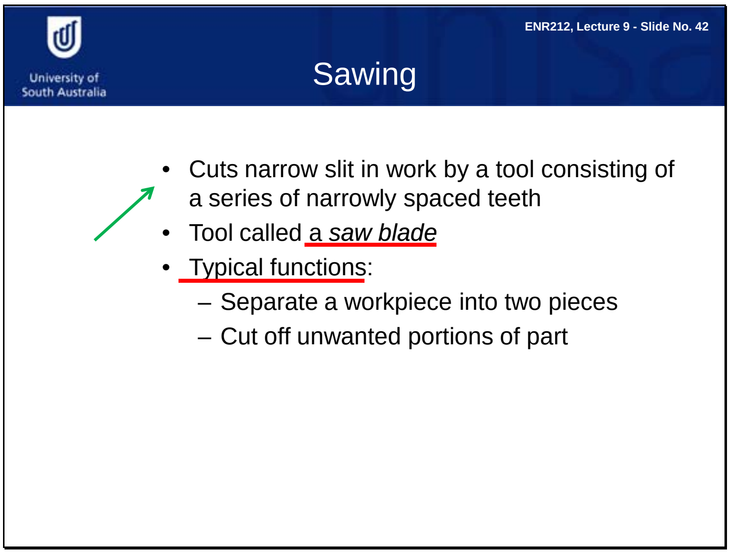

Sawing is a process in which a narrow slit is cut into the work by a tool consisting of a series of narrowly spaced teeth. The cutting tool is called a saw blade. The saw blade separates a workpiece into two pieces or cuts off unwanted portions of a part.

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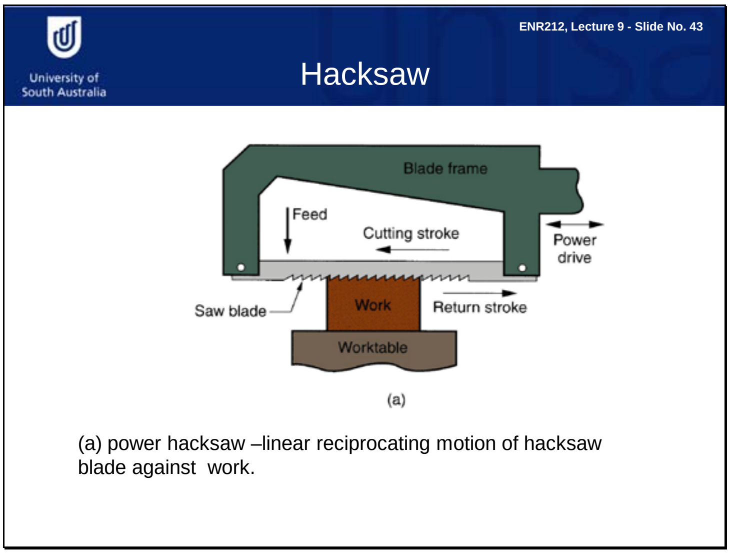

There are three basic types of sawing, depending on the type of blade motion involved. Hacksawing involves a linear reciprocating motion of the saw against the work. It is interrupted.

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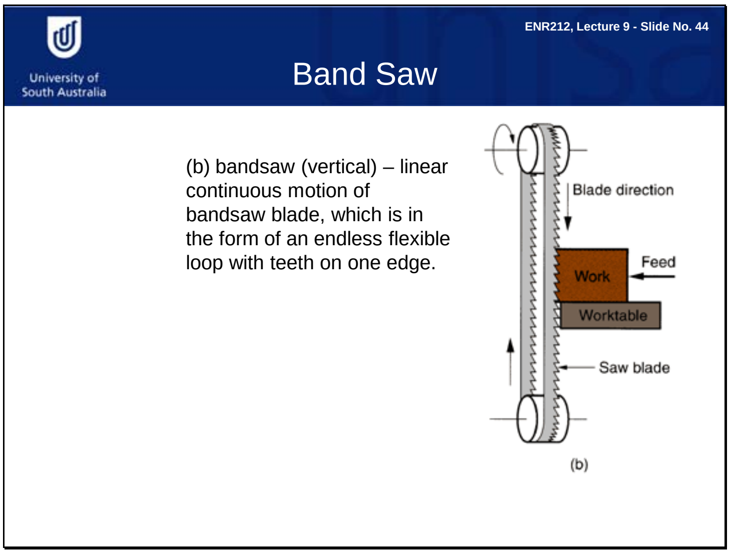

Bandsawing involves a linear continuous motion, using a bandsaw blade made in the form of an endless flexible loop with teeth on one edge.

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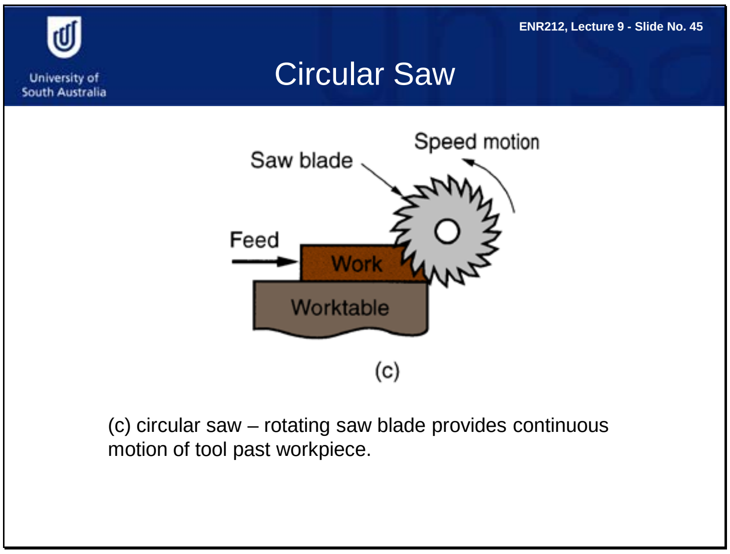

Circular sawing uses a rotating saw blade to provide a continuous motion of the tool past the work.

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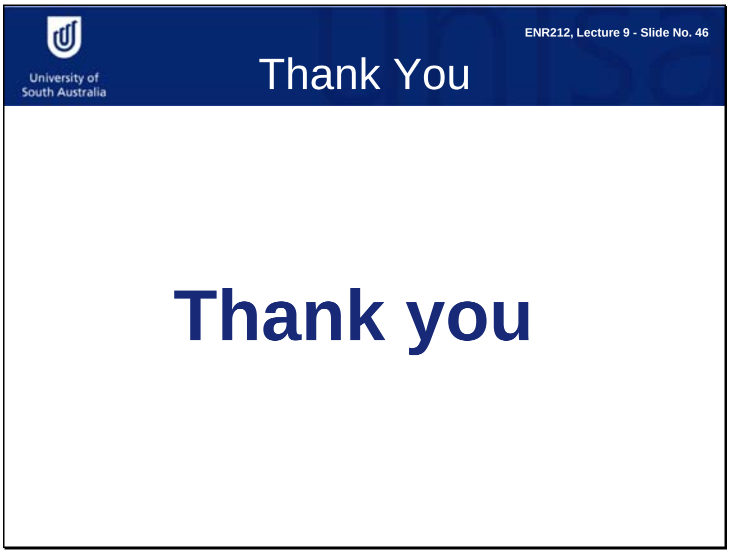
Slide 46



Thank you for your attention.