ENR212 Lecture 11 Slides and Notes

Slide 1

Hello, and welcome to the final lecture summary for Manufacturing Processes. (This lecture covers material from chapters 30 and 32 of the textbook.) In this lecture summary, we will introduce welding, brazing, soldering and adhesive bonding. The lecture will be in two parts: in this part, we will look at the fundamentals of welding.

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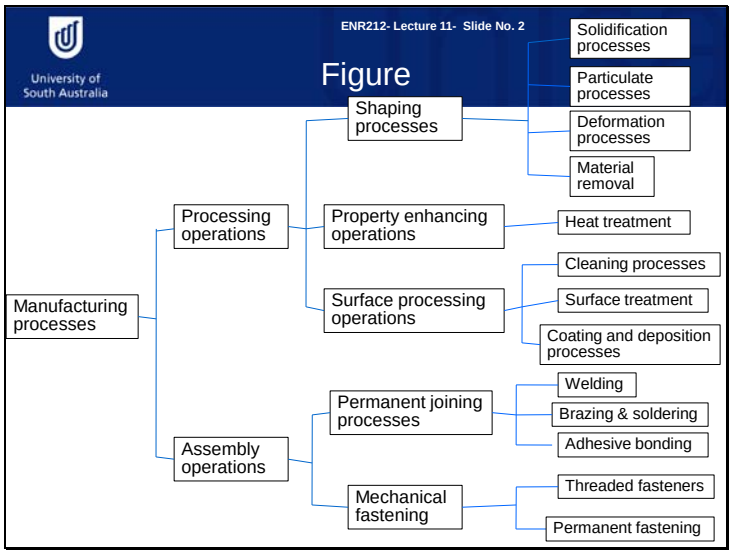

First, let us review what we have learnt about the classification of manufacturing processes. Manufacturing processes consist of processing operations and assembling operations. The processing operations include shaping processes, property enhancing operations and surface processing operations. Of these three, shaping processes are the focus of this unit. This lecture covers permanent joining processes which belong to assembling operations; these permanent joining processes include welding, brazing, solldering and adhesive bonding.

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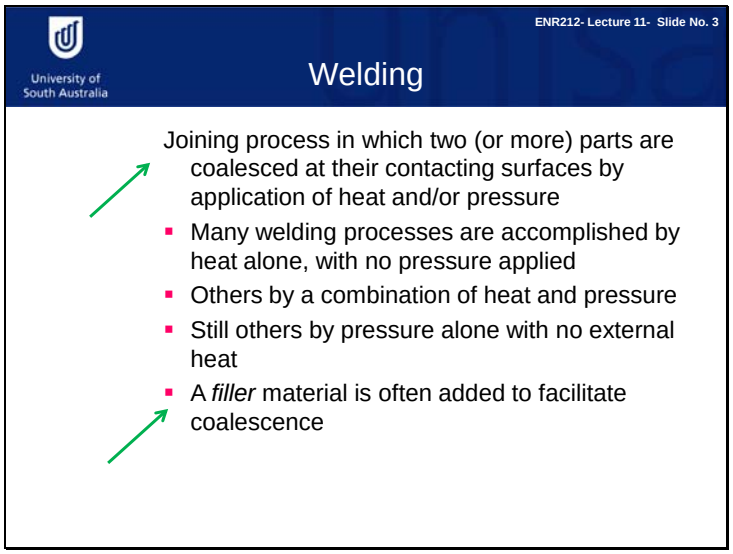

Welding is defined as a materials joining process in which two (or more) parts are coalesced at their contacting surfaces by an application of heat, or of pressure, or a combination of both.
A filler material is often added to facilitate coalescence.

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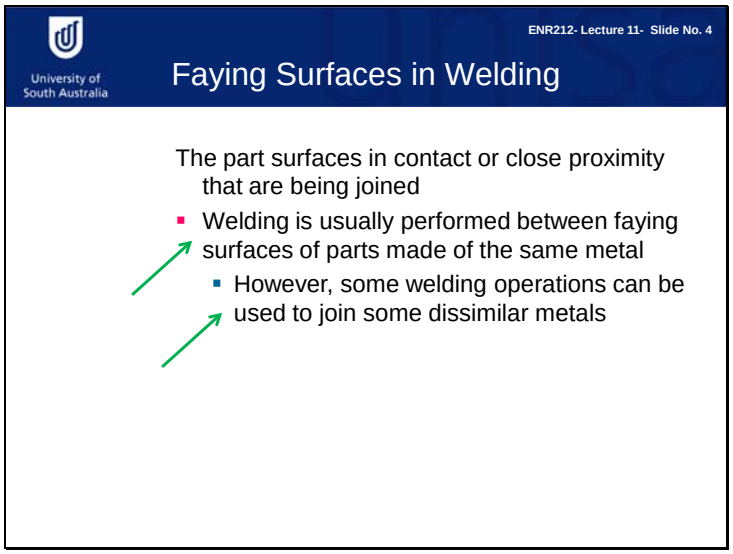

Welding is usually performed on parts made of the same metal. However, in some cases, depending on the application, welding operations are also used to join dissimilar metals.

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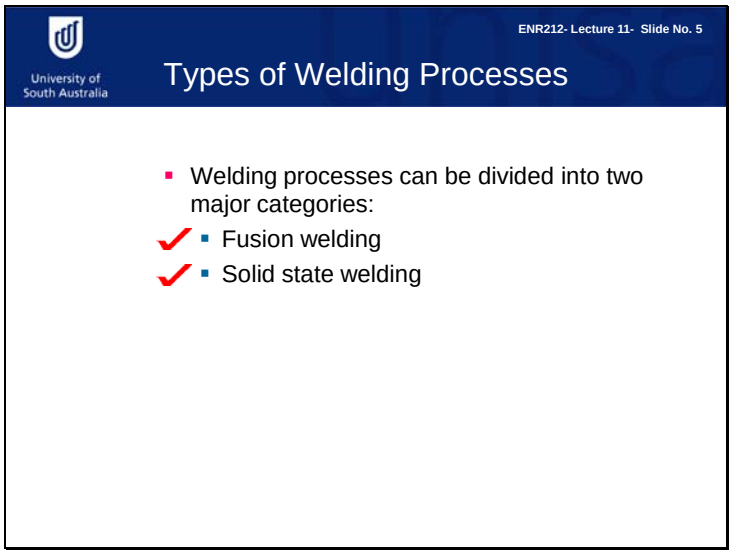

Welding processes can be divided into two major categories, depending on the working temperature: fusion welding and solid state welding.

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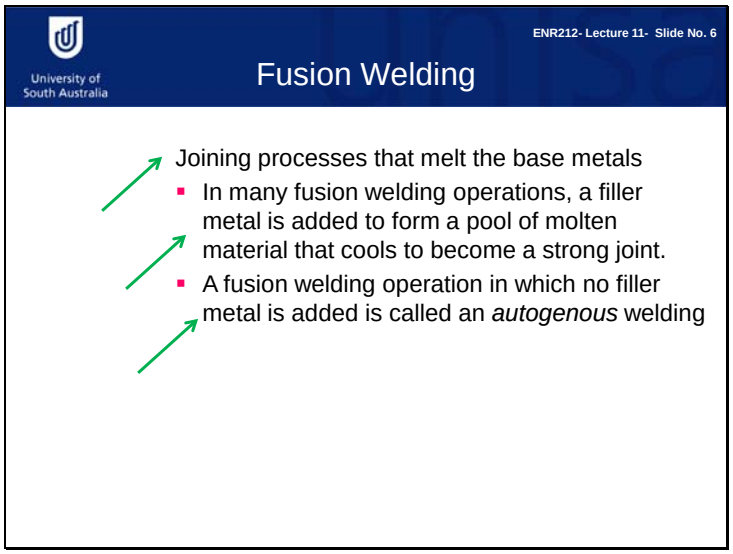

Fusion welding is a joining process that uses heat to melt the base metals. This is done through the application of heat alone or through a combination of heat and pressure. In many fusion welding operations, a filler metal is added to form a pool of molten material that cools to become a strong joint. A fusion welding operation in which no filler metal is added is called an autogenous welding.

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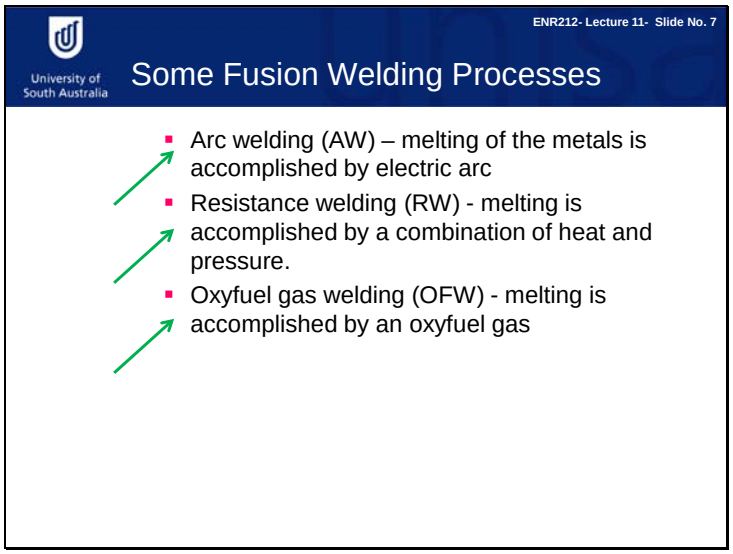

Fusion welding processes are further classified according to the source of heat. Arc welding (AW) refers to a group of welding processes in which metals are melted by an electric arc. In resistance welding (RW), the melting is due to a combination of heat and pressure. The heat is generated by electrical resistance to the current flow at the junction to be welded. In oxyfuel gas welding (OFW), the melting is accomplished by an oxyfuel gas, such as a mixture of oxygen and acetylene.

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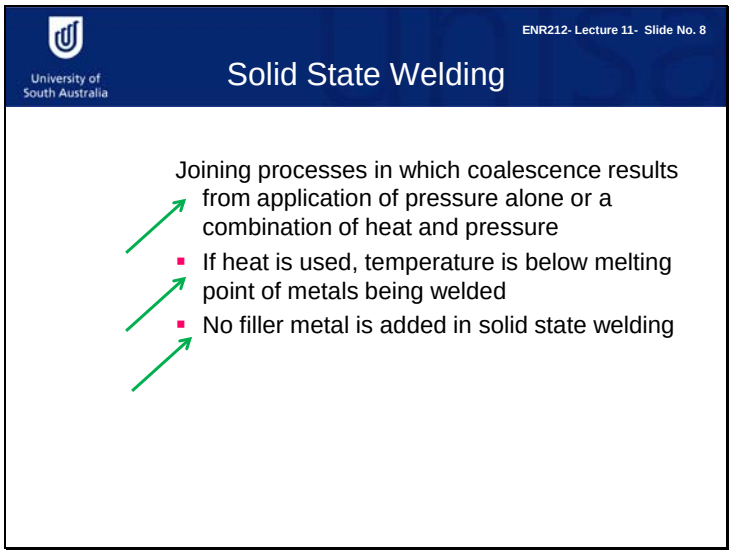

Solid state welding refers to joining processes in which the coalescence results from the application of pressure alone, or from a combination of heat and pressure. If heat is used, the temperature is below the melting point of the metals being welded. No filler metal is added in solid state welding.

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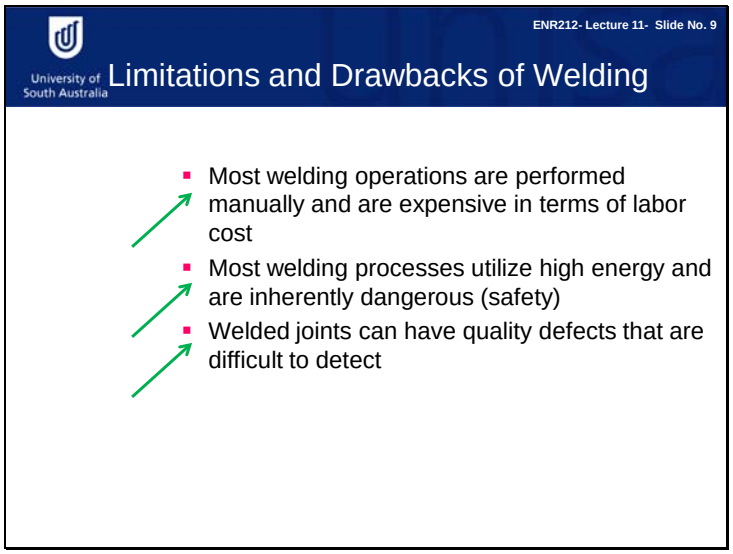

There are several limitations to welding. Firstly, most welding operations are performed manually and are therefore expensive in terms of labor cost. Secondly, most welding processes use high temperatures, which can be a safety hazard. Finally, welded joints can have quality defects that are difficult to detect.

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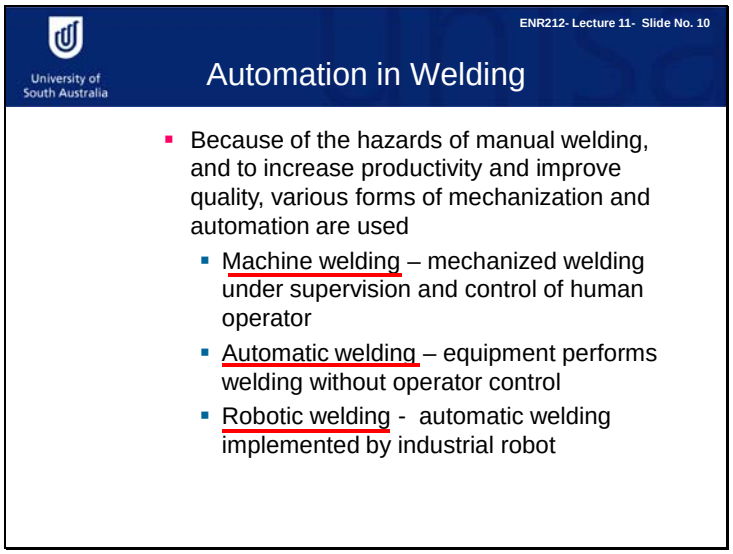

To overcome these three limitations, three types of welding have been developed: machine welding, automatic welding and robotic welding.

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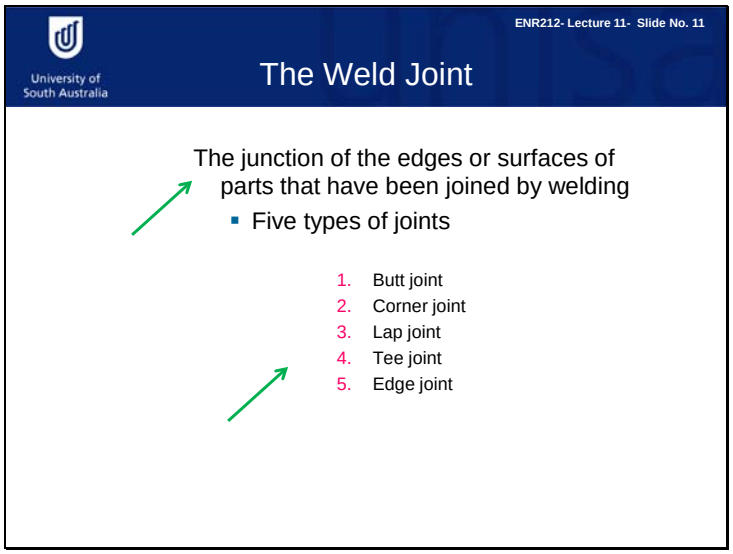

Welding produces a solid connection between two pieces, called a weld joint, which is the junction of the edges or surfaces of parts that have been joined by welding. There are five types of joints: butt joint, corner joint, lap joint, tee joint, and edge joint.

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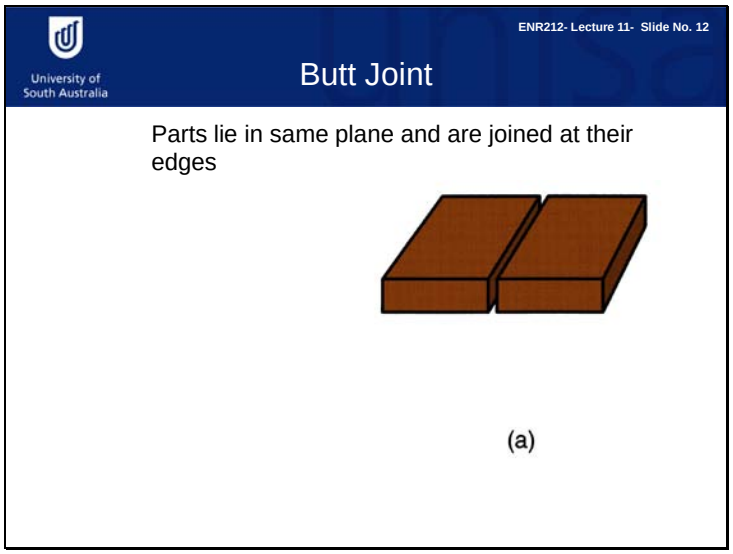

In a butt joint, parts lie in the same plane and are joined at their edges.

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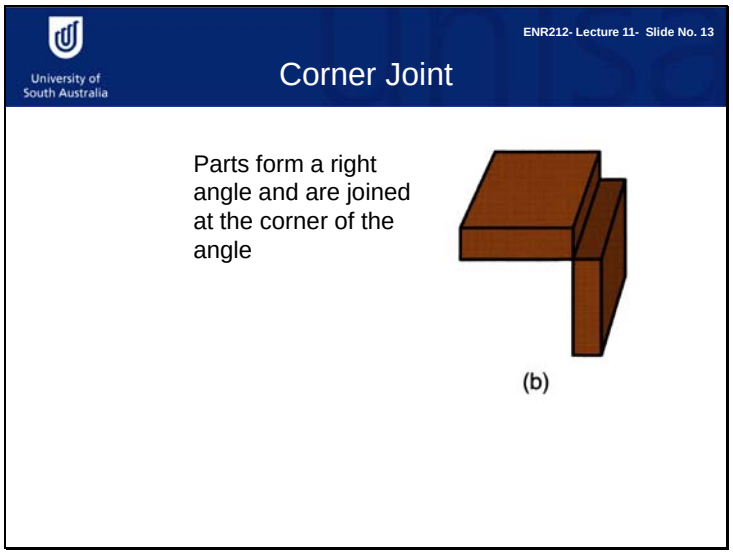

The parts in a corner joint form a right angle and are joined at the corner of the angle.

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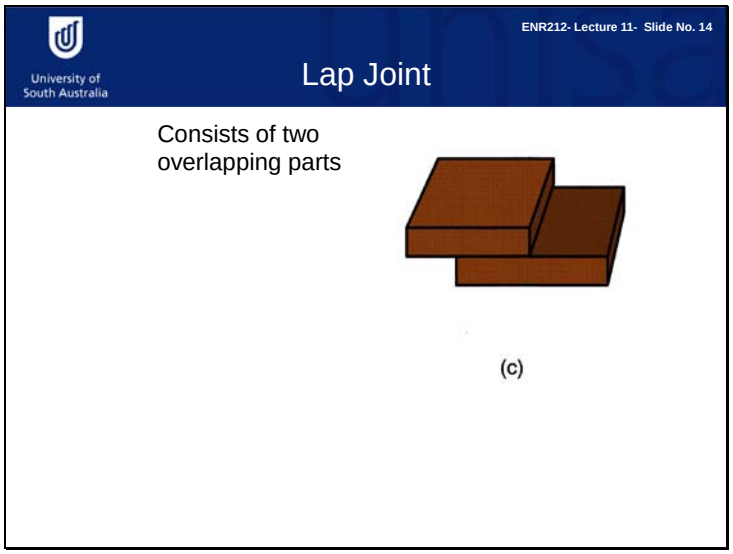

The lap joint consists of two overlapping parts.

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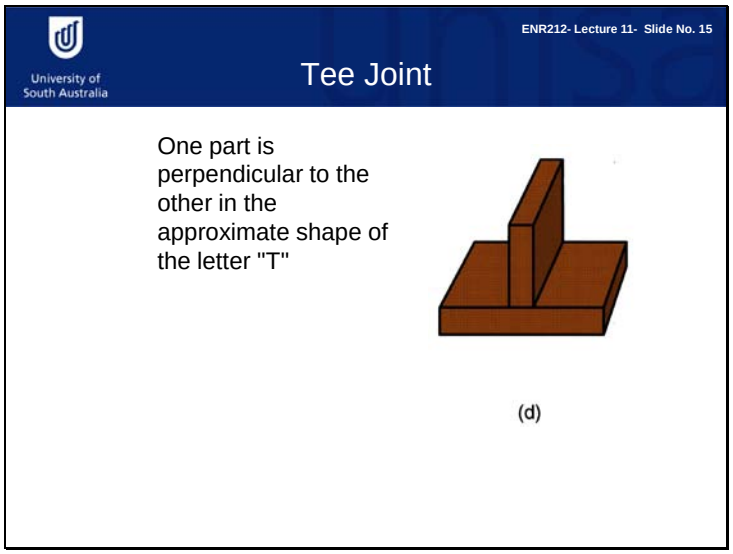

In the tee joint, one part is perpendicular to the other in the approximate shape of the letter "T“.

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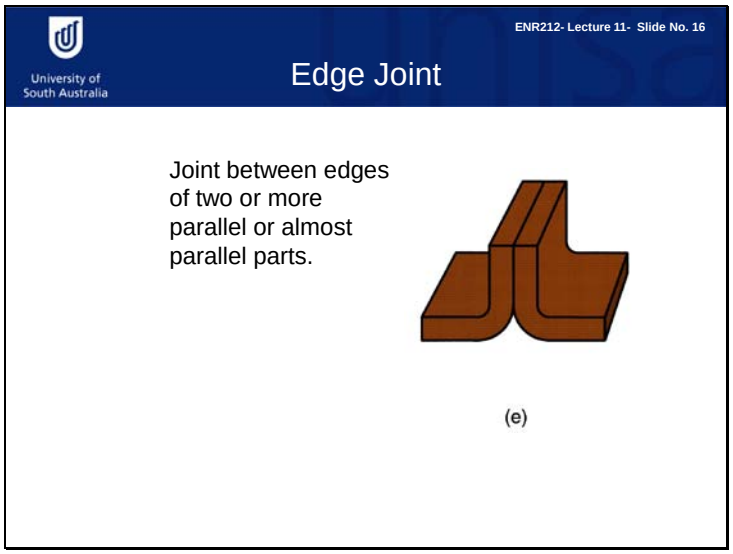

An edge joint is a joint between the edges of two or more parallel or almost parallel members. Note that these types of joints are potential assessment topics for this unit.

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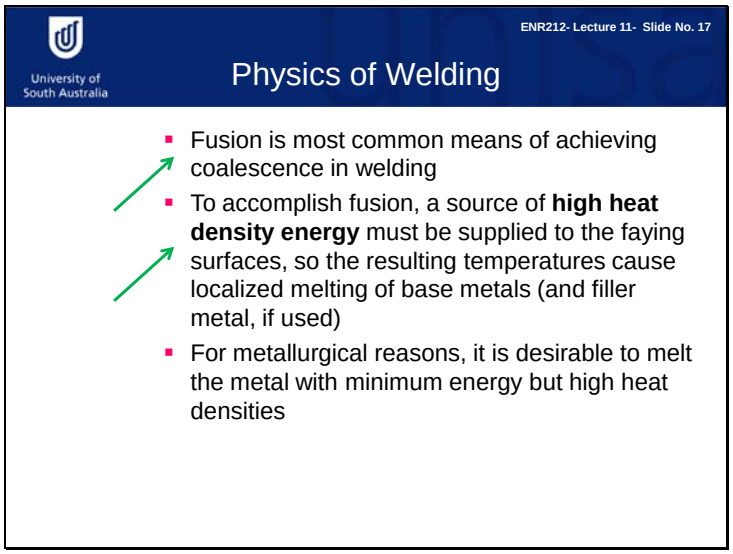

Fusion is by far the most common means of achieving coalescence in welding. In fusion, the faying surfaces of base metal are melted with or without addition of filler metal by a source of high-density heat energy. Heat density can be defined as an amount of power transferred to a work material per unit surface area.

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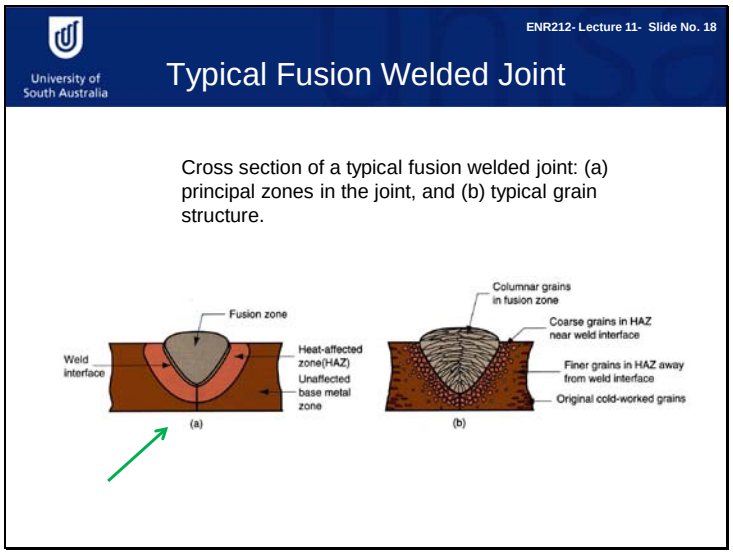

As shown in this figure, a typical fusion-weld joint consists of three zones: the fusion zone, the heat-affected zone and unaffected base metals zone. The fusion zone consists of a mixture of filler metal and base metal that has completely melted. Between the fusion zone and the heat affected zone is a weld interface, which is a narrow boundary that separates the fusion zone from the heat-affected zone.

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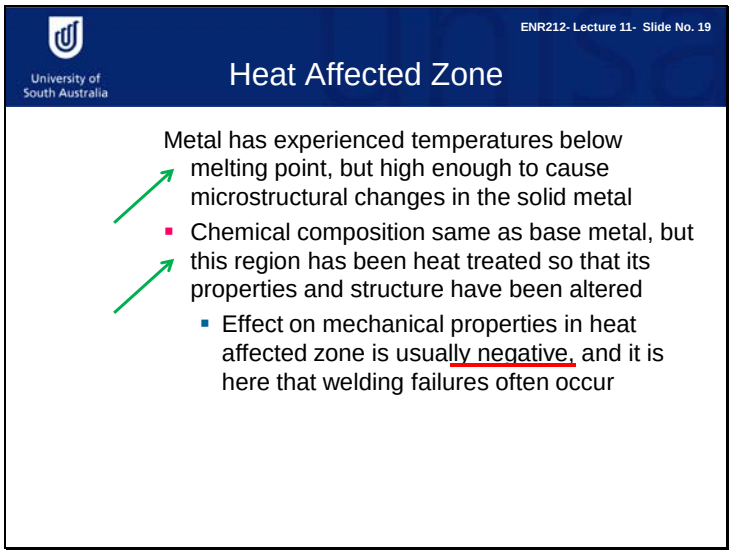

It is the heat-affected zone that experiences a temperature gradient. The chemical composition is same as the base metal, but this region has been heat treated, so that its properties and structure have been altered. In most cases, the mechanical properties in this zone just decrease, so it is here that welding failures often occur.

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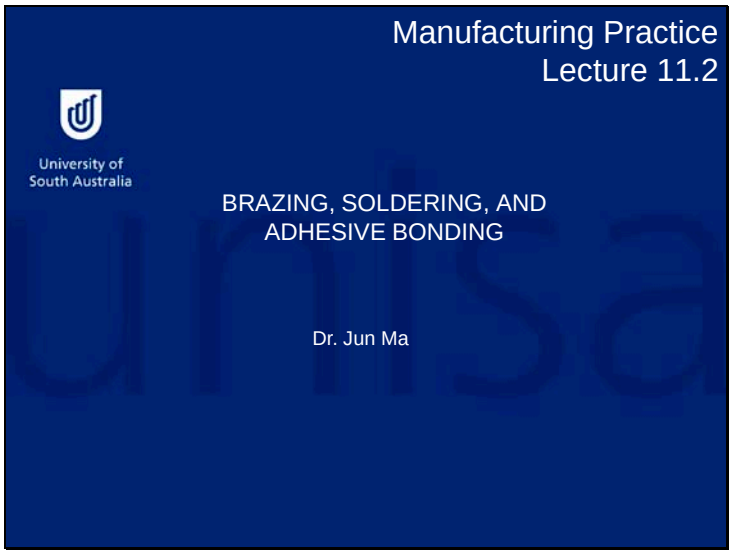

Now, we will move onto the second part of this lecture. In this part (lecture summary 11b), we will look at brazing, soldering and adhesive bonding.

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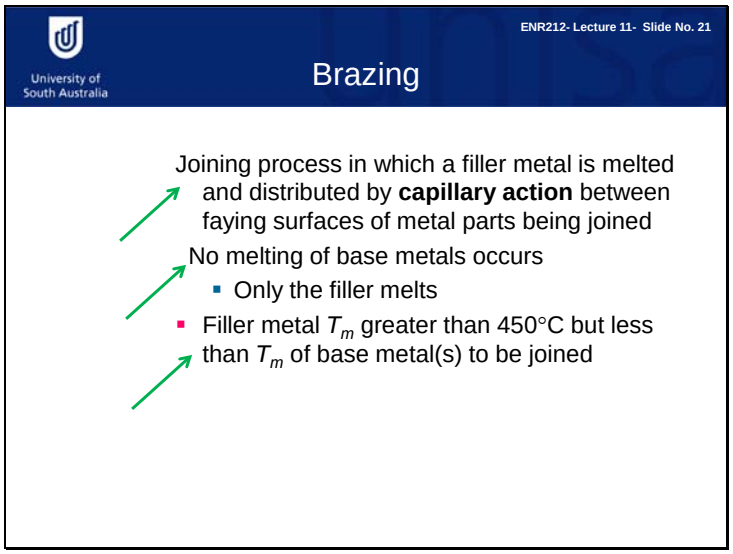

Brazing is a joining process in which a filler metal is melted and distributed by capillary action between the faying surfaces of the metal parts being joined. The capillary action, capillarity, capillary motion, and wicking refer to the ability of a substance to draw another substance into itself. In brazing, there is no melting of base metals, only of the filler metals. To be joined, the filler metal melting temperature must be greater than 450□C but must be less than the melting temperature of the base metals.

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This table shows you which metals are base metals and which are filler metals. If you compare the base metals and the filler metals, you will probably notice two things. First, filler metals are not as strong as base metals. Second, filler metals have lower melting temperatures than base metals.

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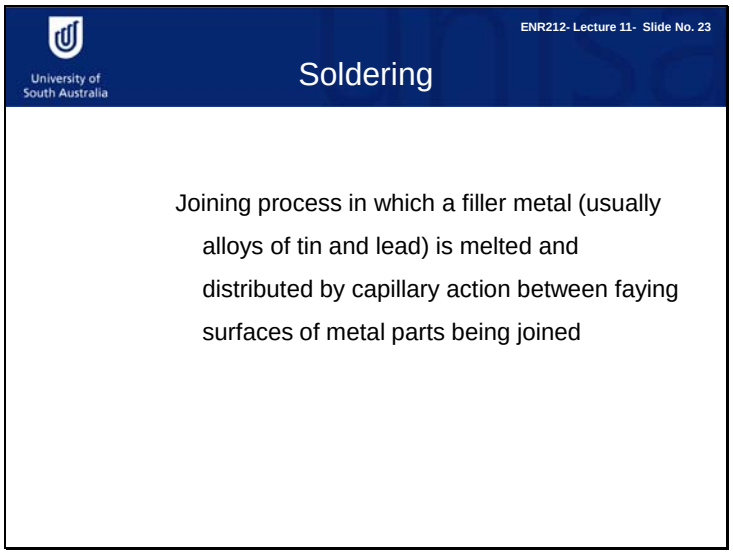

Soldering is defined as a joining process in which a filler metal is distributed by capillary action between the faying surfaces of the metal parts being joined. In soldering, the filler metal must have a melting point lower than 450 degrees.

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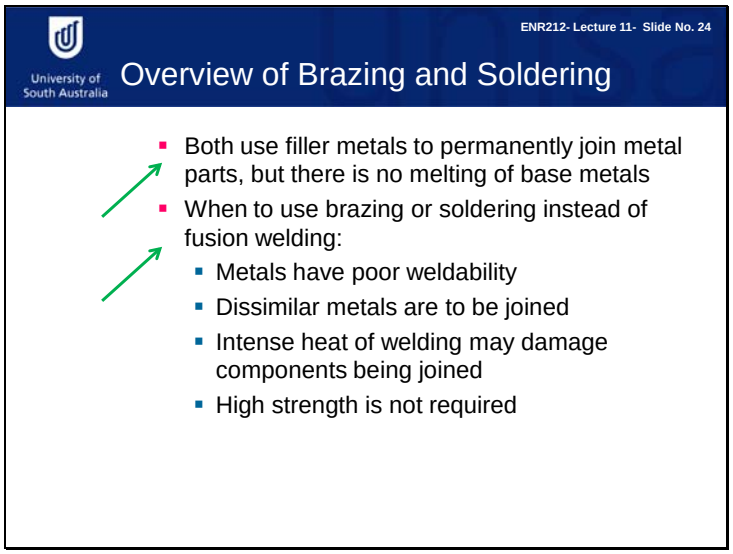

Brazing and soldering are used where metals have poor weldability, where dissimilar metals are to be joined, where intense heat of welding may damage the components being joined, or where high strength is not required.
So what is the difference between brazing and soldering? They both use filler metals to permanently join metal parts, with no melting of base metals. However, the melting point of the filler metals for brazing and soldering are different.

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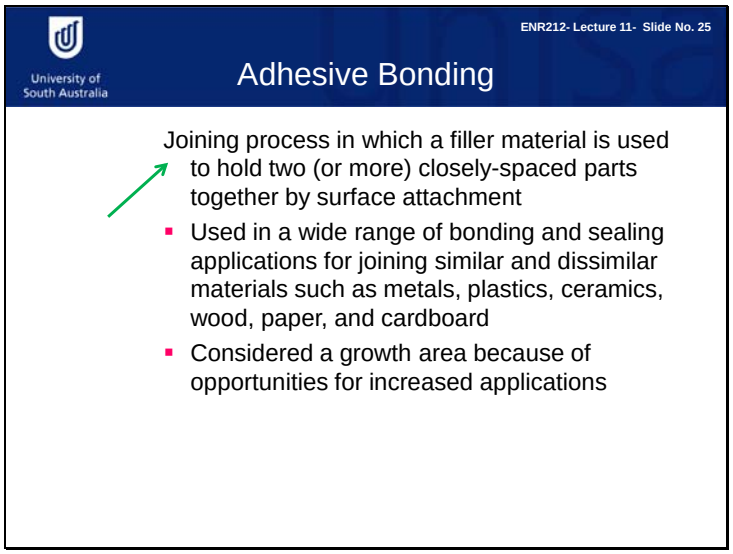

Adhesive bonding is a joining process in which a filler material (which is often a polymer) is used to hold two or more closely spaced parts together by surface attachment.
Adhesive bonding is becoming more common for two reasons. First, adhesively bonded joints are strongest on the shear and tension. Second, adhesive bonding is low cost. It is much cheaper than mechanical fastening.

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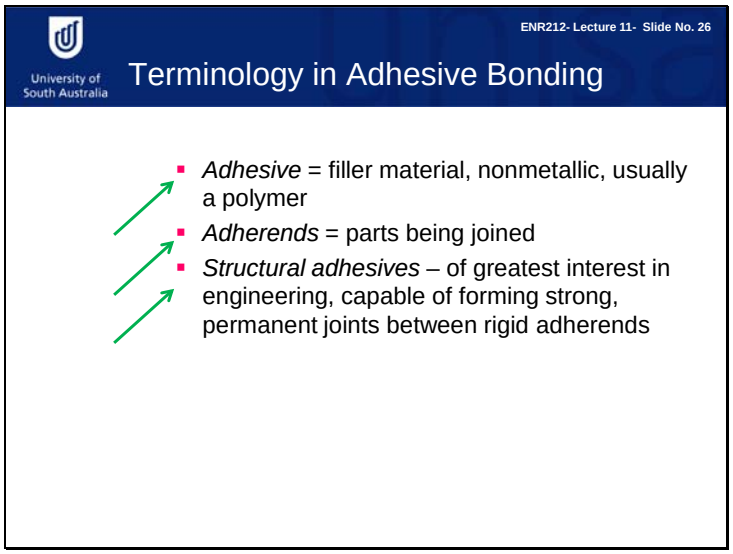

You will need to understand these new terms. Adhesive is a filler material which is often a polymer. It is used to glue two or more parts together. The adherents are the parts being joined. The most important adhesives in engineering are structural adhesives.

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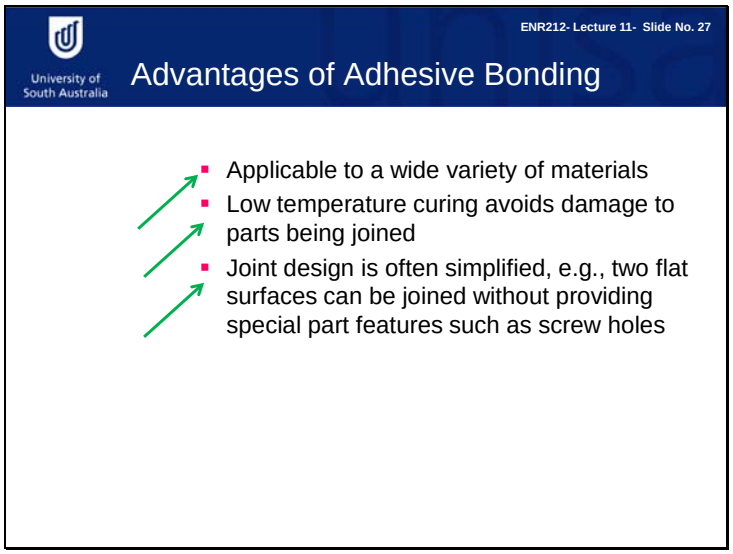

Adhesive bonding has a number of strengths. First, it is applicable to a wide variety of materials. Second, unlike welding, adhesive bonding just needs low temperatures to cure. Third, the joint design is simple.

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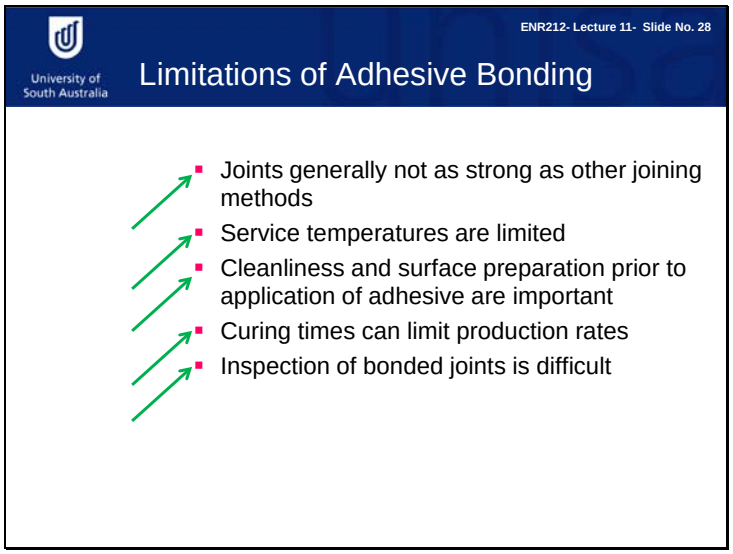

Adhesive bonding also has a few limitations. First, the adhesive joints are not as strong as in other joining methods, such as welding. Second, service temperatures are limited. Most adhesive bonding can not be used at temperatures higher than 100 degrees. Third, the surfaces in adhesive bonding need to be clean. Fourth, the adhesive bonding takes time to cure. Fifth, the inspection of bonded joints is difficult.

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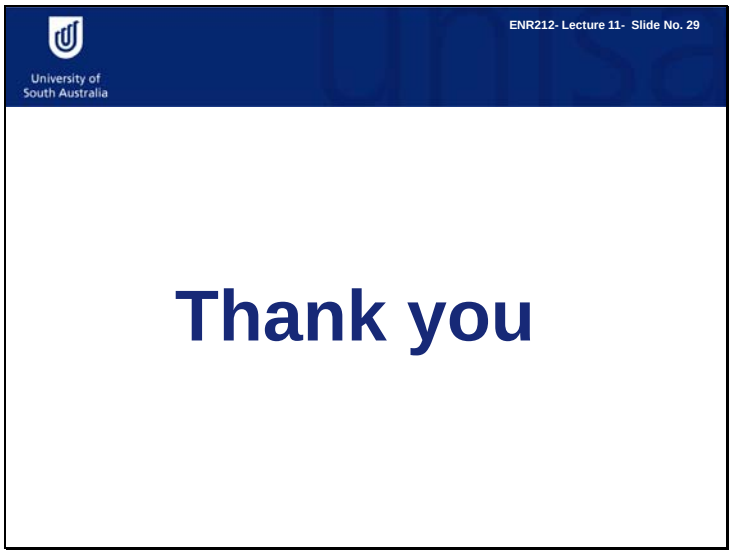

Thanks for your attention.