ENR212 Lecture 1 Slides and Notes

Slide 1

Hello, ladies and gentleman, and welcome to this first lecture summary for ENR212 Manufacturing Processes. (This lecture works through material covered in Chap 1 of the textbook.)

In this lecture, we will introduce you to manufacturing processes by addressing following three questions. First, what is manufacturing? There are a few new terms for you to learn, including production quantity, product variety, manufacturing capability and production systems. Second, how many classes of materials are used in manufacturing, and what are they? Third, what are the major manufacturing processes, and what are the classifications of manufacturing processes?

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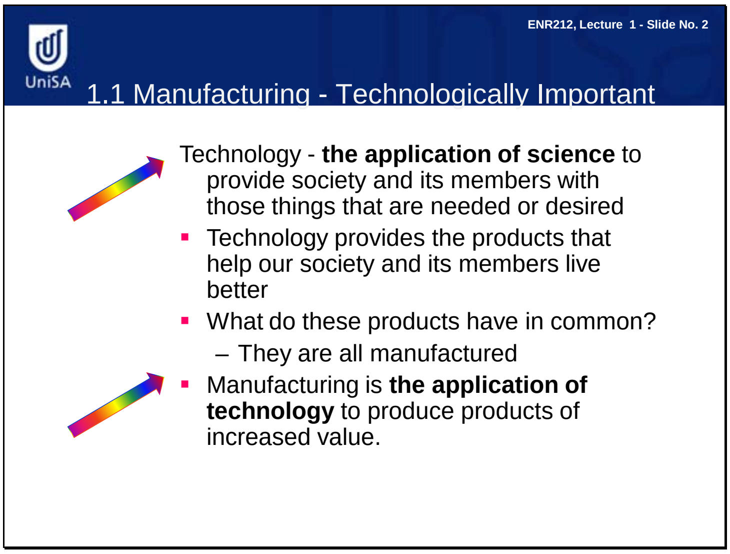

Manufacturing is technologically, economically and historically important. So, what is technology? Technology is the application of science. What is the manufacturing? Manufacturing is the application of technology to produce products of increased value.

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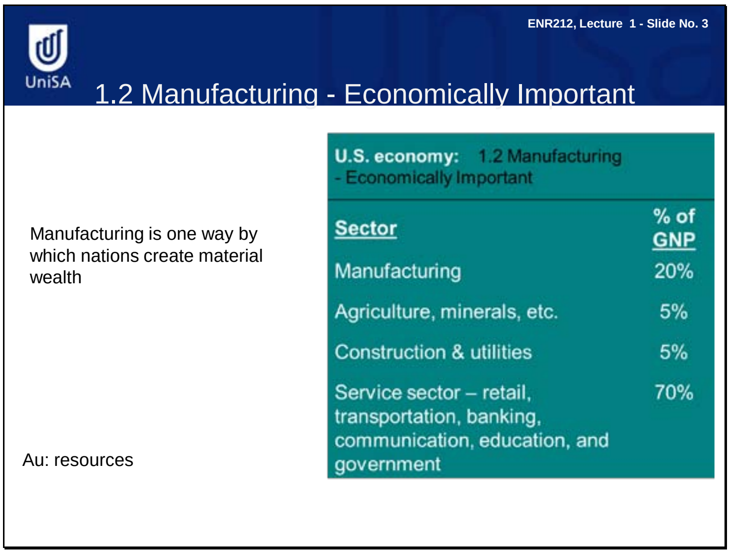

Manufacturing is economically important. In the USA, manufacturing contributes to the economy and produces 20% of the Gross National Product, while the agriculture and mineral sectors only takes contribute 5%. This means that the USA has a high manufacturing capability. Typical examples of USA manufacturing include advanced weapons and Computer Processing Units. Americans sell weapons to many countries. If these weapons need maintenance or repairs, then these countries have to pay whatever the producers ask. Nearly every computer in the world uses processing units produced in the USA. This means that America can set up the price, with no competition. This is one reason why the USA is one of the most powerful countries.

Manufacturing in Australia is not as advanced as in other developed nations, because of the population and because of mining. Mining is the top industry. However, we need to consider what we are going to leave for our offspring. It is urgent for Australia to develop so that we can catch up with other developed countries.

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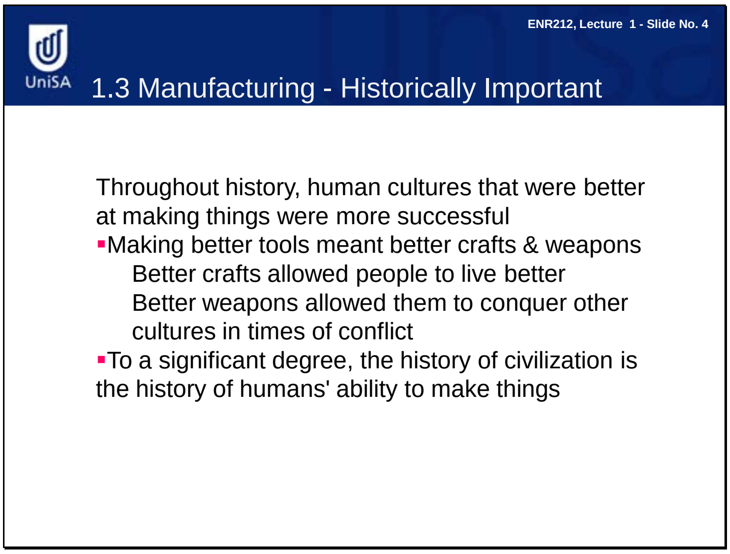

Manufacturing is historically important. The evolution of human being is actually aligned to the development of tools, from stone tools to copper tools to mechanized and automated manufacturing facilities.

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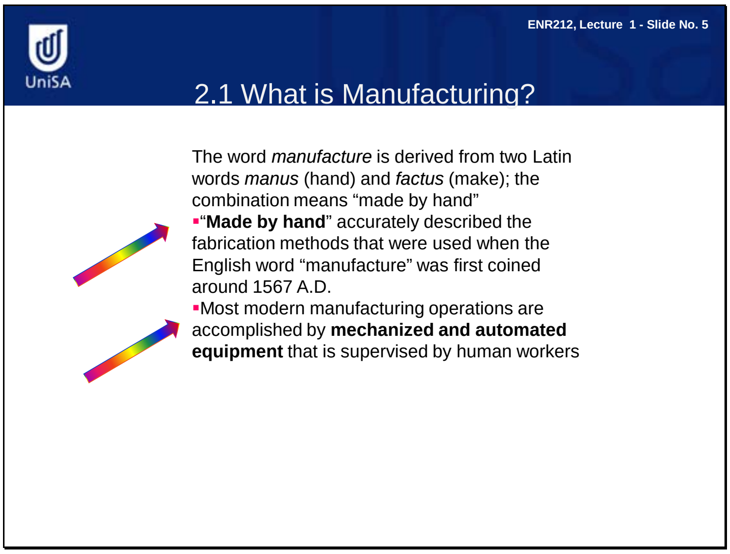

What is manufacturing? In ancient time, to ‘’manufacture’’ means to make by hand, but now manufacturing means made by technology; that is, mechanized and automated equipment.

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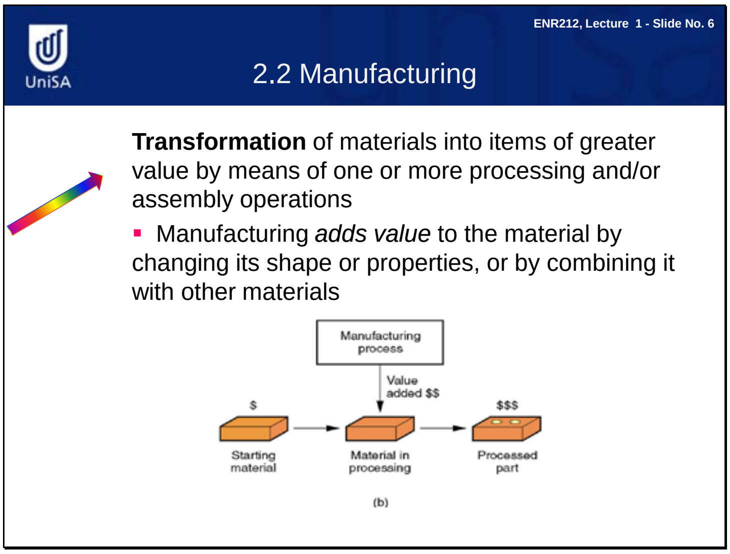

Manufacturing means transforming materials into products of increased value.

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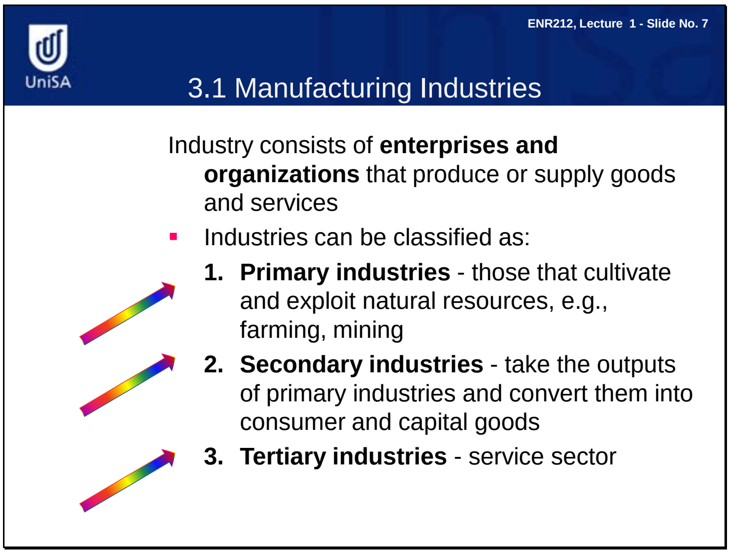

Manufacturing industries comprise all enterprises and organisations that produce or supply goods and services. Based on the input and output of industries, there are three categories of industries.

First, Primary industries cultivate and exploit natural resources, such as farming, and mining.

Secondary industries take the outputs of primary industries and convert them into consumer and capital goods. Capital goods are those purchased by other companies to produce goods or supply services. Examples of capital goods are aircraft and construction equipment.

Tertiary industries are service sectors

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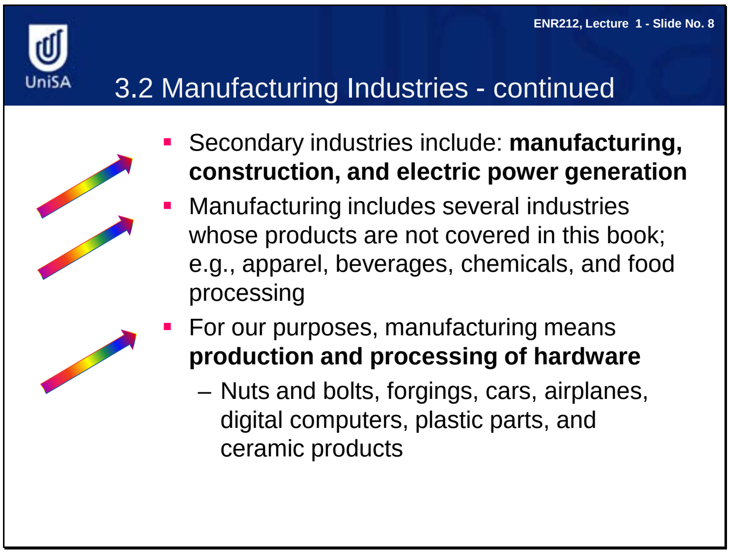

Secondary industries generally include manufacturing, construction, and electric power generation. In this course, manufacturing refers to the production and processing of hardware.

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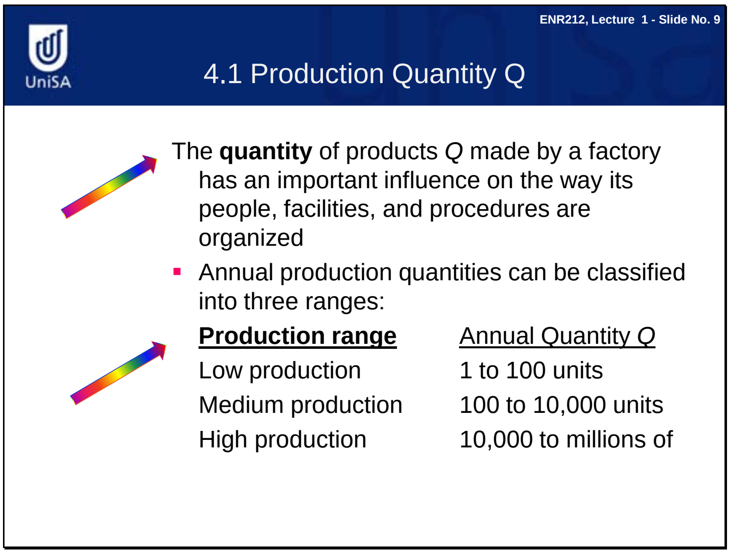

The definition of production quantity is the number of products that a manufacturing plant makes in a given period. There are three ranges of production quantity: Low production, Medium production and High production ranges.

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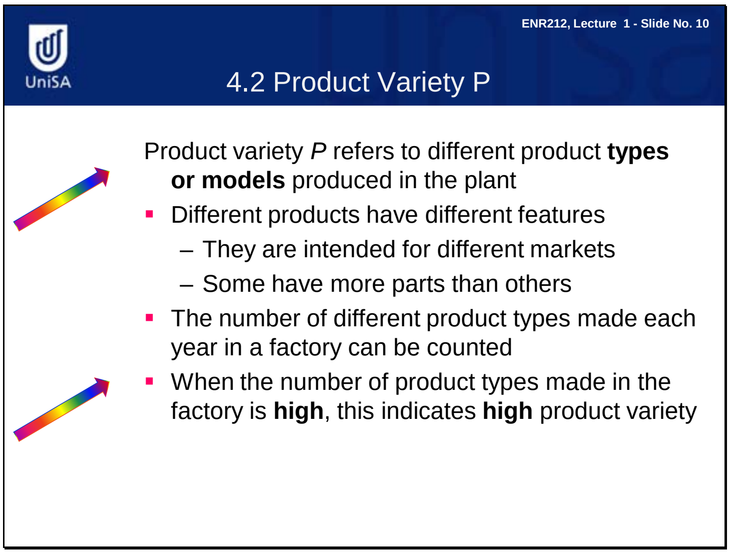

Product variety refers to different product types or models produced in the plant. If there is a High Product variety, there are more types or models produced..

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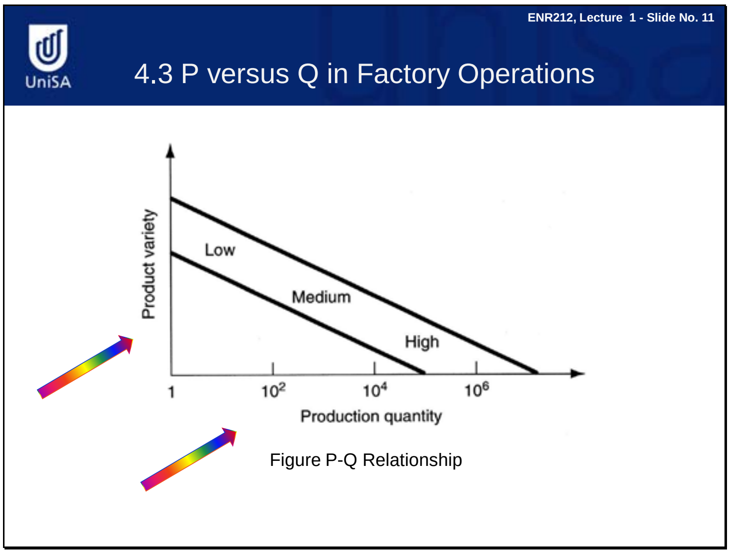

This graph shows you the relationship between the production quantity and the product variety. The x axis represents production quantity, while the y axis represents the product variety. Generally, production quantity is inversely related to product variety. A factory that produces a large variety of products will produce a smaller quantity of each product.

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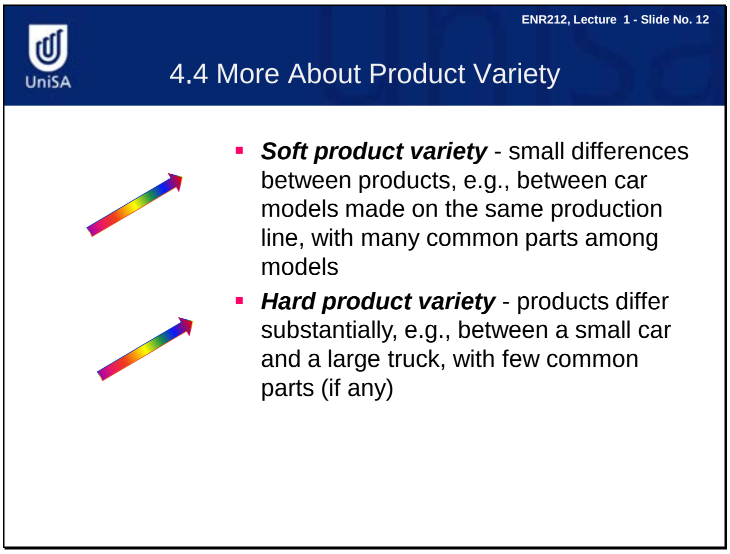

Product variety includes soft products and hard products. In a soft product variety, there are small differences between products. In a hard product variety, there are huge differences between products.

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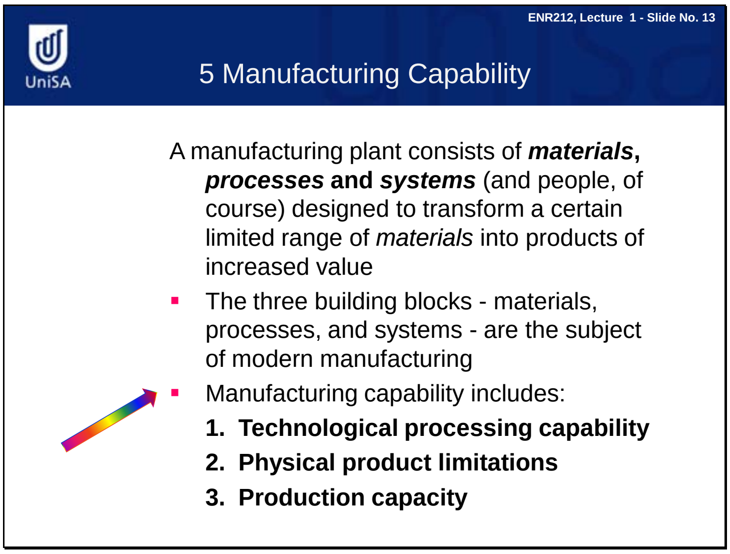

Manufacturing capability includes technological processing capability, physical product limitations and production capacity.

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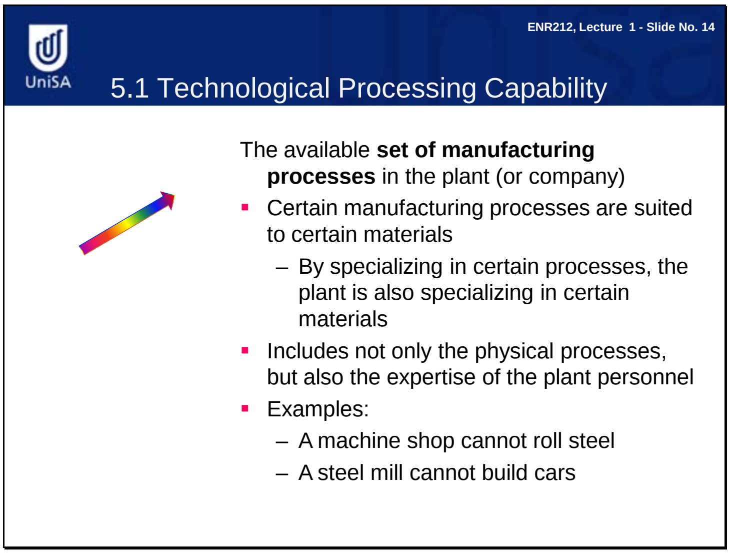

Technological Processing Capability refers to the available set of manufacturing processes in the plant. Different sets of manufacturing processes produce different products of quality.

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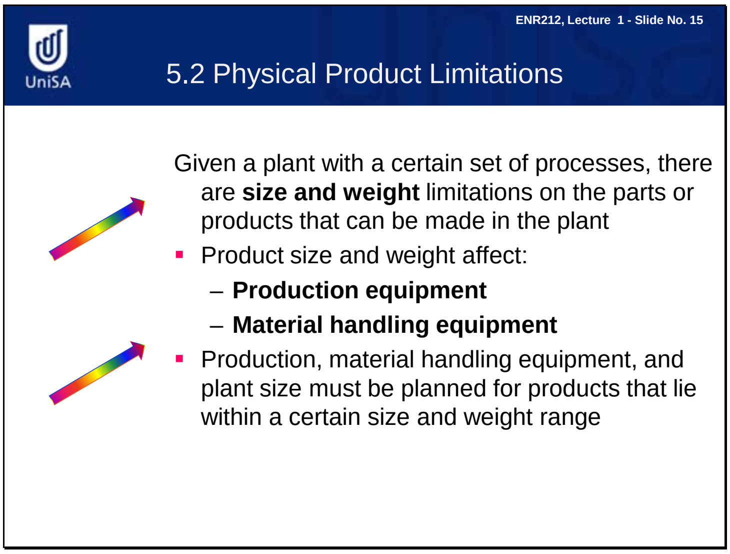

Physical product limitations refer to the size and weight limitations on the parts or products. Product size and weight determines the type of production equipment and material handling equipment needed.

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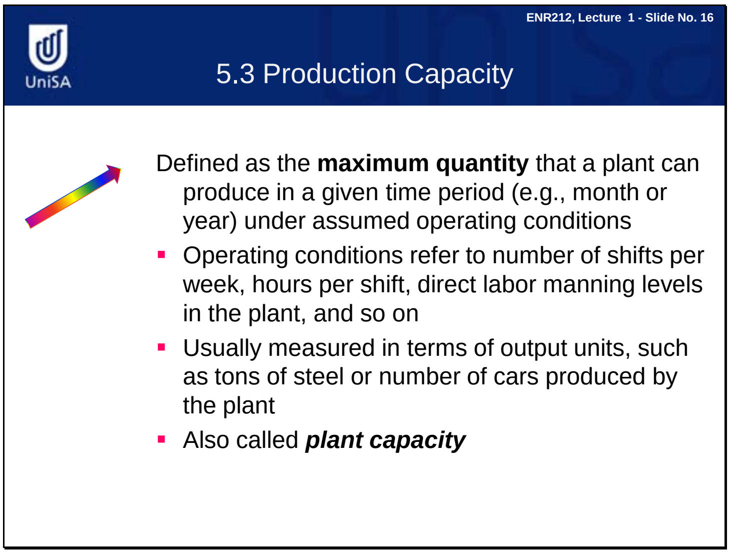

Production Capacity is also called plant capacity. It refers to the maximum quantity that a plant can produce in a given time period under assumed operating conditions.

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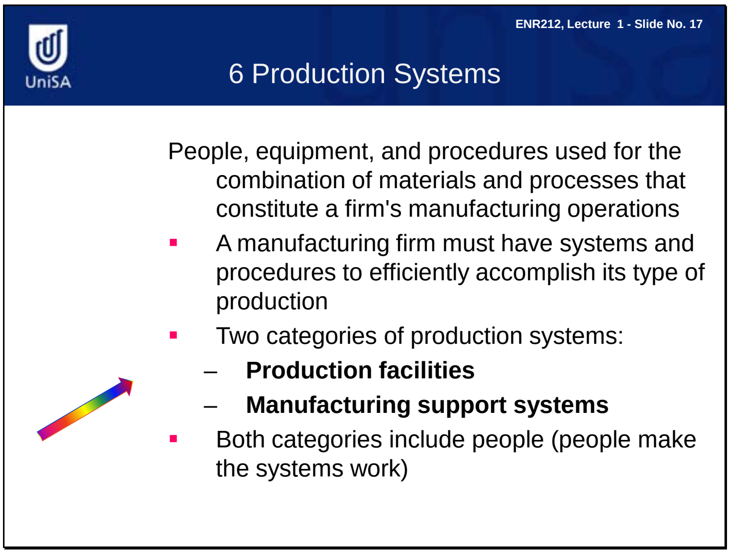

Production systems contain production facilities and manufacturing support systems.

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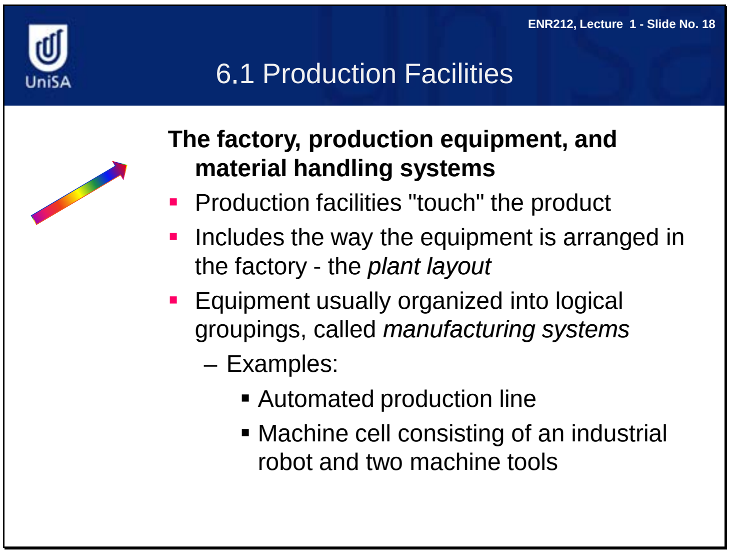

Production facilities include the factory, production equipment and material handling systems. Products are made through processing using facilities, so facilities touch the products.

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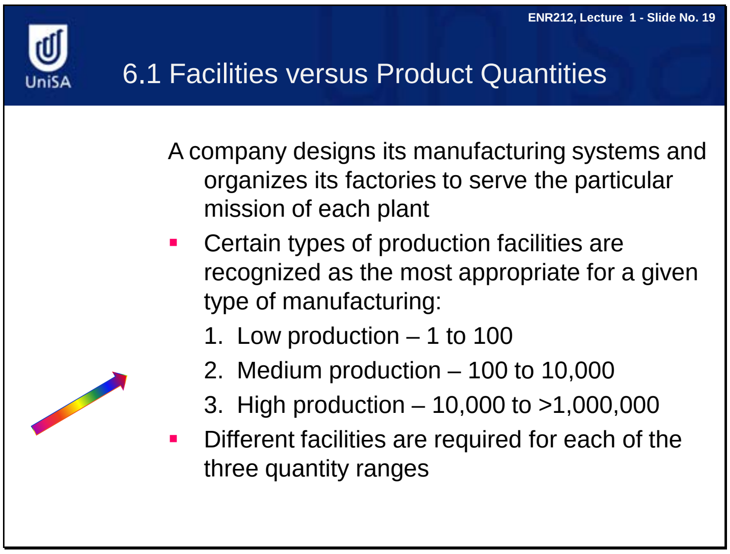

IN slide 9, we looked at three production quantities: low, medium and high production ranges. These three range productions correspond to different facilities.

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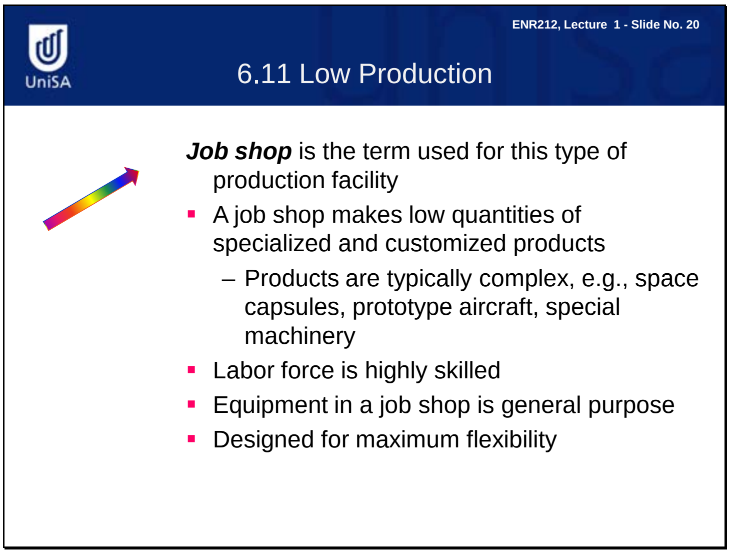

Job shop refers to the production facility for low production range. In a job shop, the labour force is highly skilled, and the equipment is just general purpose.

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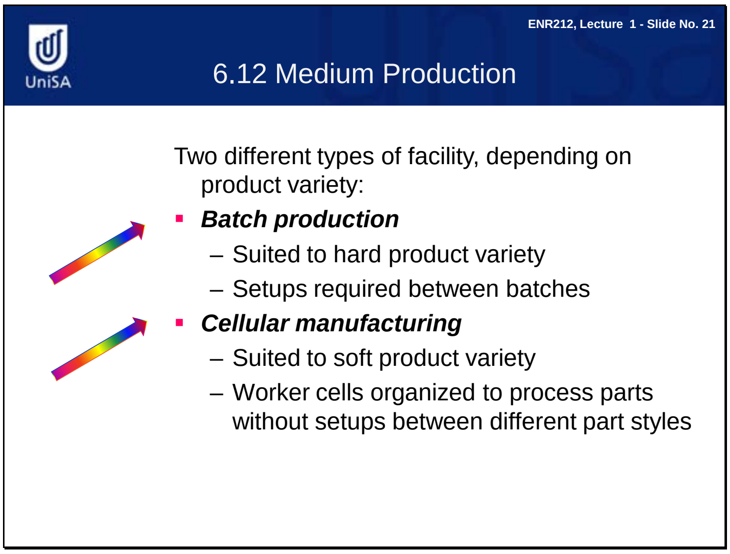

There are two type of facilities for medium production: batch production facilities and cellular manufacturing facilities. Batch production suit hard product varieties, where there is a big difference in the products. It needs setups between batches. Cellular manufacturing facility suit soft product varieties. There is no set up needed between different batches.

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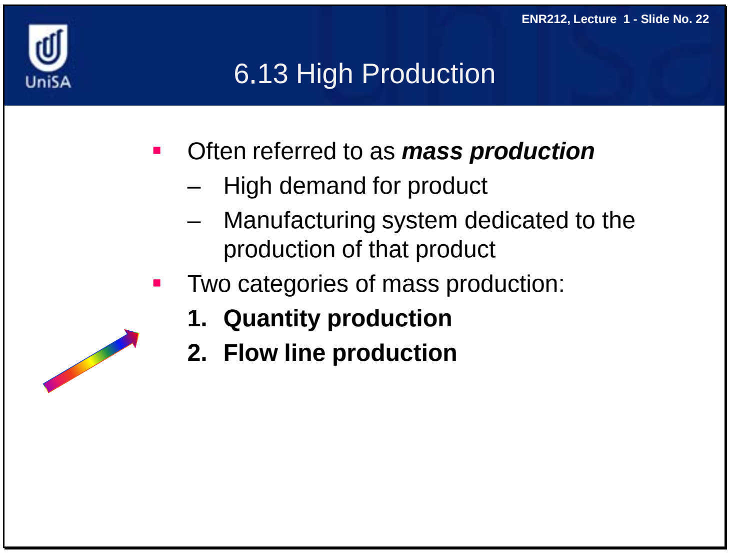

High production is also known as mass production. High production includes quantity production and flow line production.

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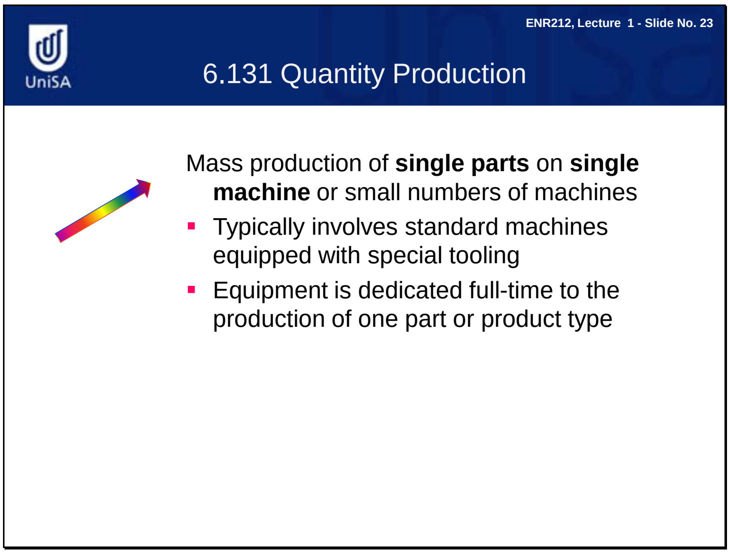

Quantity production refers to Mass production of single parts on single machine or small numbers of machines. The main feature of quantity production is single parts or single products.

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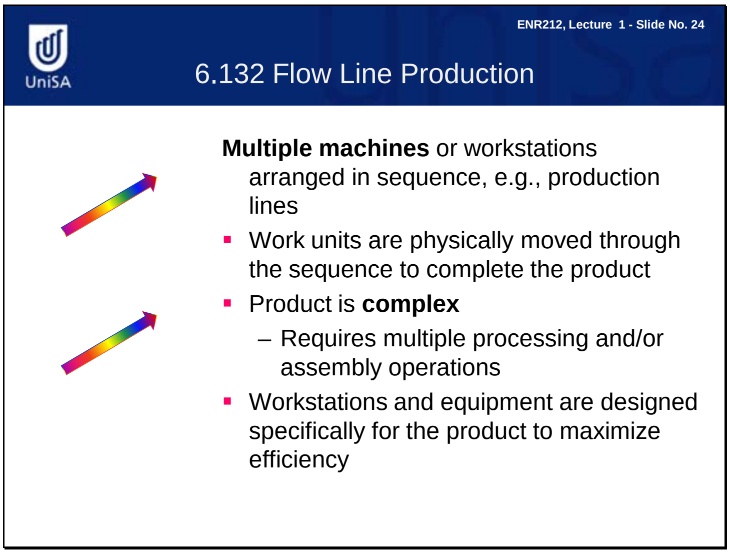

Flow line production contains Multiple machines or workstations arranged in sequence. The products in a flow line production are complex.

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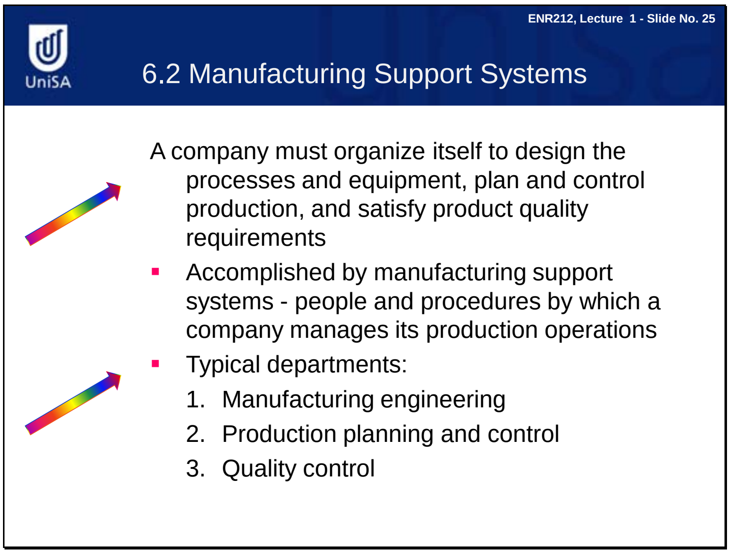

To operate the facilities efficiently, a company must organize itself to design the processes and equipment, plan and control production, and satisfy product quality requirements. Manufacturing support systems contain the following types of departments: manufacturing engineering, production planning, and control and quality control.

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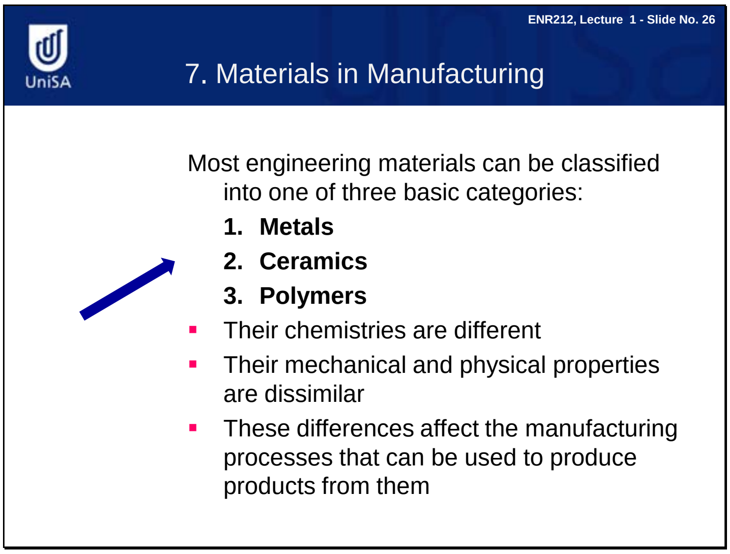

In general, there are three types of materials in manufacturing. They are metals, ceramics and polymers. These materials are structurally different, and thus have completely different physical and mechanical properties. So which of these three - metals, ceramics and polymers - is the toughest? Which one is stiffest? And which one has the highest specific strength?

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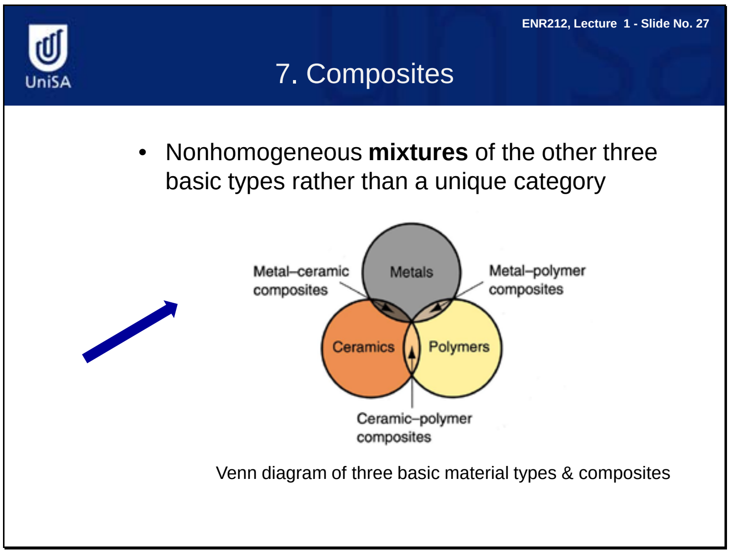

The three types of composites are shown in this figure, where you can see mixtures of different materials. The purpose of making composites is to obtain averaged properties.

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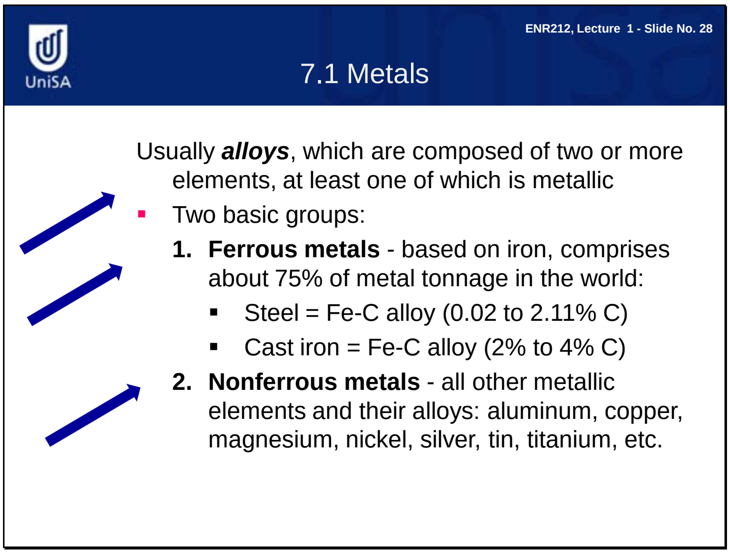

Metals are usually alloys, which are composed of two or more elements, at least one of which is metallic. Metals are classified as ferrous metals and nonferrous metals. Ferrous metals are based on iron. They comprise about 75% of metal tonnage in the world. Nonferrous metals refer to all other metallic elements and their alloys: aluminum, copper, magnesium, nickel, silver, tin, and titanium.

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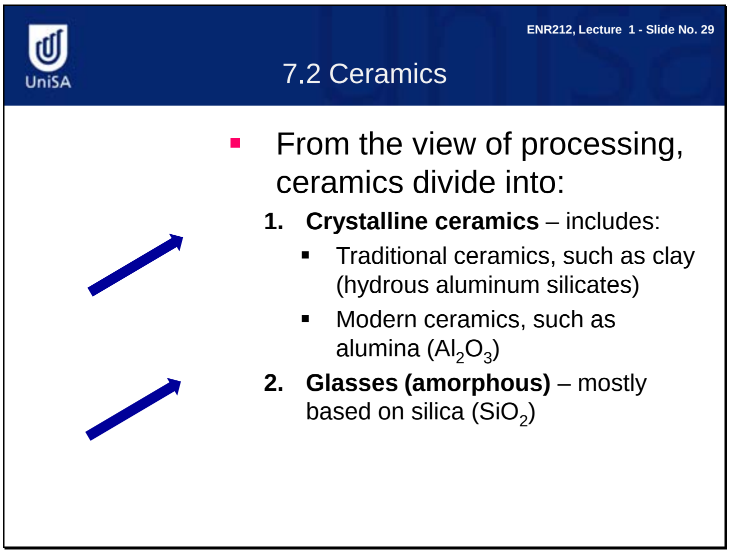

Ceramics are compounds of metallic and nonmetallic elements. Depending on the crystallinity, they are classified into crystalline ceramics and amorphous ceramics. Crystalline ceramics are often stronger and tougher than amorphous ceramics. However, amorphous ceramics are normally transparent. That is the advantage of amorphous ceramics.

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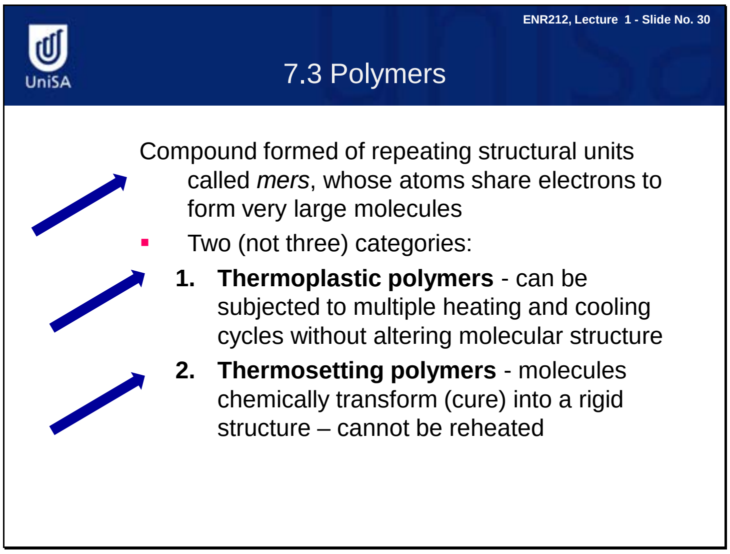

Polymers are entangled long chain molecules. They are divided into thermoplastics and thermosets, depending on their behaviour in increasing temperature. If temperature is increased, thermoplastic can be melted, molded and reused. However, thermosets can not be melted, reused and recycled because of the chemical bonding between chains of thermosets.

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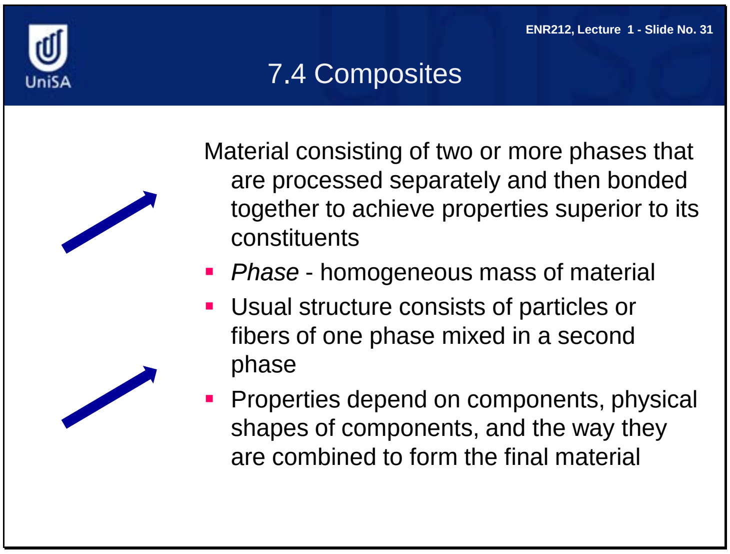

In plain words, a composite is a mixture of different materials. If a composite is a mixture of two materials, we call it a two-phase composite.

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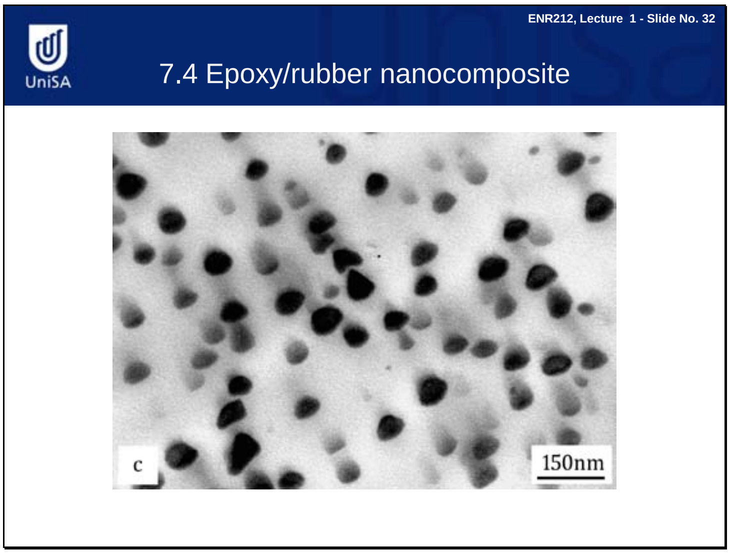

This photograph represents the morphology of epoxy rubber composites. Epoxy takes ninety volume %. Rubber only takes ten volume %. These black particles represent rubber particles. Epoxy is brittle, while rubber is very ductile.   So mixing ductile rubber particles with epoxy certainly toughens epoxy.

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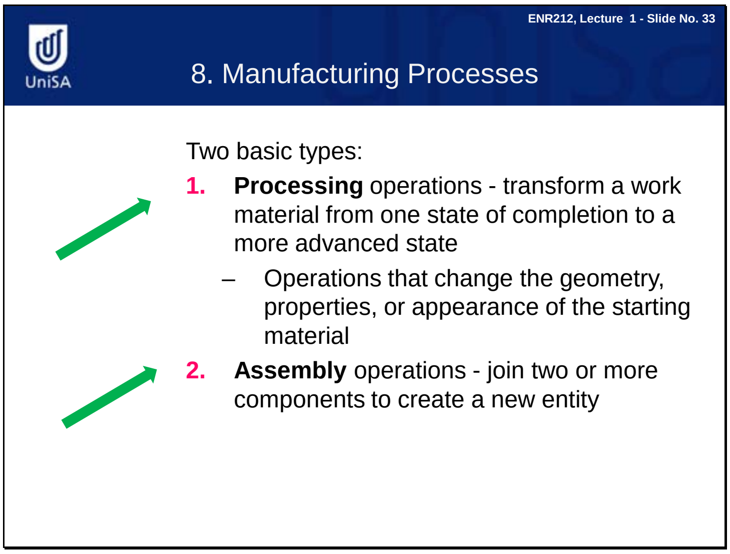

Manufacturing processes include processing operations and assembly operations. Processing operations transform a work material from one state of completion to a more advanced state. The purpose of a processing operation is to enhance properties or improve the appearance of the starting material. Assembly operations join two or more components to create a new entity.

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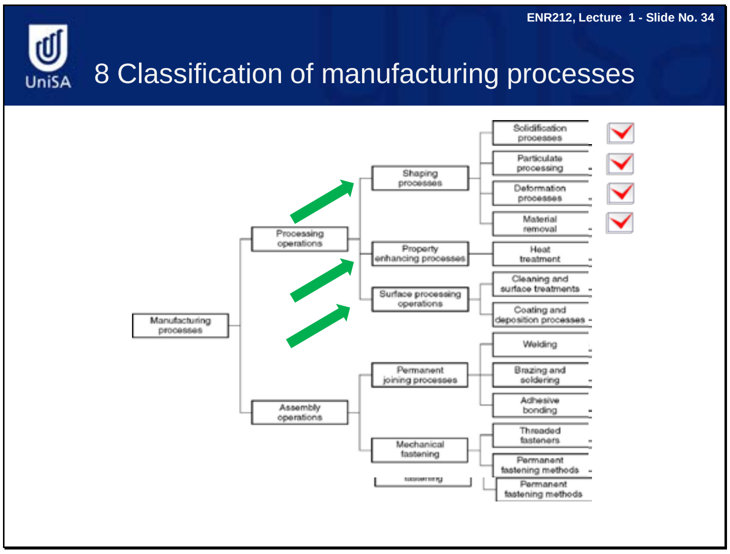

Now we have a look at the classification of manufacturing processes, which is very important for you to learn.

Manufacturing processes contain processing operations and assembly operations. The processing operations contain shaping processes (for producing a shape), property enhancing processes, and surface processing operations. Depending on the state of starting materials, shaping processes are classified into solidification processes, particulate processing, deformation processes and material removal processes.

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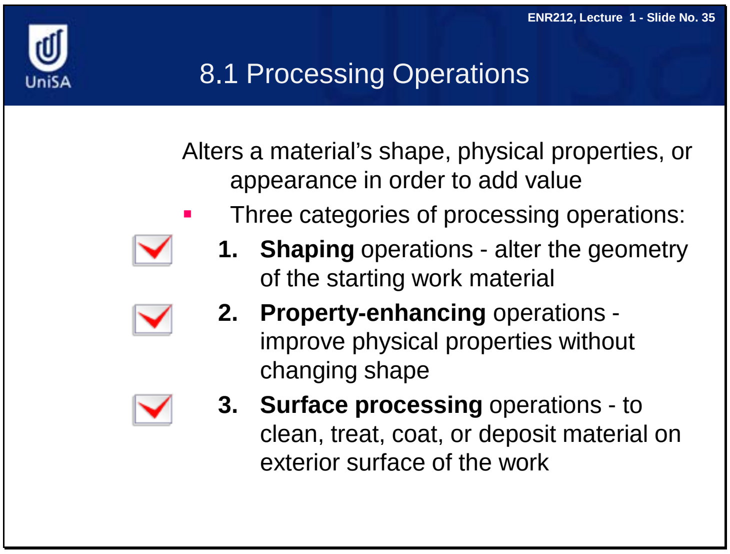

Processing operations consist of three branches: shaping operations, property enhancing operations, and surface processing operations. These are the focus of this unit.

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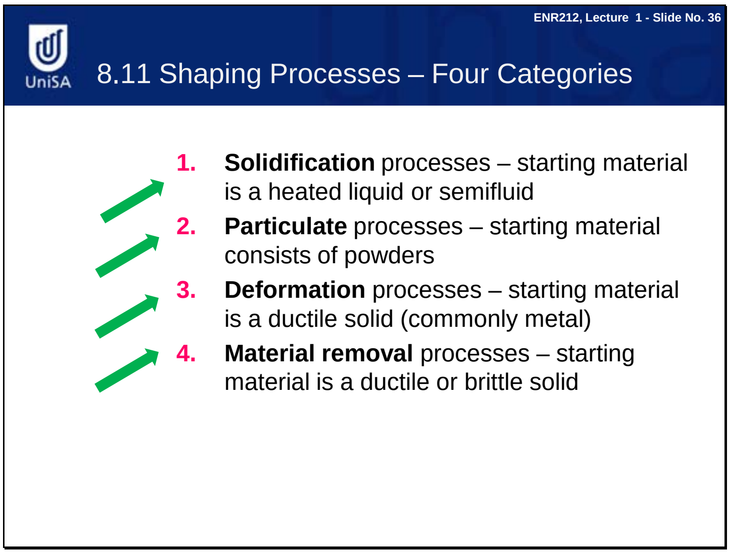

There are four categories of shaping processes. Solidification processes start with a material which is a heated liquid or semifluid. In Particulate processes, the starting material consists of powders. In deformation processes, the starting material is a ductile solid. In this unit, we refer to a ductile metal. In material removal processes, the starting material is a ductile or brittle solid.

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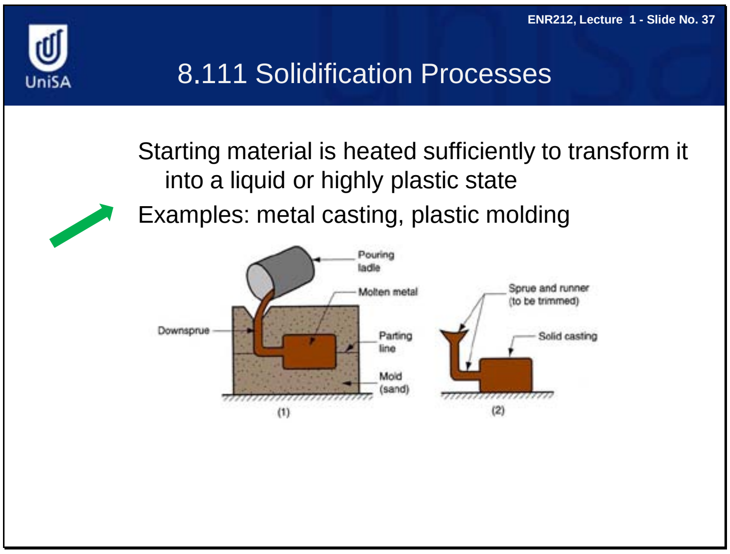

In solidification processes, the starting material is heated sufficiently to transform it into a liquid or highly plastic state

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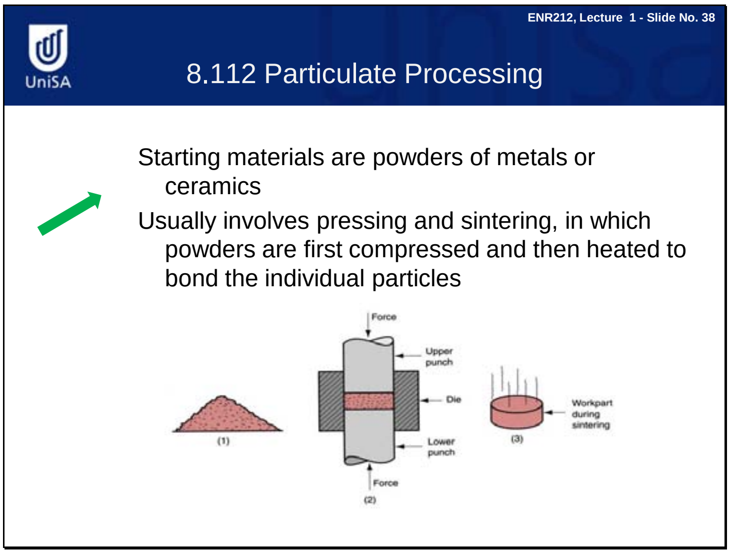

Particulate processing usually involves pressing and sintering, in which powders are first compressed and then heated to bond the individual particles.

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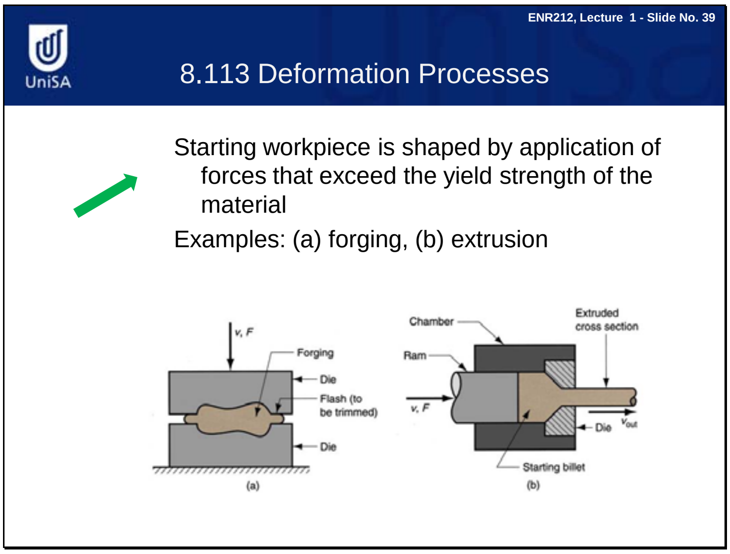

In deformation processes, the starting workpiece is shaped by application of forces that exceed the yield strength of the material.

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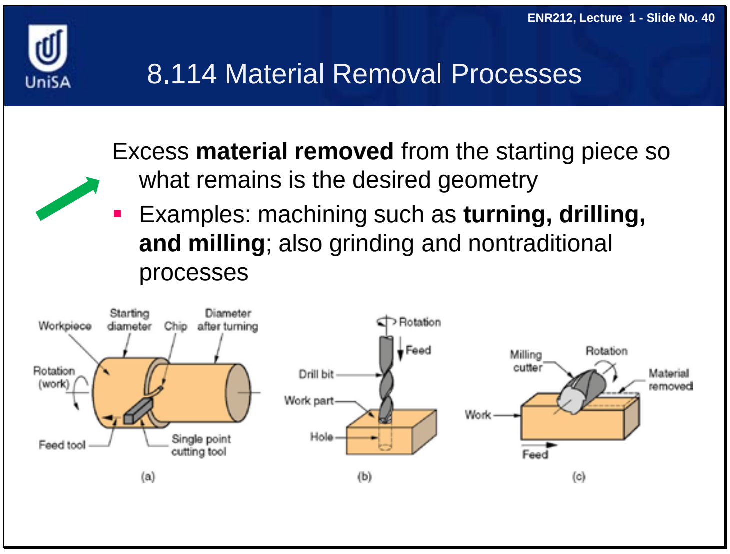

In material removal processes, excess materials are removed from the starting part to obtain a desired geometry.

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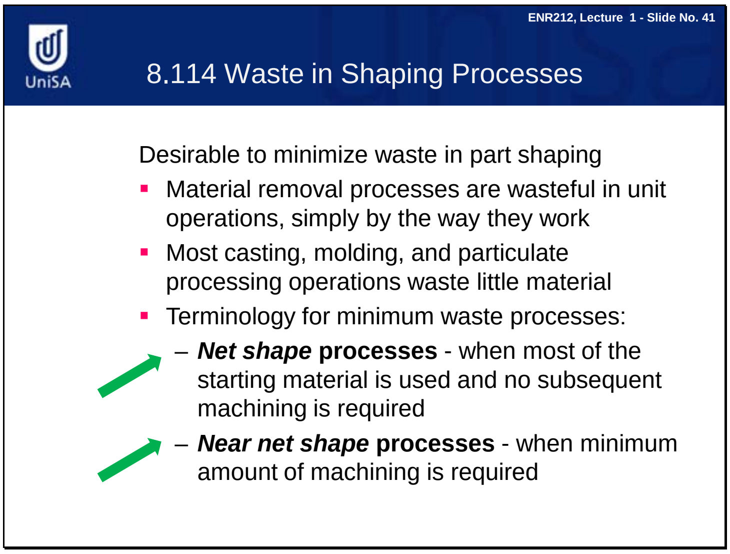

In shaping processes, it is desireable to minimize waste. Depending on the quantity of waste produced, shaping processes are classified into net shape processes and near net shape processes. Net shape processes produce no waste. Near net shape processes produce a little waste.

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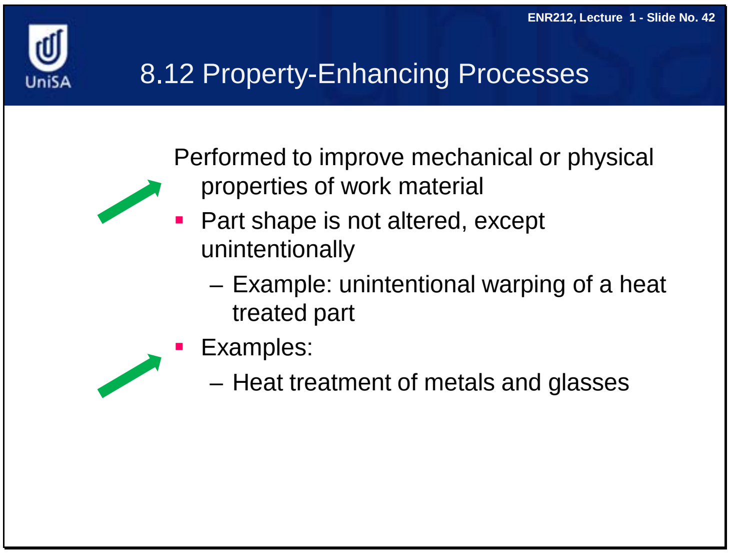

Property enhancing processes are operations to improve the mechanical or physical properties of a material without changing the material geometry, such as the mechanical properties and the stiffness of a metal. A typical example is heat treatment of metals and glasses, such as anealling.

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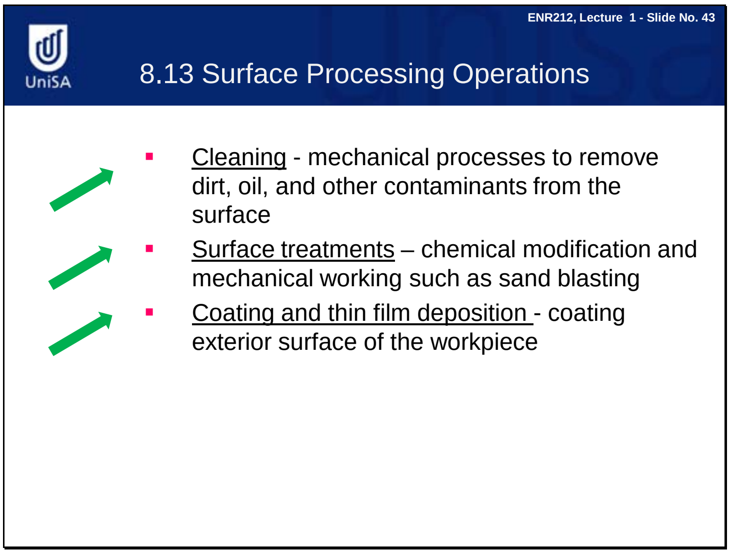

Surface processing operations include cleaning, surface treatment, and coating and thin film deposition.
Cleaning aims to recover the original surface by using mechanical processes to remove dirt, oil and other contaminants from the surface.
Surface treatments include chemical modification, which produces a new surface of a different material, or mechanical working, which creases a new surface of the same materials.
Coating and thin film deposition produce a coating on the exterior surface of the workpiece.

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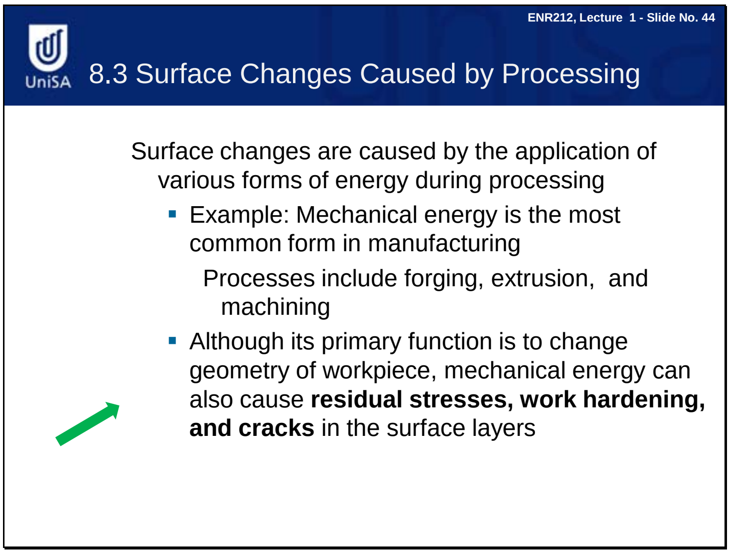

In manufacturing, surface changes are caused by the application of various forms of energy during processing. Mechanical energy is the most common form, such as drilling, forging, extrusion and machining.   However, the mechanical energy can cause residual stresses and cracks in the surface layers, which need to be avoided.

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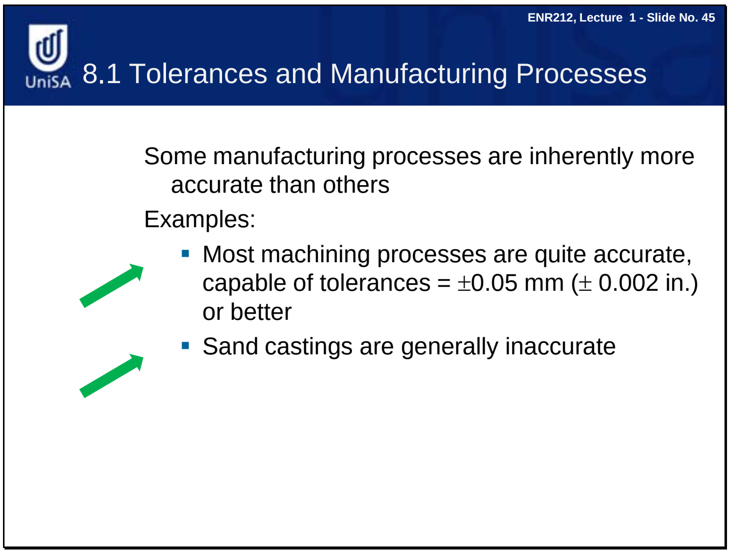

Tolerance is an important element of mechanical design. Most machining processes are accurate, although they may produce waste. Lower tolerances means higher costs. Sand casting is inaccurate, but produces minimum waste. Near net waste processes have a higher tolerance.

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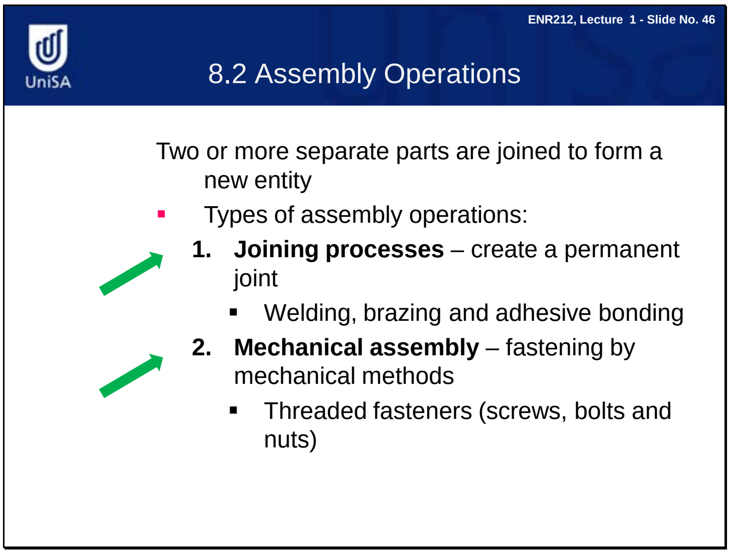

Assembly operations contain joining processes and mechanical assembly. Joining processes create a permanent joint. On the other hand, mechanical assembly is really just fastening by mechanical methods. It is not permanent.

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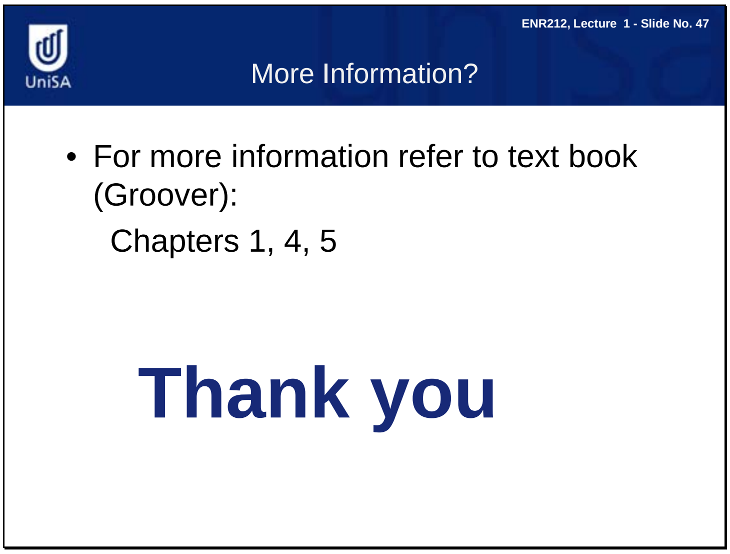

Here you will see some sources of further information. Thanks for your attention.