

ENR212 Lecture 1 Slides and Notes

Slide 1



Manufacturing Processes
Lecture 1

UniSA

INTRODUCTION AND OVERVIEW OF
MANUFACTURING

Dr Jun Ma

- 1. What is Manufacturing
- 2. Materials in Manufacturing
- 3. Manufacturing Processes

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?

ENR212 Lecture 1 Slides and Notes

Slide 2

The slide features a dark blue header with the UniSA logo on the left and the text 'ENR212, Lecture 1 - Slide No. 2' on the right. Below the header, the title '1.1 Manufacturing - Technologically Important' is displayed. The main content area is white and contains two rainbow-colored arrows pointing to the right. The first arrow points to a definition of technology, followed by a bulleted list. The second arrow points to a definition of manufacturing.

ENR212, Lecture 1 - Slide No. 2

UniSA 1.1 Manufacturing - Technologically Important

Technology - **the application of science** to provide society and its members with those things that are needed or desired

- Technology provides the products that help our society and its members live better
- What do these products have in common?
 - They are all manufactured
- Manufacturing is **the application of technology** to produce products of increased value.

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.

ENR212 Lecture 1 Slides and Notes

Slide 3

ENR212, Lecture 1 - Slide No. 3

UniSA

1.2 Manufacturing - Economically Important

Manufacturing is one way by which nations create material wealth

Au: resources

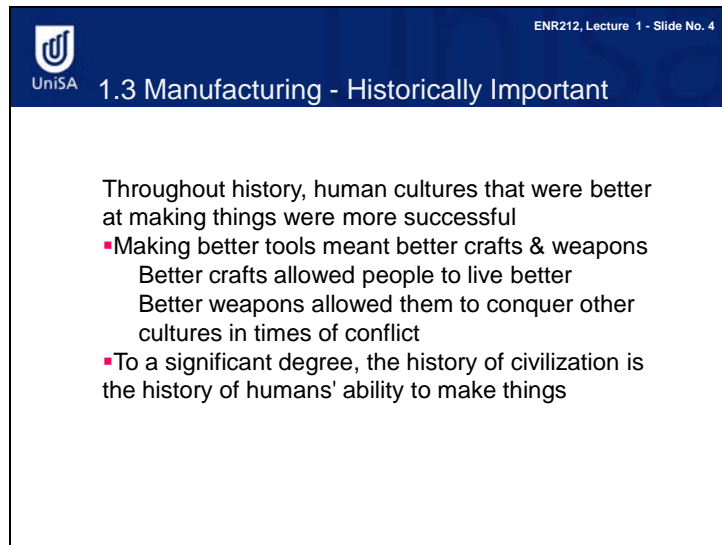
U.S. economy: 1.2 Manufacturing - Economically Important	
Sector	% of GNP
Manufacturing	20%
Agriculture, minerals, etc.	5%
Construction & utilities	5%
Service sector – retail, transportation, banking, communication, education, and government	70%

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 take 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.

ENR212 Lecture 1 Slides and Notes

Slide 4

A presentation slide with a dark blue header and a white main content area. The header contains the UniSA logo and the text 'ENR212, Lecture 1 - Slide No. 4' and '1.3 Manufacturing - Historically Important'. The main content area contains a paragraph and two bullet points.

ENR212, Lecture 1 - Slide No. 4

UniSA 1.3 Manufacturing - Historically Important

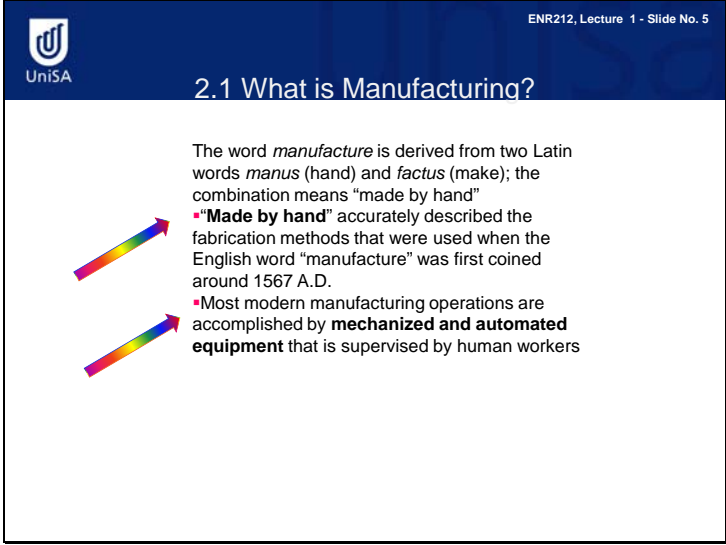
Throughout history, human cultures that were better at making things were more successful

- Making better tools meant better crafts & weapons
 - Better crafts allowed people to live better
 - Better weapons allowed them to conquer other cultures in times of conflict
- To a significant degree, the history of civilization is the history of humans' ability to make things

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.

ENR212 Lecture 1 Slides and Notes

Slide 5



ENR212, Lecture 1 - Slide No. 5

UniSA

2.1 What is Manufacturing?

The word *manufacture* is derived from two Latin words *manus* (hand) and *factus* (make); the combination means "made by hand"

- **"Made by hand"** accurately described the fabrication methods that were used when the English word "manufacture" was first coined around 1567 A.D.
- Most modern manufacturing operations are accomplished by **mechanized and automated equipment** that is supervised by human workers

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.

ENR212 Lecture 1 Slides and Notes

Slide 6

ENR212, Lecture 1 - Slide No. 6

UniSA

2.2 Manufacturing

Transformation of materials into items of greater value by means of one or more processing and/or assembly operations

- Manufacturing *adds value* to the material by changing its shape or properties, or by combining it with other materials

```
graph LR; A["Starting material ($)"] --> B["Material in processing ($$)"]; B --> C["Processed part ($$$)"]; subgraph Process; B -- "Manufacturing process (Value added $$)" --> C; end;
```

(b)

Manufacturing means transforming materials into products of increased value.



ENR212, Lecture 1 - Slide No. 7

UniSA

3.1 Manufacturing Industries

Industry consists of **enterprises and organizations** that produce or supply goods and services

- Industries can be classified as:
 - 1. Primary industries** - those that cultivate and exploit natural resources, e.g., farming, mining
 - 2. Secondary industries** - take the outputs of primary industries and convert them into consumer and capital goods
 - 3. Tertiary industries** - service sector

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.

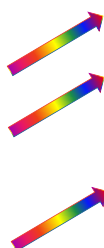
Tertiary industries are service sectors

ENR212 Lecture 1 Slides and Notes

Slide 8

ENR212, Lecture 1 - Slide No. 8

3.2 Manufacturing Industries - continued



- Secondary industries include: **manufacturing, construction, and electric power generation**
- Manufacturing includes several industries whose products are not covered in this book; e.g., apparel, beverages, chemicals, and food processing
- For our purposes, manufacturing means **production and processing of hardware**
 - Nuts and bolts, forgings, cars, airplanes, digital computers, plastic parts, and ceramic products

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


ENR212 Lecture 1 Slides and Notes

Slide 9

ENR212, Lecture 1 - Slide No. 9

UniSA

4.1 Production Quantity Q

 The **quantity** of products Q made by a factory has an important influence on the way its people, facilities, and procedures are organized

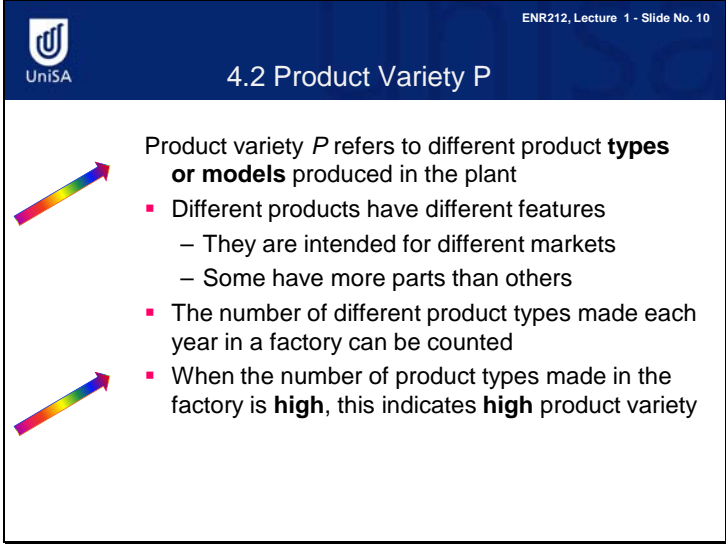
- Annual production quantities can be classified into three ranges:

<u>Production range</u>	<u>Annual Quantity Q</u>
Low production	1 to 100 units
Medium production	100 to 10,000 units
High production	10,000 to millions of

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.

ENR212 Lecture 1 Slides and Notes

Slide 10



The slide features a dark blue header with the UniSA logo on the left and the text 'ENR212, Lecture 1 - Slide No. 10' on the right. Below the header, the title '4.2 Product Variety P' is centered. The main content area is white and contains a definition of product variety P and a bulleted list of characteristics. Two rainbow-colored arrows point towards the text.

ENR212, Lecture 1 - Slide No. 10

UniSA

4.2 Product Variety P

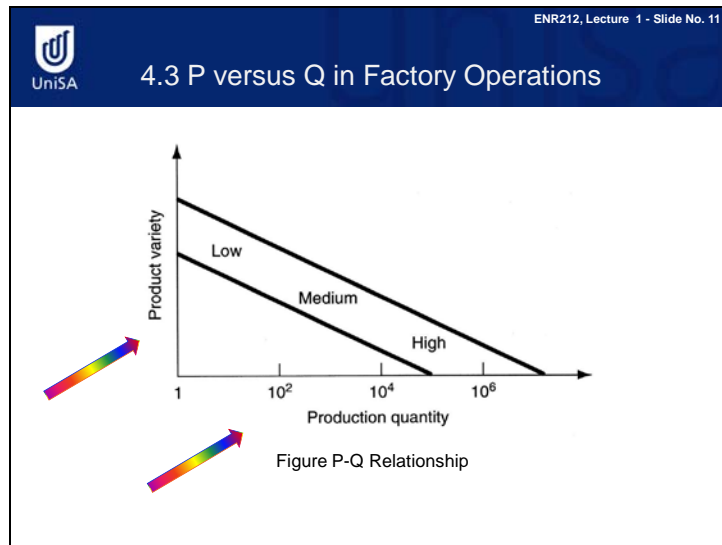
Product variety P refers to different product **types** or **models** produced in the plant

- Different products have different features
 - They are intended for different markets
 - Some have more parts than others
- The number of different product types made each year in a factory can be counted
- When the number of product types made in the factory is **high**, this indicates **high** product variety

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..

ENR212 Lecture 1 Slides and Notes

Slide 11



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.

ENR212 Lecture 1 Slides and Notes

Slide 12

ENR212, Lecture 1 - Slide No. 12

UniSA

4.4 More About Product Variety

- **Soft product variety** - small differences between products, e.g., between car models made on the same production line, with many common parts among models
- **Hard product variety** - products differ substantially, e.g., between a small car and a large truck, with few common parts (if any)



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.


ENR212, Lecture 1 - Slide No. 13

UniSA

5 Manufacturing Capability

A manufacturing plant consists of **materials, processes and systems** (and people, of course) designed to transform a certain limited range of *materials* into products of increased value


- The three building blocks - materials, processes, and systems - are the subject of modern manufacturing
- Manufacturing capability includes:
 1. **Technological processing capability**
 2. **Physical product limitations**
 3. **Production capacity**




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

ENR212 Lecture 1 Slides and Notes

Slide 14

ENR212, Lecture 1 - Slide No. 14


5.1 Technological Processing Capability



The available **set of manufacturing processes** in the plant (or company)

- Certain manufacturing processes are suited to certain materials
 - By specializing in certain processes, the plant is also specializing in certain materials
- Includes not only the physical processes, but also the expertise of the plant personnel
- Examples:
 - A machine shop cannot roll steel
 - A steel mill cannot build cars

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


ENR212, Lecture 1 - Slide No. 15

5.2 Physical Product Limitations


Given a plant with a certain set of processes, there are **size and weight** limitations on the parts or products that can be made in the plant

- Product size and weight affect:
 - **Production equipment**
 - **Material handling equipment**
- Production, material handling equipment, and plant size must be planned for products that lie within a certain size and weight range

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.

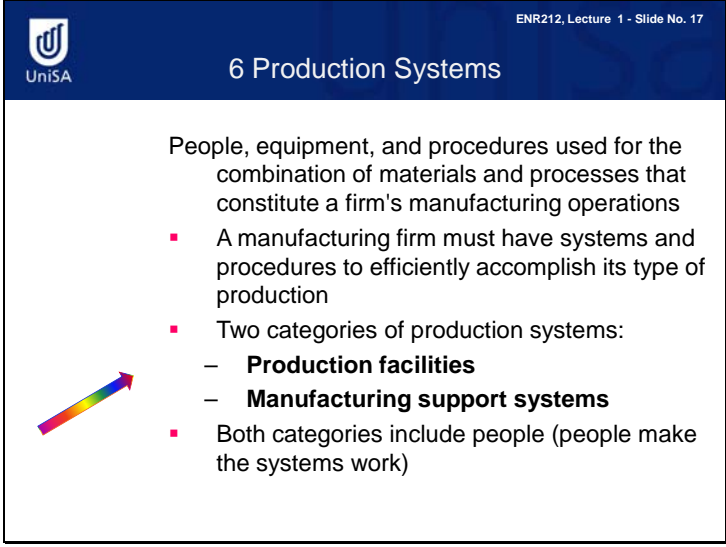
ENR212, Lecture 1 - Slide No. 16

5.3 Production Capacity

 Defined as the **maximum quantity** that a plant can produce in a given time period (e.g., month or year) under assumed operating conditions

- Operating conditions refer to number of shifts per week, hours per shift, direct labor manning levels in the plant, and so on
- Usually measured in terms of output units, such as tons of steel or number of cars produced by the plant
- Also called ***plant capacity***

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.



The slide features a dark blue header with the UniSA logo on the left and the text 'ENR212, Lecture 1 - Slide No. 17' on the right. The main title '6 Production Systems' is centered in the header. The body of the slide is white and contains a definition of production systems, a list of characteristics, and two categories of production systems. A rainbow-colored arrow points from the left towards the list items.

ENR212, Lecture 1 - Slide No. 17


UniSA

6 Production Systems

People, equipment, and procedures used for the combination of materials and processes that constitute a firm's manufacturing operations

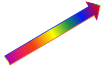
- A manufacturing firm must have systems and procedures to efficiently accomplish its type of production
- Two categories of production systems:
 - **Production facilities**
 - **Manufacturing support systems**
- Both categories include people (people make the systems work)

Production systems contain production facilities and manufacturing support systems.



ENR212, Lecture 1 - Slide No. 18

6.1 Production Facilities



The factory, production equipment, and material handling systems

- Production facilities "touch" the product
- Includes the way the equipment is arranged in the factory - the *plant layout*
- Equipment usually organized into logical groupings, called *manufacturing systems*
 - Examples:
 - Automated production line
 - Machine cell consisting of an industrial robot and two machine tools

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

ENR212 Lecture 1 Slides and Notes

Slide 19


ENR212, Lecture 1 - Slide No. 19

UniSA


6.1 Facilities versus Product Quantities

A company designs its manufacturing systems and organizes its factories to serve the particular mission of each plant

- Certain types of production facilities are recognized as the most appropriate for a given type of manufacturing:
 1. Low production – 1 to 100
 2. Medium production – 100 to 10,000
 3. High production – 10,000 to >1,000,000
- Different facilities are required for each of the three quantity ranges




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



ENR212, Lecture 1 - Slide No. 20

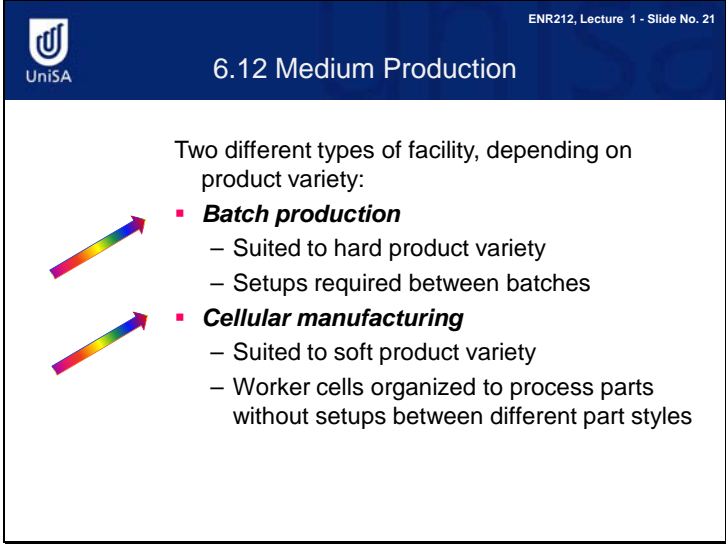
6.11 Low Production



Job shop is the term used for this type of production facility

- A job shop makes low quantities of specialized and customized products
 - Products are typically complex, e.g., space capsules, prototype aircraft, special machinery
- Labor force is highly skilled
- Equipment in a job shop is general purpose
- Designed for maximum flexibility

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.



ENR212, Lecture 1 - Slide No. 21

UniSA

6.12 Medium Production

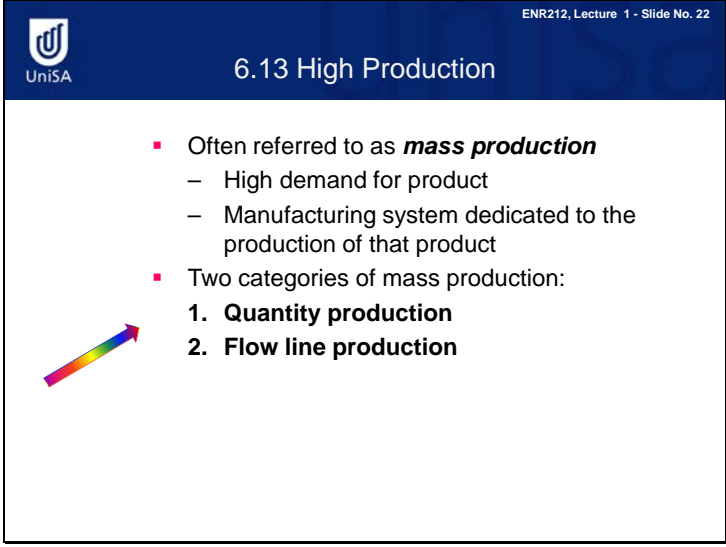
Two different types of facility, depending on product variety:

- **Batch production**
 - Suited to hard product variety
 - Setups required between batches
- **Cellular manufacturing**
 - Suited to soft product variety
 - Worker cells organized to process parts without setups between different part styles

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.

ENR212 Lecture 1 Slides and Notes

Slide 22




ENR212, Lecture 1 - Slide No. 22

UniSA

6.13 High Production


- Often referred to as ***mass production***
 - High demand for product
 - Manufacturing system dedicated to the production of that product
- Two categories of mass production:
 1. **Quantity production**
 2. **Flow line production**



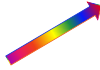
High production is also known as mass production. High production includes quantity production and flow line production.

ENR212 Lecture 1 Slides and Notes

Slide 23

ENR212, Lecture 1 - Slide No. 23


6.131 Quantity Production




Mass production of **single parts** on **single machine** or small numbers of machines

- Typically involves standard machines equipped with special tooling
- Equipment is dedicated full-time to the production of one part or product type

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.

ENR212, Lecture 1 - Slide No. 24

6.132 Flow Line Production



Multiple machines or workstations arranged in sequence, e.g., production lines

- Work units are physically moved through the sequence to complete the product
- Product is **complex**
 - Requires multiple processing and/or assembly operations
- Workstations and equipment are designed specifically for the product to maximize efficiency

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

ENR212, Lecture 1 - Slide No. 25

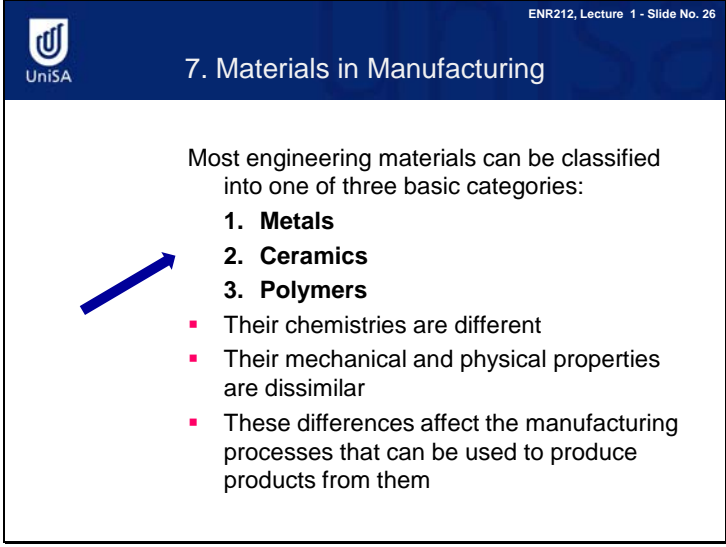
UniSA

6.2 Manufacturing Support Systems

A company must organize itself to design the processes and equipment, plan and control production, and satisfy product quality requirements

- Accomplished by manufacturing support systems - people and procedures by which a company manages its production operations
- Typical departments:
 1. Manufacturing engineering
 2. Production planning and control
 3. Quality control

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.



ENR212, Lecture 1 - Slide No. 26

UniSA

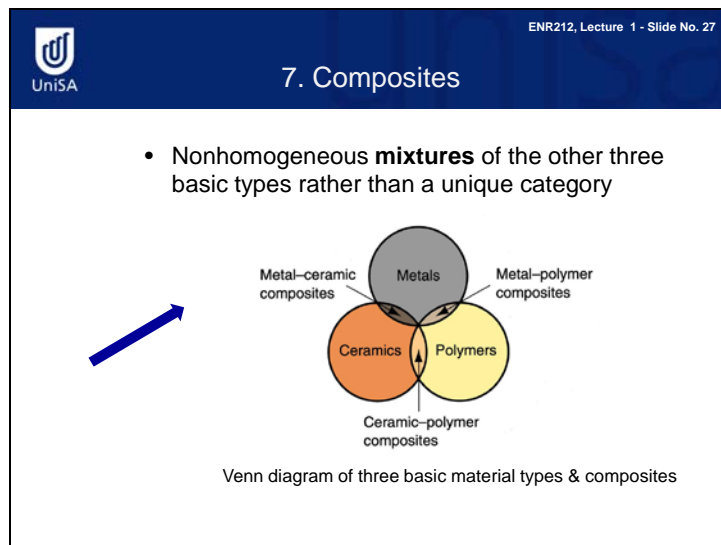
7. Materials in Manufacturing

Most engineering materials can be classified into one of three basic categories:

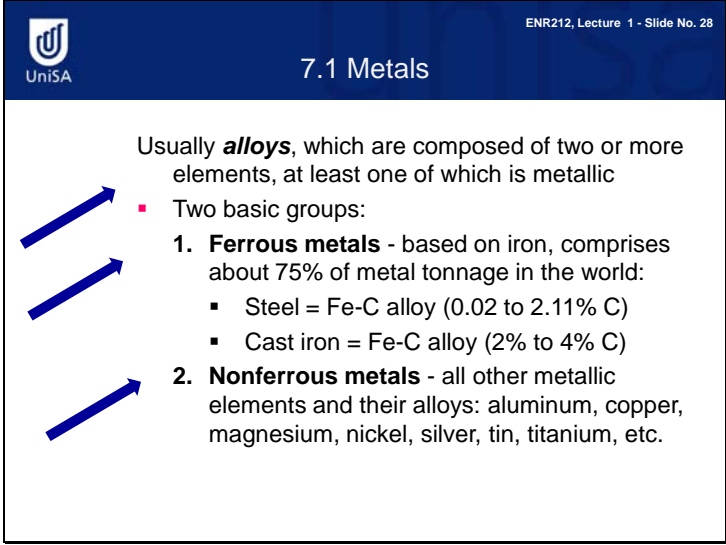
- 1. Metals**
- 2. Ceramics**
- 3. Polymers**

- Their chemistries are different
- Their mechanical and physical properties are dissimilar
- These differences affect the manufacturing processes that can be used to produce products from them

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?



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.



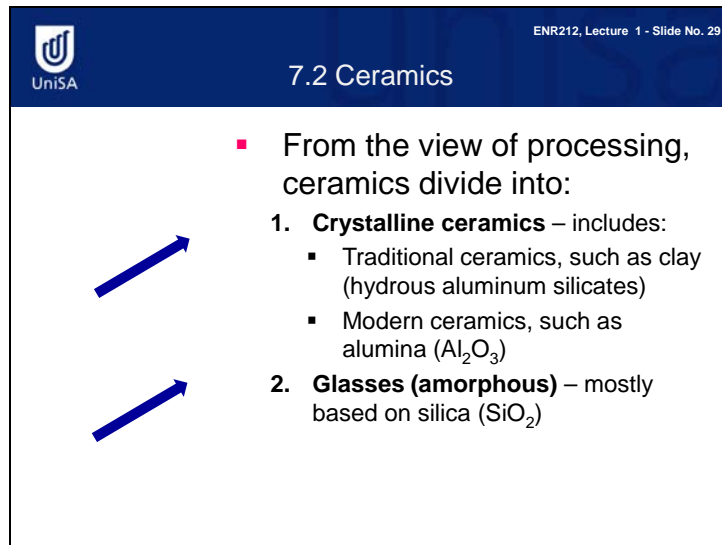
ENR212, Lecture 1 - Slide No. 28

7.1 Metals

Usually **alloys**, which are composed of two or more elements, at least one of which is metallic

- Two basic groups:
 - Ferrous metals** - based on iron, comprises about 75% of metal tonnage in the world:
 - Steel = Fe-C alloy (0.02 to 2.11% C)
 - Cast iron = Fe-C alloy (2% to 4% C)
 - Nonferrous metals** - all other metallic elements and their alloys: aluminum, copper, magnesium, nickel, silver, tin, titanium, etc.

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.



ENR212, Lecture 1 - Slide No. 29

UniSA

7.2 Ceramics

- From the view of processing, ceramics divide into:
 - Crystalline ceramics** – includes:
 - Traditional ceramics, such as clay (hydrated aluminum silicates)
 - Modern ceramics, such as alumina (Al_2O_3)
 - Glasses (amorphous)** – mostly based on silica (SiO_2)

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.

ENR212, Lecture 1 - Slide No. 30

UniSA

7.3 Polymers

Compound formed of repeating structural units called *mers*, whose atoms share electrons to form very large molecules

- Two (not three) categories:
 - 1. Thermoplastic polymers** - can be subjected to multiple heating and cooling cycles without altering molecular structure
 - 2. Thermosetting polymers** - molecules chemically transform (cure) into a rigid structure – cannot be reheated

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.

ENR212, Lecture 1 - Slide No. 31

7.4 Composites

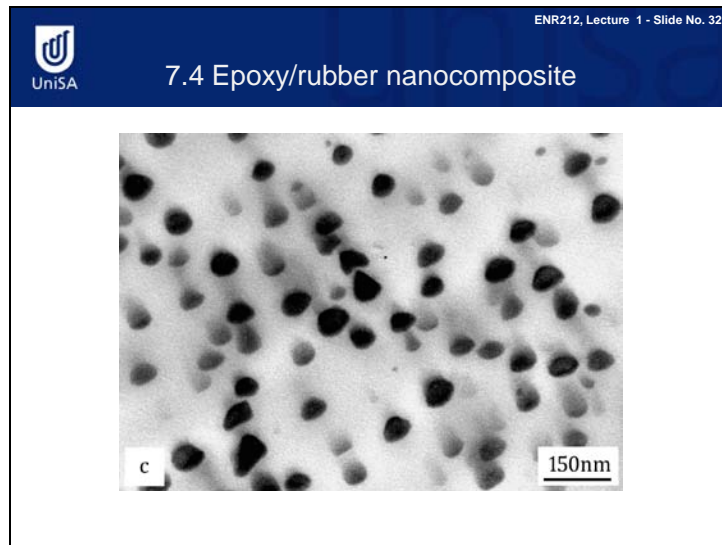
Material consisting of two or more phases that are processed separately and then bonded together to achieve properties superior to its constituents

- *Phase* - homogeneous mass of material
- Usual structure consists of particles or fibers of one phase mixed in a second phase
- Properties depend on components, physical shapes of components, and the way they are combined to form the final material

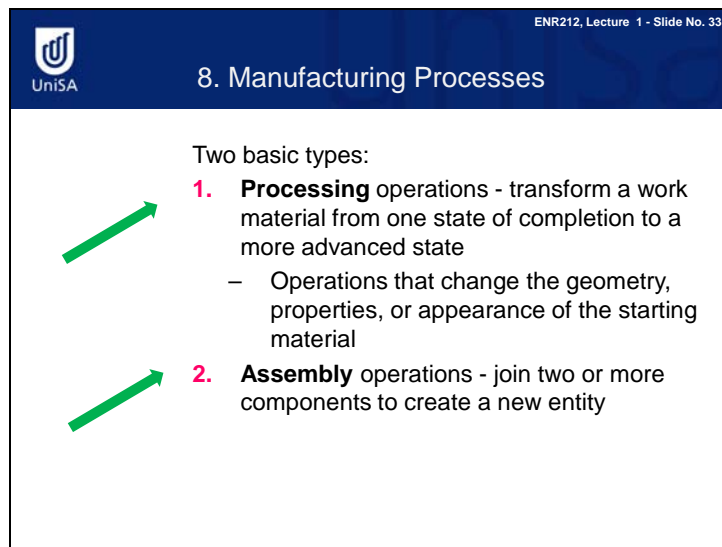
In plain words, a composite is a mixture of different materials. If a composite is a mixture of two materials, we call it a two-phase composite.

ENR212 Lecture 1 Slides and Notes

Slide 32



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.



ENR212, Lecture 1 - Slide No. 33

UniSA

8. Manufacturing Processes

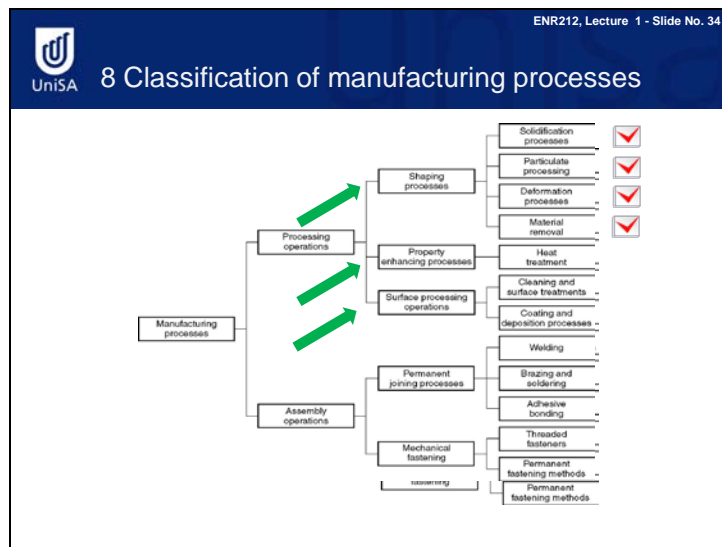
Two basic types:

- 1. Processing** operations - transform a work material from one state of completion to a more advanced state
 - Operations that change the geometry, properties, or appearance of the starting material
- 2. Assembly** operations - join two or more components to create a new entity

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.

ENR212 Lecture 1 Slides and Notes

Slide 34



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.

ENR212, Lecture 1 - Slide No. 35

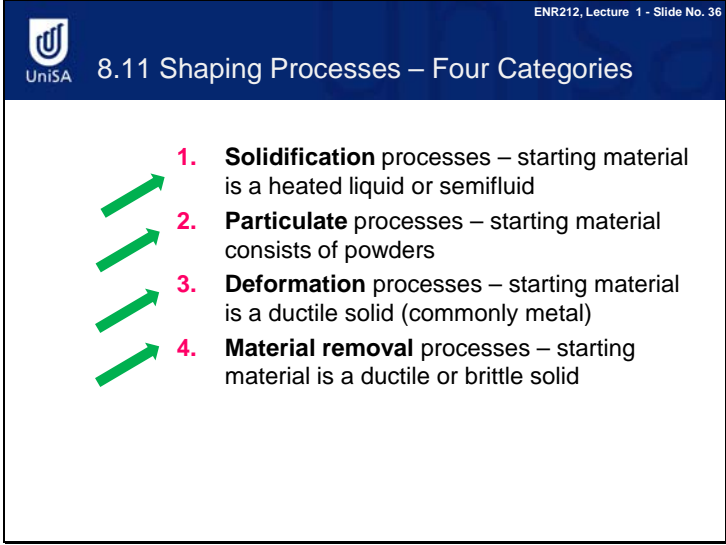
UniSA

8.1 Processing Operations

Alters a material's shape, physical properties, or appearance in order to add value

- Three categories of processing operations:
 -  **1. Shaping** operations - alter the geometry of the starting work material
 -  **2. Property-enhancing** operations - improve physical properties without changing shape
 -  **3. Surface processing** operations - to clean, treat, coat, or deposit material on exterior surface of the work

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



ENR212, Lecture 1 - Slide No. 36

UniSA 8.11 Shaping Processes – Four Categories

1. **Solidification** processes – starting material is a heated liquid or semifluid
2. **Particulate** processes – starting material consists of powders
3. **Deformation** processes – starting material is a ductile solid (commonly metal)
4. **Material removal** processes – starting material is a ductile or brittle solid

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.

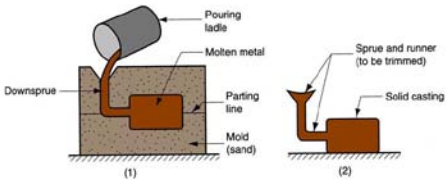
ENR212, Lecture 1 - Slide No. 37

UniSA

8.111 Solidification Processes

Starting material is heated sufficiently to transform it into a liquid or highly plastic state

Examples: metal casting, plastic molding



(1) (2)

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

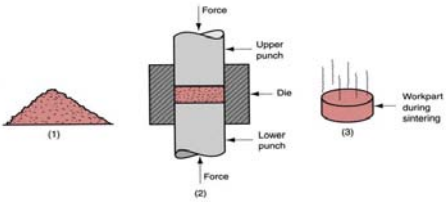
ENR212, Lecture 1 - Slide No. 38

UniSA

8.112 Particulate Processing

Starting materials are powders of metals or ceramics

Usually involves pressing and sintering, in which powders are first compressed and then heated to bond the individual particles



The diagram illustrates the three stages of particulate processing:

- (1) Powder: A pile of red particulate material.
- (2) Pressing: A cross-sectional view of a die containing the powder. An upper punch is positioned above the powder and a lower punch is positioned below it. Arrows labeled 'Force' indicate pressure being applied from both punches to compress the powder into a solid disk.
- (3) Sintering: A cross-sectional view of the resulting solid disk. Vertical lines above the disk represent heat being applied, and the label 'Workpart during sintering' indicates the final stage of the process.

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

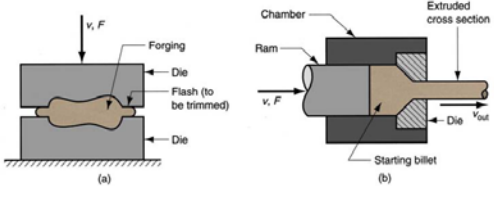
ENR212, Lecture 1 - Slide No. 39

UniSA

8.113 Deformation Processes

Starting workpiece is shaped by application of forces that exceed the yield strength of the material

Examples: (a) forging, (b) extrusion



The image contains two diagrams illustrating deformation processes. Diagram (a) shows the forging process: a starting workpiece is placed between two dies. A downward force F is applied, causing the workpiece to be compressed and shaped. Labels include 'Forging', 'Die', 'Flash (to be trimmed)', and 'Die'. Diagram (b) shows the extrusion process: a starting billet is pushed through a die by a ram. The force F is applied to the ram, and the extruded cross section is pushed out of the die. Labels include 'Chamber', 'Ram', 'Starting billet', 'Die', and 'Extruded cross section'.

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

ENR212, Lecture 1 - Slide No. 40

UniSA

8.114 Material Removal Processes

Excess **material removed** from the starting piece so what remains is the desired geometry

- Examples: machining such as **turning, drilling, and milling**; also grinding and nontraditional processes

(a) Turning: A cylindrical workpiece rotates (Rotation (work)) while a single point cutting tool (Feed tool) moves along its length. Labels include: Workpiece, Starting diameter, Chip, Diameter after turning, Rotation (work), and Feed tool.

(b) Drilling: A drill bit rotates (Rotation) and moves forward (Feed) into a work part to create a hole. Labels include: Drill bit, Work part, and Hole.

(c) Milling: A milling cutter rotates (Rotation) and moves across a work piece (Work) to remove material. Labels include: Milling cutter, Rotation, Material removed, and Feed.

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

ENR212, Lecture 1 - Slide No. 41

UniSA

8.114 Waste in Shaping Processes

Desirable to minimize waste in part shaping

- Material removal processes are wasteful in unit operations, simply by the way they work
- Most casting, molding, and particulate processing operations waste little material
- Terminology for minimum waste processes:
 - **Net shape processes** - when most of the starting material is used and no subsequent machining is required
 - **Near net shape processes** - when minimum amount of machining is required

In shaping processes, it is desirable 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.

ENR212, Lecture 1 - Slide No. 42

UniSA

8.12 Property-Enhancing Processes

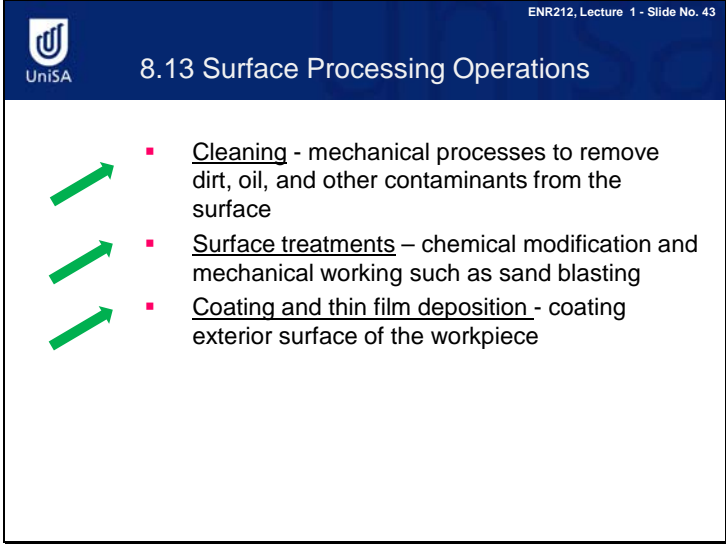
Performed to improve mechanical or physical properties of work material

- Part shape is not altered, except unintentionally
 - Example: unintentional warping of a heat treated part
- Examples:
 - Heat treatment of metals and glasses

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 annealing.

ENR212 Lecture 1 Slides and Notes

Slide 43



ENR212, Lecture 1 - Slide No. 43

UniSA

8.13 Surface Processing Operations

- Cleaning - mechanical processes to remove dirt, oil, and other contaminants from the surface
- Surface treatments – chemical modification and mechanical working such as sand blasting
- Coating and thin film deposition - coating exterior surface of the workpiece

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 creates a new surface of the same materials.

Coating and thin film deposition produce a coating on the exterior surface of the workpiece.

ENR212 Lecture 1 Slides and Notes


Slide 44

ENR212, Lecture 1 - Slide No. 44

UniSA 8.3 Surface Changes Caused by Processing

Surface changes are caused by the application of various forms of energy during processing

- Example: Mechanical energy is the most common form in manufacturing
 - Processes include forging, extrusion, and machining
- Although its primary function is to change geometry of workpiece, mechanical energy can also cause **residual stresses, work hardening, and cracks** in the surface layers



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.

ENR212 Lecture 1 Slides and Notes

Slide 45

ENR212, Lecture 1 - Slide No. 45

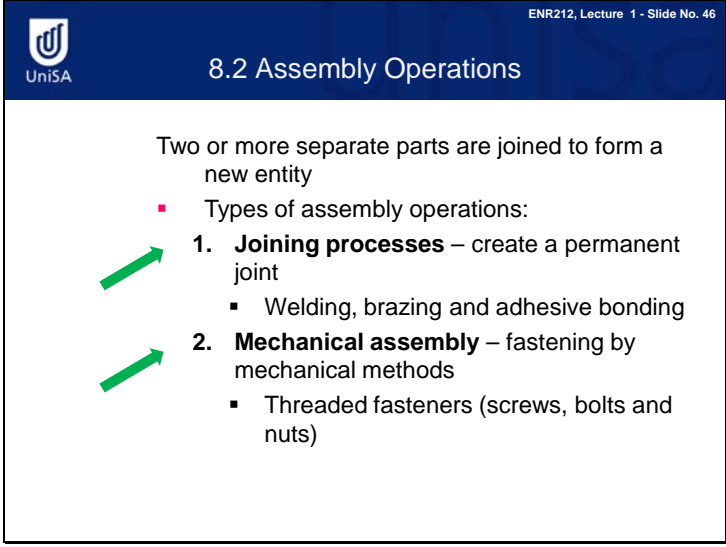
UniSA 8.1 Tolerances and Manufacturing Processes

Some manufacturing processes are inherently more accurate than others

Examples:

- Most machining processes are quite accurate, capable of tolerances = ± 0.05 mm (± 0.002 in.) or better
- Sand castings are generally inaccurate

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.





ENR212, Lecture 1 - Slide No. 46

UniSA

8.2 Assembly Operations

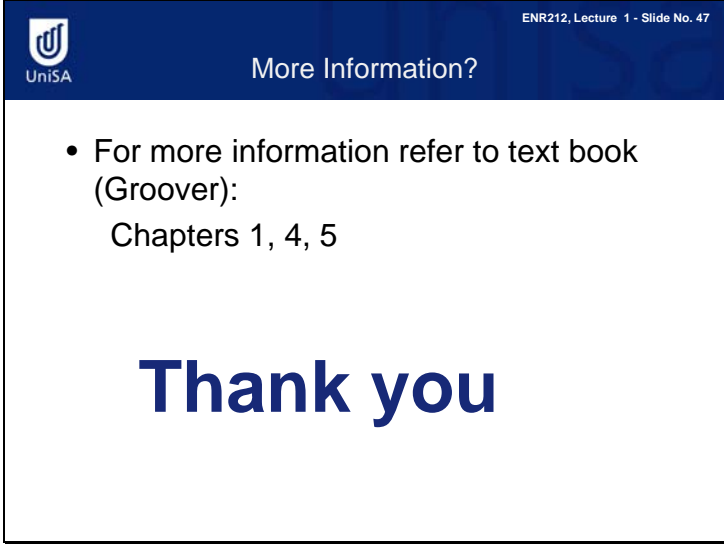
Two or more separate parts are joined to form a new entity

- Types of assembly operations:
 -  **1. Joining processes** – create a permanent joint
 - Welding, brazing and adhesive bonding
 -  **2. Mechanical assembly** – fastening by mechanical methods
 - Threaded fasteners (screws, bolts and nuts)

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.

ENR212 Lecture 1 Slides and Notes

Slide 47

The slide features a dark blue header with the UniSA logo on the left and the text 'ENR212, Lecture 1 - Slide No. 47' on the right. Below the header, the title 'More Information?' is centered. A bulleted list follows, and the slide concludes with the text 'Thank you' in a large, bold font.

ENR212, Lecture 1 - Slide No. 47

UniSA

More Information?

- For more information refer to text book (Groover):
Chapters 1, 4, 5

Thank you

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