

# Engineering and Manufacturing

## 3.3.1 Materials – Cost, Form, Size, Shape, Density and Availability



### Materials – Cost, Form, Size, Shape, Density and Availability

#### Learning outcomes

Students should be able to:

- apply knowledge and understanding of the following aspects of materials:
  - cost;
  - form;
  - size;
  - shape;
  - density; and
  - availability.

#### Material costs

In today's world of fluctuating raw material costs and limited raw material supplies, manufacturers need to be proactive to avoid being a victim of these fluctuations. Raw material price increases and supply shortages could have a negative effect on profitability and financial results. The supply of raw materials to the manufacturer and to their component suppliers could be interrupted for a variety of reasons, including pricing, availability and Brexit.

Raw material prices have fluctuated significantly in the past. The price of these raw materials is directly linked to their supply and availability. The supply can be affected by environmental conditions which can have a negative impact on the growth and harvesting of materials. For example, climate changes and adverse weather conditions can reduce the supply of timber, reducing the supply of raw timber which in turn forces the price of the raw materials up.

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Suppliers can control the supply of raw materials. It has been the practice of some oil producing states to limit the supply of their crude oil in order to increase the price on the market to boost their profits. This increase in market price causes an increased price to the buyers, pushing up their production costs and this in turn is passed on to their customers.

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To avoid the effects of price fluctuation, manufacturing companies will, whenever it is possible purchase the raw materials through negotiated long-term contracts. This is primarily to minimise the impact of market price fluctuations. Within a company's purchasing or procurement division, it is the responsibility of the buyers to seek and identify new sources of supply.

## Form

The processing of raw materials involves a series of operations that transform industrial materials from a raw material into finished parts or products.

Forming and shaping processes may be classified into two broad types, those performed on the material in a liquid state and those performed on the material in a solid or plastic condition.

Casting is the processing of materials in liquid form which involves metals, glass, and ceramics.

Materials in their solid state are formed into desired shapes by the application of a force or pressure.

### Bar Stocks

This is a common form of metal, used by industry to manufacture metal parts and products. Metal suppliers typically stock bar items in rod, hex, square and flat shapes.

### Sheet and Plate Stock

Sheet metal is simply metal formed into thin and flat pieces. Thicknesses can vary significantly with pieces thicker than 6 mm being referred to as plate.

### Tubes and Pipes

Steel pipes are long, hollow tubes that are used for a variety of purposes. They are produced by one of two methods which result in either a welded or seamless pipe. The raw steel is first cast into a more workable starting form and then made into a pipe by stretching the steel out into a seamless tube or by welding the edges together to form a seal.

### Extrusions

Extrusion is a process of shaping molten materials by force under pressure then cut to produce a desired length. Having parts extruded can produce significant savings.

## Sand Casting

This process uses sand moulds to form complex metal parts that can be made of nearly any alloy. Metal is melted in a furnace and then poured into the cavity of the sand mould, which is formed by the pattern. The sand is separated from the solidified casting through vibration and the casting can then be removed.

## Size and shape

Generally raw materials in the state they are sourced are not ready for the manufacture of products. These raw materials have not been machined or processed into stock sizes that can be used by manufacturing industries on a production line.

Having raw materials machined or processed into standard forms has a number of benefits for manufacturing industries which include:

- handling and transportation is made easier;
- standard sizes and forms are cheaper because they are processed in large quantities;
- manufacturers will use standard stock sizes which are readily available; and
- the standard sizes and forms are the same in most countries forming an international standard.

Natural woods are supplied in standard stock lengths and sections. The most common sections are:

- square;
- rectangular;
- round; and
- molded sections can also be supplied.

The standard stock sections for metals are:

- solid sections:
  - flats;
  - square;
  - hexagonal; and
  - angle iron.
- tubes:
  - hexagonal;
  - round; and
  - square.

Tubes are lighter than solid sections and this makes them ideal for products which have a framework such as scaffolding.

## Density

Density is the mass per unit volume of any object. It is calculated by dividing the mass of an object by its volume. Density is a measure of how heavy an object is for a given size.

## Availability

Companies purchase raw materials from numerous domestic and international suppliers, some of which



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are sole suppliers. Any interruption in the delivery of these materials can have a negative impact on the company.

The supply chain can be affected by a number of factors including:

- environmental factors;
  - weather cycles such as the monsoon season, have a negative impact on the growth and harvesting of materials.
- cost of production;
  - this can rise due to several factors, such as loss of fertility of land, high labour costs, transport cost, and tax rate.
- workforce issues;
  - availability of skilled workforce.
- industrial instability;
  - strikes and industrial action.
- transportation issues;
  - transport is always a constraint to the supply of raw materials. as these may not be available on time due to poor transport, e.g. shipping, road, rail and air transport delays.
- political or civil unrest; and
- government policies;
  - government policies, such as fiscal policy and industrial policy, has an impact on the supply of materials. For example, an increase in tax on excise duties could decrease the supply of a material. However, if the tax rate is low, then the supply of materials could increase.

Companies generally employ a supply and forward-purchase contracts to help ensure availability and help manage the volatility of the pricing of raw materials needed in its operations. However, the manufacturing companies are still exposed to changes in the price of commodities used as raw materials in the manufacturing of their products.

## Revision Questions

1. Why are materials processed into standard forms and shapes?

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2. List **three** factors which can influence the cost of raw materials.

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3. How does a manufacturer try to reduce the impact of material price fluctuations?

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4. Why would a supplier want to control the supply of materials?

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5. What is meant by the term “casting?”

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6. List **three** common forms of metals.

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7. How is sanding casting used to produce complex metal parts?

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8. Name **two** standard stock sections for wood and metals.

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9. Why is the density of a material of interest to a manufacturer?

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10. List **three** factors which can influence the availability of a material.

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### Additional resources

[www.bbc.co.uk/schools/gcsebitesize/design/resistantmaterials](http://www.bbc.co.uk/schools/gcsebitesize/design/resistantmaterials)

[www.designandtech.com/resistantmaterials](http://www.designandtech.com/resistantmaterials)

<https://traccsolution.com>

[news.thomasnet.com](http://news.thomasnet.com)

<http://www.independent.co.uk/news/business/news/uk-inflation-falls-pound-value-crash-consumer-price-index>

<http://www.economicdiscussion.net>

<https://www.nytimes.com/interactive/2015/07/31/.../rising-cost-of-manufacturing>

<https://www.britannica.com/technology/materials-processing>

AQA Design and Technology: Resistant Materials – Nelson Thornes

Design and Technology for AQA: Resistant Materials – Heinemann

<http://www-materials.eng.cam.ac.uk/mpsite/properties/non-IE/density.html>

