İSTANBUL TİCARET ÜNİVERSİTESİ

ENGLISH PREP.PROGRAM

ENGINEERING EXTRA ARTICLES FOR SUMMER



Conductors & Insulators

Conductors

In electrical and electronic circuits and components, CONDUCTORS are materials that allow electric current to flow through them because their atomic structure lets the outermost (free) electrons move easily from one atom to another, and because the electrons carry a negative electric charge they are easily repelled by a applied negative electric charge and attracted by a positive charge. Therefore applying a voltage between the two ends of a conductor causes an ‘electron drift ’ from negative to positive giving rise to an electric current. Suitable materials to act as conductors include:

Most Metals

Some Gases

Solutions of Acids, Alkalis & Salts in water

Conductivity of Metals	
Silver	105%
Copper	100%
Gold	70%
Aluminium	61%
Brass	28%
Zinc	27%
Nickel	22%
Iron	17%
Tin	15%
Phosphor Bronze	15%

Insulators

Materials that prevent the flow of electric current are called INSULATORS. These are mostly solid materials in which the outer electrons of each atom are tightly bonded to the nucleus of the atom, preventing any electron movement within a 'normal range' of applied voltage. Materials commonly used in electronic circuits include:



Plastics (e.g. Polystyrene, PVC Bakelite and Polythene)

Glass (including Fibre Glass)

Ceramics

Resins (e.g. epoxy resins)

Paper (usually impregnated with wax, resin etc.)

Rubber (Natural or synthetic)

Air

Both the terms "Insulator" and "Conductor" are relative. That is, they each have some properties of the other as well as their own. For example an insulator may pass very small currents, but not sufficiently to be called a conductor. An insulator can work well at low voltages, such as those found in battery operated equipment, but fail totally and pass large currents if connected to a much higher voltage.

Source : http://www.learnabout-electronics.org/Resistors/resistors_01.php

Design engineering

Design engineering is the study of problem solving by ‘traditional’ engineering and design. It applies an understanding of materials, creative design thinking and manufacturing techniques.

Selecting materials

Design engineers have to take into account a wide range of factors when selecting materials for products. Often the decisions made will be based on the functional aspects of the design and take into account different factors, eg the blade on a lawnmower will need to use materials that are tough to withstand impacts, hard to withstand bending and resistant to corrosion due to being exposed to moisture.

Properties

Each material has properties that make them good for specific tasks, and these must be considered when designing a product.

Physical property	**Usage example**
Density - amount of matter a material has to its volume	Low-density foams, eg low density polyethylene (LDPE), can be used as low-weight, shock absorbing packaging materials to protect fragile items
Absorbency - ability to retain heat, light or water in a structure	Paper towels are absorbent and are used to soak up liquid spills or dry wet hands
Conductivity - ability of heat (thermal) or an electric charge (electrical) to pass through	Wooden handles are used on saucepans as they are poor thermal (heat) conductors, and copper is used for wires in power cables as they are good electrical conductors
Corrosive resistance - ability to withstand chemicals, water and weather conditions, eg snow	Glass is used in external windows as it maintains its transparency for a long time in most weather conditions
Flammability - ability to ignite (catch on fire) or combust (burn)	Specially engineered ceramics are used in brake pads for high-performance motorbikes as they have low flammability, and can be used in places where high-friction occurs

Working properties

Working property	Usage example
Strength - how a solid material behaves when stress and strain are applied, eg compressive, tensile and shear strength	Steel is used for cables in suspension bridges as it has high tensile strength to support the weight of the bridge and vehicles
Hardness - ability to withstand indentations (dents) or abrasions (scratches)	A tunnelling drill can be encrusted with synthetic diamonds to ensure it stays sharp while drilling through rocks
Durability - ability to maintain functionality without requiring excessive repair or maintenance	Most plastics are durable - eg acrylonitrile butadiene styrene (ABS) is used to make safety helmets for builders and toy building blocks
Strength to weight ratio - strength divided by its density	Carbon fibre is used to make the bodies of racing cars as it is both lightweight and able to withstand the aerodynamic forces on it in a race
Stiffness - ability to withstand deformation (change in shape) when a force is applied	When constructing a frame of a building, steel will be used for its stiffness, preventing the building from deflecting (moving under the load)
Elasticity - ability to return to original shape after a force is applied	Silicone rubber is often used in swimming caps as it is extremely flexible
Impact resistance (toughness) - ability to withstand a sudden high force or shock	Polycarbonate is used in motorcycle visors for its impact resistance as it will not shatter if hit by a stone when at high speed
Plasticity - ability to be shaped or moulded	When heated, thermoplastics like ABS can be injection moulded into a variety of products

A racing car design engineer may choose a material like carbon fibre for the body because of its good strength-to-weight ratio and its low corrosion resistance to water, amongst many other considerations

Once the design engineer has taken into account all of the physical and working properties of the material, they should address these areas:

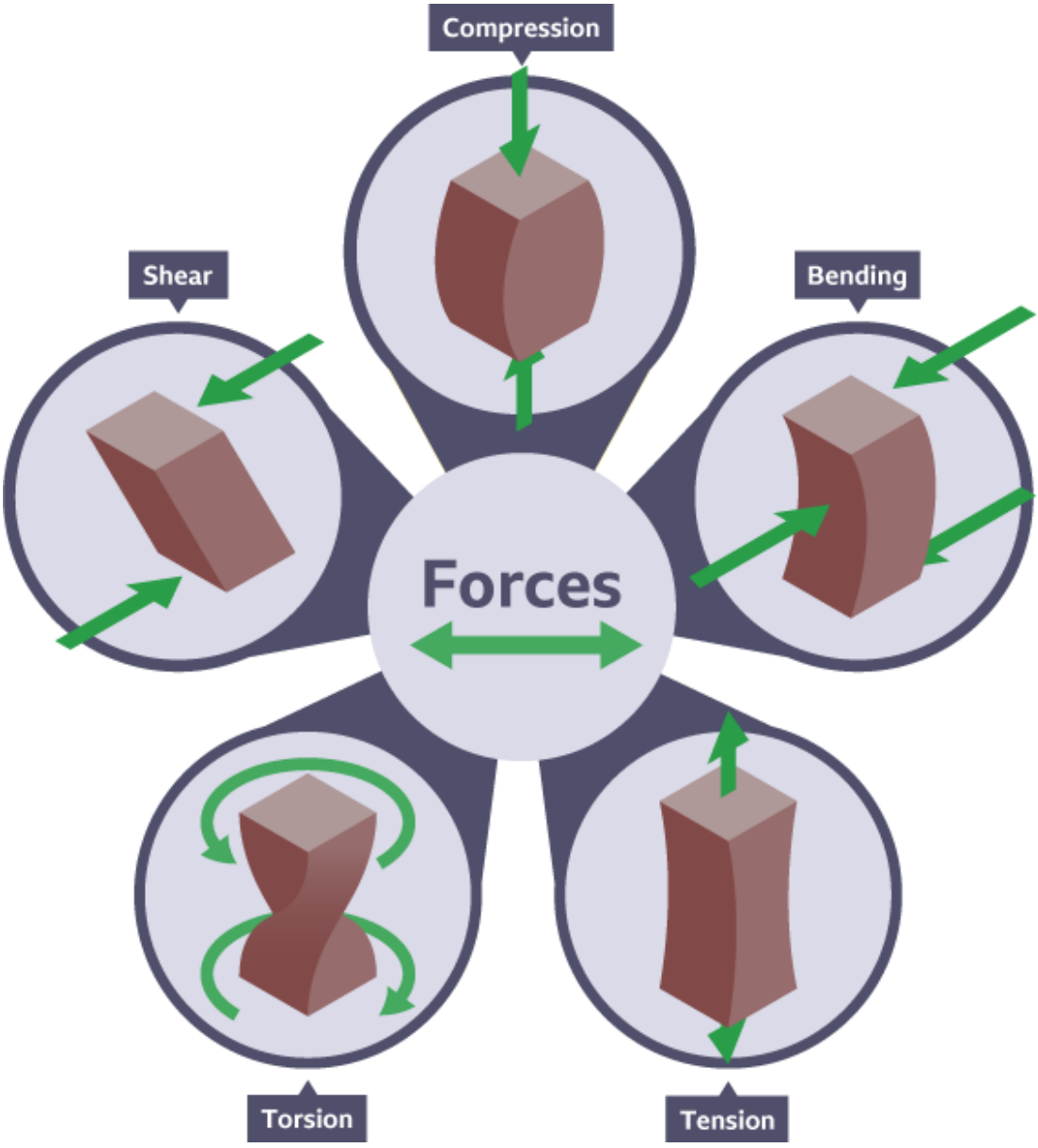
- **Functionality** - Does the material perform in the way that is required?
- **Aesthetics** - What does it look and feel like?
- **Environmental considerations** - What impact does it have on the environment during extraction and processing? Does it require chemical treatment and can it be recycled?
- **Availability** - What stock forms does it come in and are they fit for purpose?
- **Social, cultural and ethical considerations** - Does the material have any a special cultural value or come from an endangered or unethical source? What were the working conditions for those extracting the material? Are there social trends that the material contradicts, eg the use of single-use plastics?

Ensuring structural integrity

Forces act on materials all the time - even if a material appears stationary it still has a force acting on it. There are five terms used to describe what type of force can act on a material:

- tension - a pulling force
- compression - a pushing force
- bending - forces at an angle to the material
- torsion - a twisting force
- shear - forces acting across the material

source : https://www.bbc.com/bitesize/subjects/zvg4d2p



Design engineers often adapt materials to alter their performance, improving their ability to withstand loads, deformation and failure.

For example, a bicycle frame is commonly made up of a number of triangulated tubular pieces, most notable in the classic ‘double diamond’ design.

Forces

Forces are pushes or pulls. They can be balanced or unbalanced. If unbalanced they can change the shape of objects and change the way they are moving. Moments are turning forces.

What are forces?

A force can be a **push** or a **pull**. For example, when you push open a door you have to apply a force to the door. You also have to apply a force to pull open a drawer.

You cannot see a force but often you can see what it does. When a force is exerted on an object, it can change the object's:

- speed
- direction of movement
- shape (for example, an elastic band gets longer if you pull it)



A force meter, also called a newton meter, is used to measure forces

Forces can be contact forces, where objects must touch each other to exert a force. Other forces are non-contact forces, where objects do not have to touch each other. These include:

- gravity
- magnetism
- forces due to static electricity

Measuring forces

Forces can be measured using a force meter, also called a newton meter. Force meters contain a spring connected to a metal hook. The spring stretches when a force is applied to the hook. The bigger the force applied, the longer the spring stretches and the bigger the reading.

The unit of force is called the newton, and it has the symbol N. The greater the force, the bigger the number, so 100 N is a greater force than 5 N.

Balanced forces

When two forces acting on an object are equal in size but act in opposite directions, we say that they are balanced forces.

If the forces on an object are balanced (or if there are no forces acting on it), this is what happens:

- a stationary object stays still
- a moving object continues to move at the same speed and in the same direction

Remember that an object can be moving, even if there are no forces acting on it.

Force diagrams

We can show the forces acting on an object using a force diagram. In a force diagram, an arrow represents each force. The arrow shows:

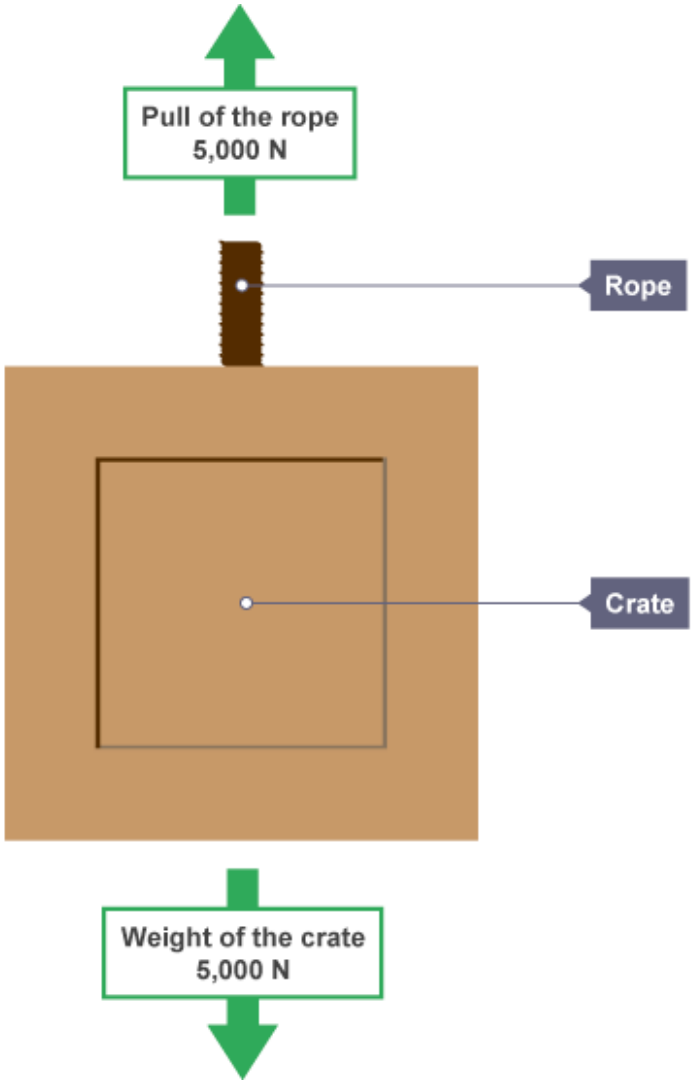
- the size of the force (the longer the arrow, the bigger the force)
- the direction in which the force acts

The arrow should be labelled with the name of the force and its size in newtons. Textbooks often show a force with a thick coloured arrow so that it looks nice, but it is more accurate if you just use a ruler and pen or pencil to draw an arrow with a single line.

Here are some examples of situations involving balanced forces.

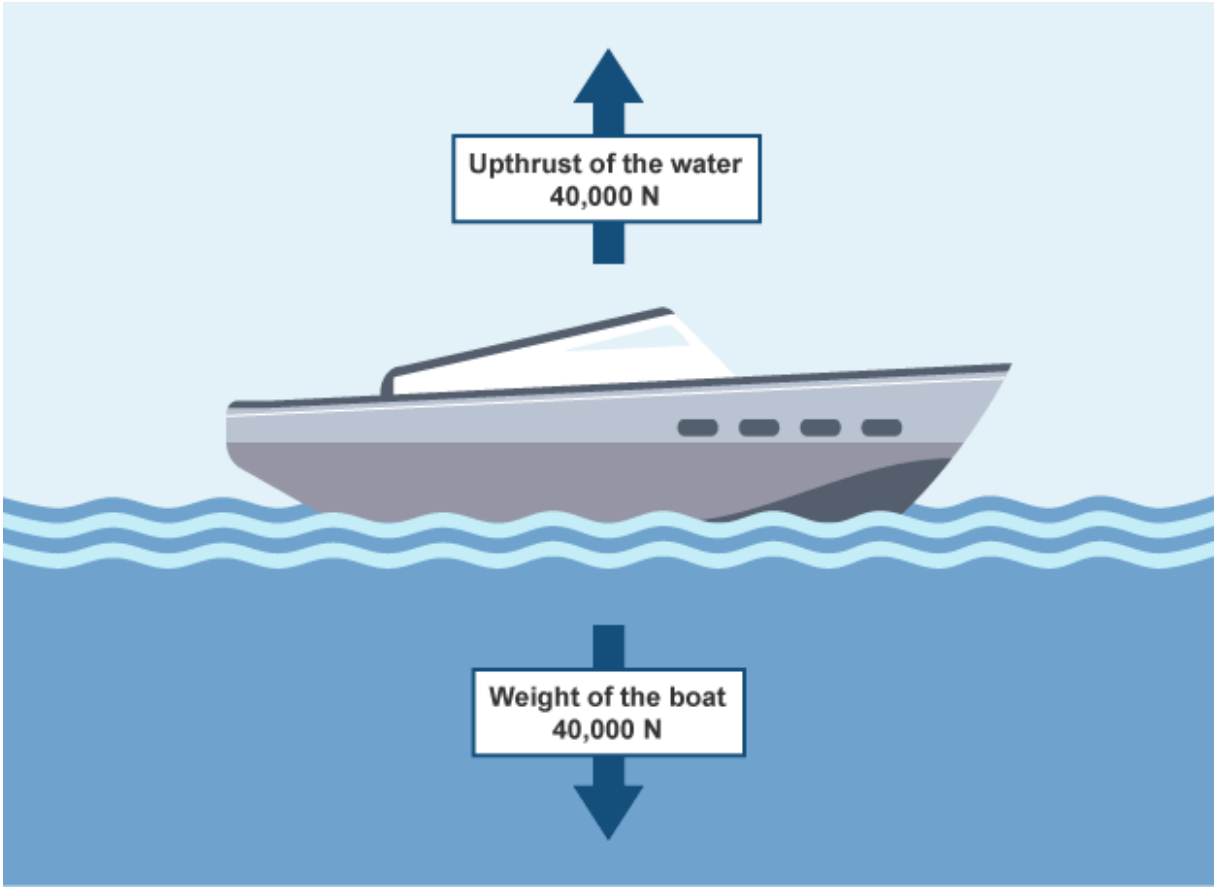
Hanging objects

The forces on this hanging crate are equal in size but act in opposite directions.
The weight pulls down and the tension in the rope pulls up.



Floating in water

Objects float in water when their weight is balanced by the upthrust from the water. The object will sink until the weight of the water it pushes out of the way is the same as the weight of the object.



Unbalanced forces

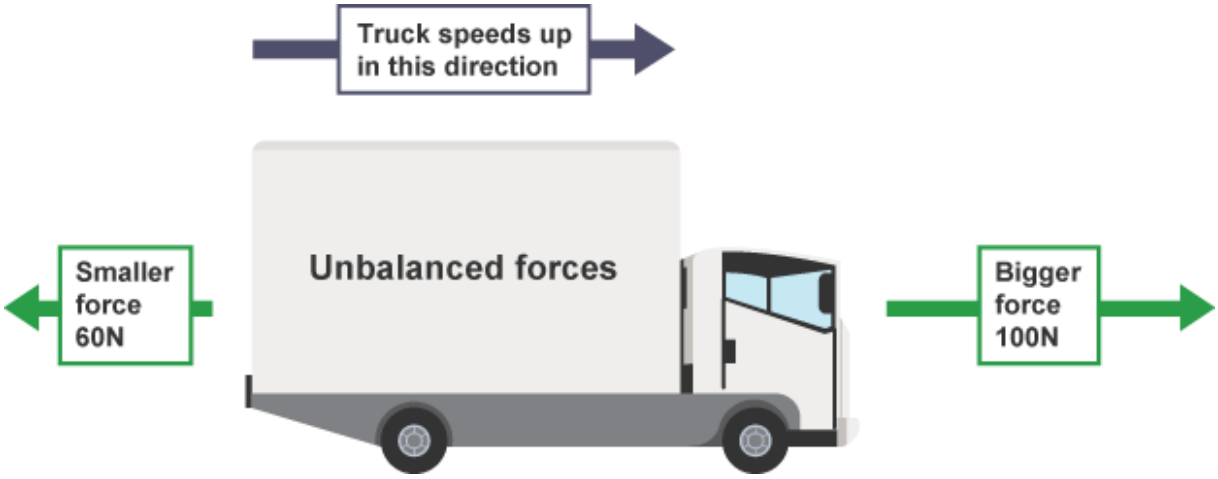
When two forces acting on an object are not equal in size, we say that they are unbalanced forces. The overall force acting on the object is called the resultant force. If the forces are balanced, the resultant force is zero.

If the forces on an object are unbalanced, this is what happens:

- a stationary object starts to move in the direction of the resultant force
- a moving object changes speed and/or direction in the direction of the resultant force

In the example below, the resultant force is the difference between the two forces:

100 – 60 = 40 N (to the right)



The change in the motion of an object depends upon:

- the size of the resultant force
- the direction of the resultant force

The greater the resultant force, the greater the change in the motion of the object. Whether a moving object speeds up, or slows down, depends on the direction of the resultant force:

- the object speeds up if the resultant force acts in the direction of movement
- the object slows down if the resultant force acts opposite to the direction of movement

Frictional forces

Whenever an object moves against another object, it feels frictional forces. These forces act in the opposite direction to the movement. Friction makes it more difficult for things to move.

Helpful frictional forces

Friction can be useful. For example:

- friction between our shoes and the floor stop us from slipping
- friction between tyres and the road stop cars from skidding
- friction between the brakes and wheel help bikes and cars to slow down

Frictional forces are much smaller on smooth surfaces than on rough surfaces, which is why we slide on ice but not on concrete.

Moments

A moment is a turning effect of a force. Forces can make objects turn if there is a pivot.

Think of a playground see-saw. The pivot is the part in the middle. The see-saw is level when no-one is on it, but the see-saw tips up if someone gets onto one end. It is possible to balance the see-saw again if someone else gets onto the other end and sits in the correct place. This is because the turning forces are balanced - we say the moments are equal and opposite.

Calculating moments

To calculate a moment, you need to know two things:

- the distance from the pivot that the force is applied
- the size of the force applied

moment = force × distance

Glossary

1. **air resistance**

A force of friction produced when an object moves through the air.

2. **balanced force**

When the total force in opposite directions are equal in magnitude. For example, with a thrust of 15 N and a frictional force of 15 N, the body experiences balanced forces.

3. **compression**

Being squashed.

4. **deformation**

Changing shape and/or size as a result of forces being applied.

5. **effort**

Force used to move a load over a distance.

6. **elastic**

Elastic materials return to their original shape and size after being stretched or squashed.

7. **extension**

Increase in length, for example, as a result of being pulled.

8. **force**

A push or a pull. The unit of force is the newton (N).

9. **frictional force**

Force that resists one object moving through or over something. An example is air resistance on a car.

10. **Hooke's Law**

Law describing that the extension of an object or material is directly proportional to the force applied.

11. **load**

Force in a machine due to the mass, weight or movement of an object.

12. **moment**

A turning effect of a force.

13. **newton**

Unit of force named after British scientist Isaac Newton (1642-1727), eg the frictional force on the boat is 20,000 N.

14. **pivot**

A point around which something can rotate or turn.

15. **reaction force**

Force exerted in the opposite direction to an action force.

16. **resultant force**

The single force that could replace all the forces acting on an object, found by adding these together. If all the forces are balanced, the resultant force is zero.

17. **tension**

Pulling force exerted by each end of an object such as a string or rope.

18. **upthrust**

Upwards force exerted by a liquid or gas on an object floating in it

19. **weight**

The force acting on an object due to the pull of gravity from a massive object like a planet. The force acts towards the centre of the planet and is measured in newtons (N).

20. **work done**

The amount of energy it takes to do a task. Measured in joules (J). For example, the work done in raising a mass through 10 m would be equal to the gain in potential energy of the mass.

Principles of flight

For thousands of years, people have wanted to fly. Our legends and fairy tales are full of humans and animals that can fly – effortlessly gliding through the air. In real life, of course, no one can just fly into the air. We don't have wings and a power source strong enough to keep the wings moving through the air to sustain the lift necessary for flight.

Planes and birds are both affected by the same forces in flight. They have to be able to provide enough lift force to oppose the weight force.

Our attempts to fly have taken us from flimsy paper hot-air balloons and strange-looking gliders to supersonic jet planes. We have learned about the forces of flight, and we know what it takes to keep birds and planes in the air.

Force can be defined as a push or pull. Unbalanced forces produce an acceleration of an object in the direction of the resultant force. Four main forces affect the flight abilities of birds and planes – weight, lift, thrust and drag.

Weight and lift

We all know that gravity is a force that pulls everything towards the Earth's surface. This pull is called the weight force.

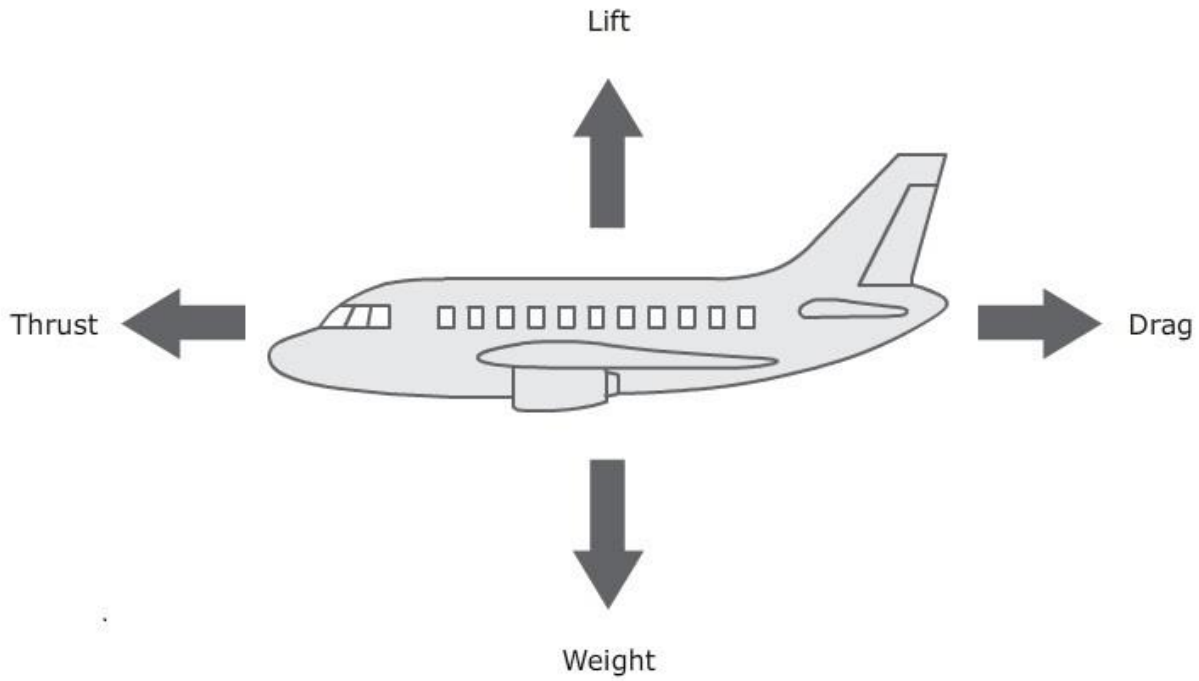
Planes and birds have to be able to provide enough lift force to oppose the weight force. Lift is a force that acts upwards against weight and is caused by the air moving over and under the wings.

Thrust and drag

The power source of a bird or plane provides the thrust. Thrust is the force that moves the object forward. Thrust is provided by:

- muscles – for birds and other flying animals
- engines – for flying machines
- gravity – for gliders that actually fly by always diving at a very shallow angle (birds do this too when they glide).

The force working against thrust is called drag. It is caused by air resistance and acts in the opposite direction to the motion. The amount of drag depends on the shape of the object, the density of the air and the speed of the object. Thrust can overcome or counteract the force of drag.



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How it works

An object in flight is constantly engaging in a tug of war between the opposing forces of lift, weight (gravity), thrust and drag. Flight depends on these forces – whether the lift force is greater than the weight force and whether thrust is greater than drag (friction) forces.

Lift and drag are considered aerodynamic forces because they exist due to the movement of an object (such as a plane) through the air. The weight pulls down on the plane opposing the lift created by air flowing over the wing. Thrust is generated by the propeller (engine) and opposes drag caused by air resistance. During take-off, thrust must counteract drag and lift must counteract the weight before the plane can become airborne.

If a plane or bird flies straight at a constant speed

- lift force upwards = weight force downwards (so the plane/bird stays at a constant height)
- thrust force forwards = opposing force of drag (so the plane/bird stays at a constant speed).

If the forces are not equal or balanced, the object will speed up, slow down or change direction towards the greatest force.

For example, if a plane's engine produces more thrust, it will accelerate. The acceleration increases air speed past the wing, which increases lift so the plane gains altitude. Then, because the plane is moving faster, drag (air resistance) is increased, which slows the plane from speeding up as quickly until thrust and drag are equal again. The plane can now remain at a constant but greater height.

A plane can lose altitude by reducing thrust. Drag becomes greater than thrust and the plane slows down. This reduces lift and the plane descends.

Source : https://www.sciencelearn.org.nz/resources/299-principles-of-flight

Quality Control In Manufacturing

By Joel Bradbury



In manufacturing, quality control is a process that ensures customers receive products free from defects and meet their needs. When done the wrong way, it can put consumers at risk. For example, the recent defect found in Takata airbags resulted in the biggest automotive recall in history. The recall includes almost 69 million airbag inflators and may cost billions of dollars. The recall will last until the end of 2019 and take until 2020 to resolve.

Major recalls like these can be prevented through effective quality control in manufacturing. Some common tools used to support quality control include:

- **Statistical process control (SPC)** monitors and controls quality by tracking production metrics. It helps quality managers identify and solve problems before products leave the facility.
- **Six Sigma** uses five key principles to ensure products meet customers' needs and have zero defects.

When supported by lean tools like Total Productive Maintenance (TPM), 5S, and Kaizen, most if not all defects can be eliminated.

Benefits of Using Quality Control in Manufacturing



Customers expect and demand high-quality products. When customers receive quality products you will:

- Increase customer loyalty
- Gain repeat business
- Gain new customers from referrals
- Maintain or improve your position in the market
- Improve safety
- Reduce liability risks
- Contribute to overall positive branding of your product

Manufacturers with quality control procedures in place are far less likely to face product recalls or place customers at risk from poorly made products. The cost associated with these recalls can be steep. Testament to this is the Takata recall, which is estimated to cost the company between $7 and $24 billion.

Discover how you can avoid costly recalls and support your quality control system with TPM. Graphic Products' Best Practice Guide to Total Productive Maintenance (TPM) will help you on the road to total quality. Improve quality, eliminate defects, and increase your profits.

Incorrect Implementation of Quality Control in Manufacturing

Quality control in manufacturing can be a little tricky. Often, it is done at the end of the production process, only catching defects after the fact.

Effective quality control is more involved and should include two levels:

- **Operators** monitor the manufacturing process and ensure that there is little variation.
- **Engineers** routinely monitor the product design for issues. When a problem is found, it is immediately fixed.

By monitoring products at the end of production as well as reviewing the products' design, companies can solve problems more efficiently, saving time and money.

Quality Assurance with Quality Control

Quality assurance streamlines production and helps to ensure that the final products meet the company's quality criteria. It ensures that the processes used to design, test, and produce products will be done correctly.

In manufacturing, quality assurance approaches, like ISO 9001, help manage and improve many processes, including:

- Acquiring raw materials
- Purchasing third-party components and sub-assemblies
- Designing and using inspection procedures
- Complying with production processes
- Responding to defects

For every business, quality assurance is different. However, ISO 9001 works for businesses both large and small and can be adapted for most any need. It provides the means for creating a lasting quality assurance program, ensuring that everything, from raw materials to inspection procedures are of the highest quality. Issues and defects from poor quality materials or third-party components are all but eliminated.

Source : https://www.graphicproducts.com/articles/quality-control-in-manufacturing/

Quality Control, QA and Lean Manufacturing



Lean manufacturing tools can bolster your company's quality program. Lean revolves around improving quality and safety, while increasing efficiency and profits. Some powerful lean manufacturing tools that can bolster your quality system include:

- **TPM** improves product quality by eliminating downtime, defects, and accidents. TPM accomplishes this through comprehensive maintenance programs and operator training.
- **Kaizen** helps eliminate problems at their source by empowering workers to find and solve problems on a daily basis.
- **5S** helps organize and standardize the workplace. Take control with the 5S System Best Practice Guide, by Graphic Products. Improve procedures and eliminate errors in your facility.

While every facility has different needs and may require a different lean tool, using lean to support quality control is essential. Procedures will be simplified, and the number of errors will be reduced.

How to Implement Quality Control in Manufacturing

To implement an effective quality control program, first create and document your approach to quality control. This includes:

- Defining the quality standards for each product
- Selecting the quality control method
- Defining the number of products/batch that will be tested
- Creating and training employees for quality control
- Creating a communication system for reporting defects or potential issues.

Next, you will need to create procedures for handling defects. Consider the following:

- Will batches be rejected if defected items are found?
- Will there be further testing and potential repair work involved?
- Will production be halted to ensure that there are no more defective products created?
- How will new product versions be handled?

Finally, use a method like 5-Whys to identify the root cause of the defect, make any needed changes, and ensure your products are defect free.

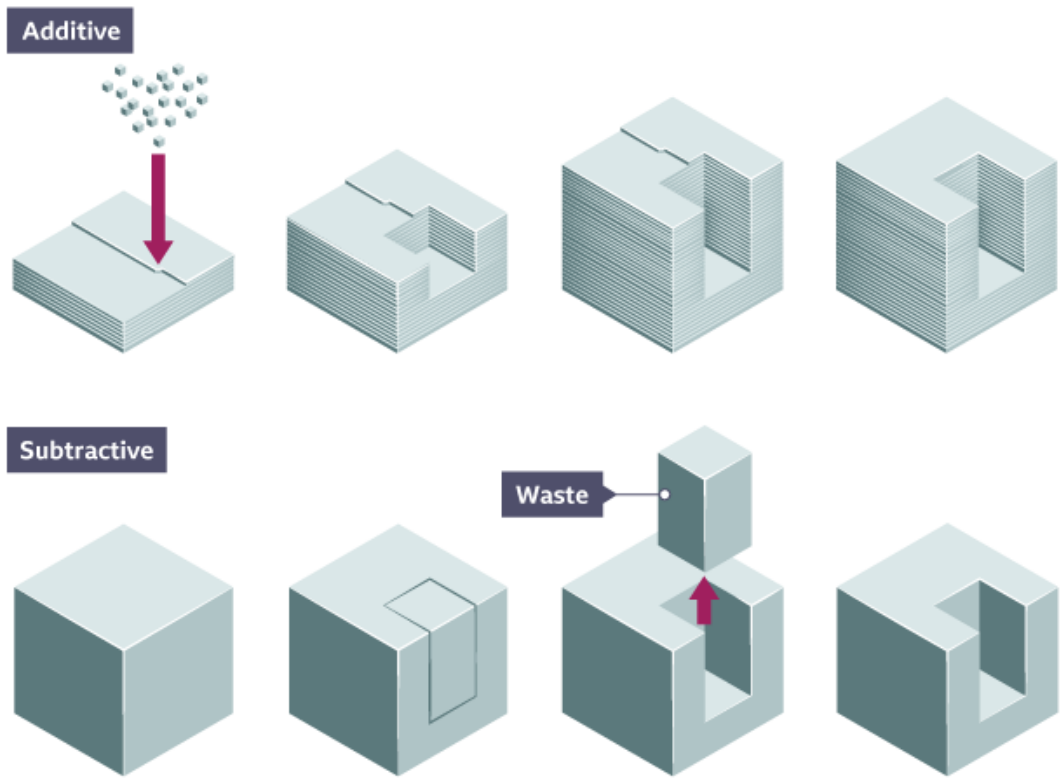
Scales of production

There are four terms used to describe the scale of production in relation to manufacturing a product:

- prototype and one-off production
- batch production
- mass production
- continuous production

Prototypes and one-off production

There are many ways to produce a prototype - some are rough and look like models and others are well finished and function as intended. It is now possible to 3D print metal, and many engineering companies have welcomed this technology as 3D printing is classed as additive manufacture, rather than subtractive. Additive manufacture builds up the metal form in layers, whereas subtractive manufacture takes material away from a larger piece. There is very little waste when using additive techniques, making it more environmentally friendly.



Batch production

Batch production is where many items of the same product are produced, such as a bike frame or parts for a metal fence. Many metal products are joined by welding, often done by hand rather than by machines, and the metal is held in place with a jigduring the manufacturing process. The jig ensures that each part stays in place whilst the welding is completed.

When a product is made in a batch, it is often far cheaper per product than when making just one.

Mass production

Mass-produced products are manufactured in large volumes, and often assembly line workers can be used to fit standard components, such as screws and hinges, to parts. Mass-produced metal products include door handles, barbecues and cooking utensils.

Continuous production

Continuous production takes place 24 hours a day, 7 days a week and, in some cases, 365 days a year. Many cars are made using a continuous production process, and the huge amount of sheet steel that is bought for this brings down the prices.

When cars are made using continuous production methods, most of the work in the factory is automated using robots, with sheet steel being cut and pressed, transported, welded and painted by them. However, people are needed to work alongside the robots to fit parts to the cars, as robots currently lack manual dexterity

What is Speed?

You are probably familiar with the concept of speed. Speed is a type of rate. A rate tells you the amount of something that occurs during a given unit of time. If you know the distance an object travels in a certain amount of time, you know the speed of the object. For example, if a car travels 70 miles in one hour, the car is traveling at a speed of 70 miles/hour (miles per hour).

If the speed of an object does not change during its motion, the object is traveling at a constant speed. Most cars are equipped with cruise control. Cruise control allows a car to travel at a constant speed.

Most objects do not move at a constant speed very long. Most moving objects change speed many times while in motion. The marathon runners pictured here do not run at a constant speed during the entire race. At the starting line, there are many runners crowded together, so the runners are forced to move slowly. As the crowd thins out, a runner can increase his or her speed. The runner may slow down as he or she climbs a hill and increases speed going down the hill. When the race is over, a runner may calculate his or her average speed. The average speed of an object tells you the average rate at which it covers distance.

What is Velocity ?

Have you heard the term velocity? Many people often use the terms speed and velocity interchangeably, but speed and velocity are different.

SPEED	VELOCITY
An airplane is traveling 804 km/h (kilometers per hour).	An airplane is traveling eastward at a rate of 804 km/h (kilometers per hour).

One of the statements describes the speed of the airplane, and the other one describes the velocity. When you know both the speed and direction of an object's motion, you know the velocity of the object.

What is ACCELERATION?

As discussed in section 2, the speed at which an object travels can change. An object can increase in speed or decrease in speed. The direction an object travels can also change. A car can travel north for 20 meters and then turn right and travel west for 50 meters. When an object changes speed or direction, we call this acceleration. Acceleration is the rate at which velocity changes. Remember, velocity has two components: speed and direction.

What is Thermal Conduction?

Heat conduction, also known as thermal conduction, is one of the three modes of heat transfer - the others are convection and radiation.

Conduction, convection and radiation

Energy can be transferred by conduction, convection and radiation. Insulation is used to stop heat energy transfers from buildings and the human body.

Conduction

Heat is thermal energy. It can be transferred from one place to another by **conduction**.

Metals are good conductors of heat, but non-metals and gases are usually poor conductors. Poor conductors are called insulators.

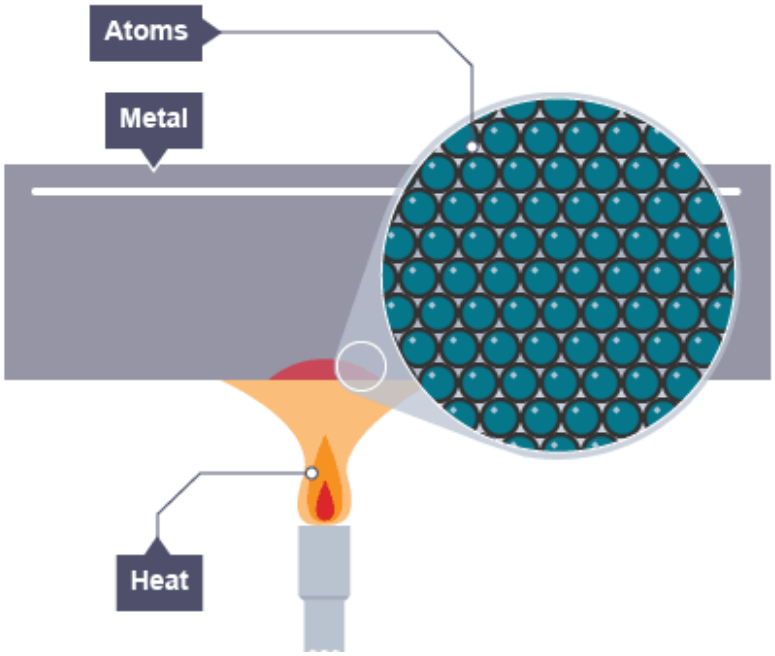
Heat energy is conducted from the hot end of an object to the cold end.

Conduction in metals

The electrons in a piece of metal can leave their atoms and move about in the metal as free electrons. The parts of the metal atoms left behind are now positively charged metal ions.

The ions are packed closely together and they vibrate continually. The hotter the metal, the more kinetic energy these vibrations have. This kinetic energy is transferred from hot parts of the metal to cooler parts by the free electrons.

These move through the structure of the metal, colliding with ions as they go.



Convection

Heat can be transferred from one place to another by convection.

Fluids

Liquids and gases are fluids because they can be made to flow. The particles in these fluids can move from place to place. Convection occurs when particles with a lot of heat energy in a liquid or gas move and take the place of particles with less heat energy.

Heat energy is transferred from hot places to cooler places by convection.

A beaker is heated and the coloured fluid inside shows convection currents

Liquids and gases **expand** when they are heated.

This is because the particles in liquids and gases move faster when they are heated than they do when they are cold.

As a result, the particles take up more volume. This is because the gap between particles widens, while the particles themselves stay the same size.

The liquid or gas in hot areas is less dense than the liquid or gas in cold areas, so it rises into the cold areas.

The denser cold liquid or gas falls into the warm areas.

Heat transfer by radiation

Heat can be transferred by infrared radiation. Unlike conduction and convection - which need particles - infrared radiation is a type of **electromagnetic radiation** that involves waves

Reducing heat transfers – houses

Heat energy is lost from buildings through their roofs, windows, walls, floors and through gaps around windows and doors. However, there are ways that these losses can be reduced.

Heat energy is transferred from homes by conduction through the walls, floor, roof and windows.

It is also transferred from homes by convection. For example, cold air can enter the house through gaps in doors and windows, and convection currents can transfer heat energy in the loft to the roof tiles.

Heat energy also leaves the house by radiation - through the walls, roof and windows.

Source : BBC bitesize

You can follow lessons on the following links :

https://www.coursera.org/learn/engineering-mechanics-statics

https://www.coursera.org/learn/stem

https://www.coursera.org/specializations/engineering-project-management