A Very Useful Guide to Understanding STEM

(Science, Technology, Engineering and Maths)

By Delphine Ryan

Version 1.0

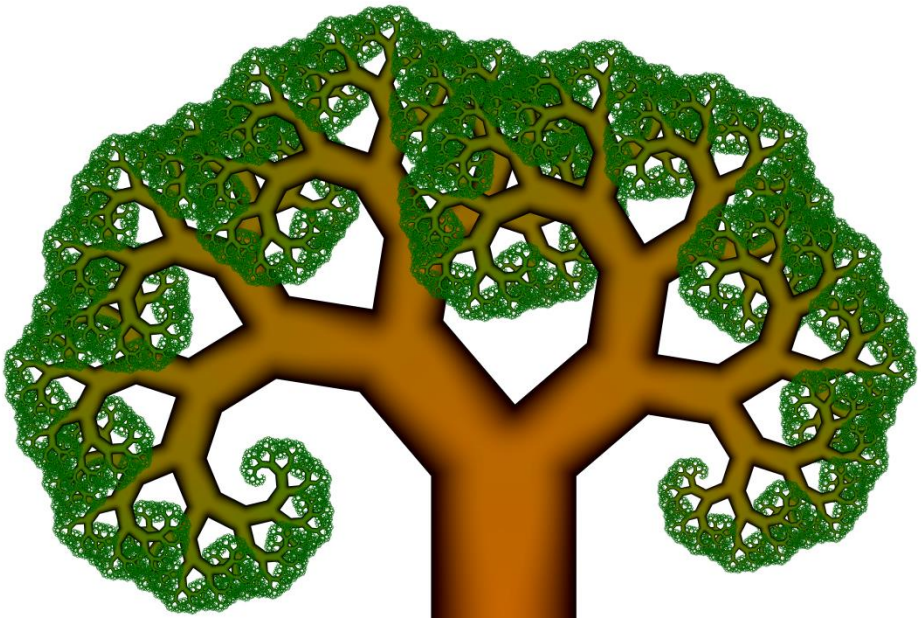
Enquiries: delphineryan@hotmail.co.uk

INTRODUCTION

Imagine a tree with many branches representing human knowledge. We could say that this knowledge may be split into two large branches, with one branch being science and the other being the humanities. From these two large branches, lots of smaller branches have grown, and each represent a specific subject, but are still connected to the larger branches in some way.

What do we mean by the humanities? The humanities refers to the learning concerned with human culture, such as literature, languages, history, art, music, geography and so on, as opposed to science.

A science is an organised collection of facts about something which have been found by individuals and groups of individuals looking into such things as how birds fly, or why different substances react with each other, or what causes the seasons of the year (different temperatures, amount of daylight, etc.). More on this will be discussed in this booklet.



In the following section, I aim to give you a balanced explanation of what we call the STEM subjects (science, technology, engineering and mathematics) in order to help you decide which career path would be best for you: a career in the sciences or in the humanities. I will also talk about art and its relationship to STEM subjects. And finally, I aim to give you a balanced view of the relationship between the sciences and the humanities, and to demonstrate to you, in the final section, how these two large branches of human knowledge work together, always.

WHAT IS STEM?

In this section, I aim to give a clear explanation of the meaning of the words 'science', 'technology', 'engineering' and 'maths' by using definitions obtained mostly from the *Oxford Dictionary of English* and other English dictionaries, as well as reference books (a list of references can be found on the last page of this guide).

To help you achieve a better understanding of a word, the origin of that word (where the word comes from) is also given. Many words in the English language derive from Latin and Greek (Latin being the language of ancient Rome, and Greek that of the ancient Greeks), as well as other languages.

Understanding the origins of words can be very useful. Origins of words (or 'derivations', as they are also called) can tell you lot about a word, and can also be very interesting.

In this guide, the origin of each word can be found in the highlighted yellow box following the definition of that word. The words in *italics* (slanted letters) indicate the original word in Latin or Greek (or other language), followed by its English equivalent highlighted in **bold**.

'**Did you know?**' boxes can be found throughout the guide. They highlight interesting facts about the subject in question.

S is for SCIENCE

A **science** is an organised collection of facts about something which have been found by individuals or groups of individuals looking into such things as how birds fly, or why different substances react with each other, or what causes the seasons of the year (different temperatures, amount of daylight, etc.)

By asking questions about such things and doing tests on them, answers can be found. These answers can be written down so that other people can use them to solve problems and make life easier. The word 'science' is often used to simply mean the facts about nature and the world around us, but it can also be used to mean the facts about *any* particular subject – for example, painting. The 'science' of painting would be the facts about different paints, brushes, etc., and how they are used to get the best results.

Science as a general subject in the field of education usually has three main divisions: (1) physics, (2) chemistry and (3) biology. Many more branches of science can be found in each of these main divisions, and I will explain a few of them in this guide.

ORIGIN

From the Latin word *scientia*, from *scio*, which means '**to know**'.

PHYSICS is a science that deals with matter, energy, motion and force, in contrast to the life sciences, such as biology, which studies and observes living things, such as animals and plants.

Physics is basically a subject which provides you with very useful information about the universe around you and the sort of 'rules' that it follows. These rules, or ways in which the universe works, do not just affect things here on Earth, but just about anywhere you care to look – including the Moon, the planets and the stars.

Earth and the Moon

ORIGIN

From the Latin word *physica*, from the Greek word *phusika*, which means '**natural things**', from *phusis* '**nature**'.

BIOLOGY is the study of living things. Biology deals with the origin, growth, reproduction and behaviour of plant and animal life.

ORIGIN

From the Greek word *bios*, which means '**life**' + *-logia*, which indicates a subject of study or interest. Therefore biology would be **a study of life**.

CHEMISTRY is the branch of science that deals with the identification of the substances from which matter is composed, the study of their properties and the ways in which they react with each other, combine and change, as well as the use of these processes to form new substances.

A chemical is a substance that is used, made or studied in chemistry. It comes from the same Arabic word as 'chemistry'.

ORIGIN

From the Arabic word *al-kimia*, which means '**alchemy**'. Alchemy was the ancient practice of attempting to change common metals into gold. *Al* means '**the**' and *kimia* means '**art of transforming metals**'. Alchemy, through medieval times to the present, eventually developed into chemistry.

An ancient portrait of an alchemist. The items on the table are very similar to what you would find in a modern chemistry lab

T is for TECHNOLOGY

TECHNOLOGY refers to the methods of application of an art or science, as opposed to just the knowledge of that art or science.

We hear the word 'technology' every day. We hear that such a person or company is developing new technology. Or we hear that something is now old technology.

Technology is not only the methods of applying an art or science, but it can also mean the actual thing produced. For example, you often hear of new mobile phone technology. When we talk about method, we mean the ways of doing something, and we talk of applying something, we mean putting it into practice.

ORIGIN

From the Greek word *tekhnologia*, which means '**systematic treatment**', from *tekhne*, which means '**art, craft**' + *-logia*, which indicates a subject of study or interest. Therefore '**technology**' would be '**the study of an art or craft; the systematic treatment of an art or craft**'.

You may also wonder how technology can also refer to the methods of application of an art. Let us take, for example, dancing.

Anyone can jiggle their bodies to music and have fun while doing it. However, if you wanted to create an amazing musical, or a ballet, or even compete in a ballroom dancing competition, you would actually need to learn the methods of application – the technology – of that particular type of dancing. This applies to many art forms, including music, painting, drawing, acting and so on.

Playing a musical instrument is the same. You have to learn how to read music, what the notes and other signs mean, the way you must position your body and the instrument, where to place your fingers, etc. These methods are all part of the technology of that art.

Now, we have seen that in both science and art there are methods and ways of applying the knowledge of a science or art. Now take a few moments to look around you and see all the things which people use on a daily basis. Now ask yourself who actually designs and builds these things? Who designs and builds mobile phones, TVs and gaming consoles? When you get in a car and drive off, fly in a plane or take the train, who has come up with the idea, designed it and then made it useful to everyone? What about movies and all the requipment required for props, filming, editing, lighting etc? And what about the daily activities that we take for granted such as having drinking water available on tap, taking showers everyday, turning on central heating or the switching on the lights? Who are the people who take scientific and artistic knowledge and put it to practical use?

Well, the answer takes us to the next section, where you will find out how engineering is the driving force that makes technology possible.

E is for ENGINEERING

ENGINEERING is the branch of science and technology concerned with the design, construction and use of engines, machines, structures and systems – for example bridges, roads, railways, harbours, drainage and water supply systems, electrical distribution systems to homes and offices, aircraft, computers, TVs, hospital equiment, communications systems, weapons, rockets, etc.

The origin of the word 'engineering' is the same as the word 'engineer'. So what is an engineer?

An **engineer** is a person trained to put scientific knowledge to practical use. It is someone whose job involves using scientific knowledge to design, build, maintain and use machines, structures or systems – including such things as bridges, roads, railways, harbours, drainage and water supply systems, electrical distribution systems to homes and offices, aircraft, computers, TVs, hospital equiment, communications systems, weapons, rockets, etc (this is only a small list).

ORIGIN

From a Middle English word referring to a designer and constructor of fortifications and weapons (Middle English is the English spoken from around 1150 to 1470 AD), from the Latin word *ingenium*, which means '**genius, invention'**.

Take a moment to think about all the new technology that you see around you, such as mobile phones, laptops, microwave ovens and so on. These only exist now because engineers were able to take the relevant scientific discoveries and actually translate them into action, and by these actions created new technology. **Engineers are the middle men and women between scientists and technology**.

People often think that an engineer only works with engines, such as a car or jet engine, and just fixes them, perhaps like a car mechanic. The maintenance of machines is only a tiny part of the field of engineering. This misunderstanding may have to do with the origin of the word 'engine' and 'engineer'. The following explanation may help to clear up the misunderstanding.

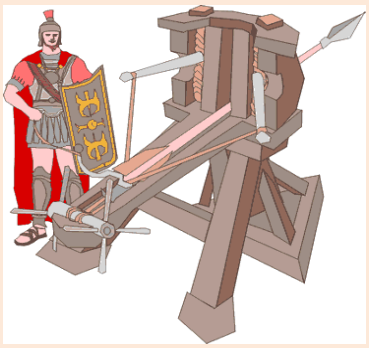
Did you know?

The word '**engine**' comes from the Latin word *ingenium*, which means 'genius, invention'. It shares the same origin as the English word 'ingenious' (possessed of genius, clever).

Earlier definitions of the word 'engine' in 1895 also included: 1. Talent, genius; 2. Skill, understanding; 3.Ingenuity, inventiveness; and 4. The rack, an instrument of torture.

The current meaning of the word 'engine' is 'a machine that uses energy to produce movement or mechanical force', such as a car or jet engine. (In fact, any machine that uses energy to produce movement or mechanical force is indeed an engine; it does not have to be just a car or jet engine.)

However, before the invention of the modern engine, an engine meant any instrument constructed with skill, or a military machine for casting stones, battering down walls or setting fire to castles, for example. During Roman times, an engineer was a person who was skilled in building war machines, such as ballistae or battering rams.



www.giantbomb.com

A Roman ballista

For the next 2,000 years, the meaning of an engineer evolved into not just a person skilled in designing and building war machines, but someone skilled in designing and building bridges, roads, sewerage systems and lots of other things that have improved the way we live. And today an engineer is still such a person, but the great advances in science in the past 150 years mean that an engineer has much more scientific knowledge available to put into practice or action: they are no longer limited to just steam or animal-driven machines. The fields of electricity, electronics and communications have opened up a completely new era of engineering.

Engineers work with all sorts of people and professions to come up with better solutions for the society in which we live. This could be better medical equipment, better ways of producing energy, new technology and machines, etc.

What you need to keep in mind is that an engineer 'invents' and 'creates' things. Just like artists. If you have ever invented something, or designed something, or created something, you are already an engineer!

EXAMPLES OF DIFFERENT TYPES OF ENGINEERING

In this section, I aim to give you a selection of some common areas of engineering, although there are many more branches. I explain the meanings of additional words to help you get a good idea of the kind of engineering that I am talking about. In each field of engineering, the engineers will use **scientific knowledge** and transfer that knowledge into **application** – which we then call **technology**.

MECHANICAL ENGINEERING

A mechanical engineer is an engineer (a person trained to put scientific knowledge to practical use) who is efficient in the invention, construction, maintenance and adjustment of all kinds of machinery. They should also be knowledgeable in the strength and quality of materials to be used in such inventions, or in their construction, maintenance and adjustment.

The word **mechanical** means 'relating to machines and mechanisms and how they are put together'.

This car has been designed by a mechanical engineer using state-of-the-art computer software

ORIGIN

The word 'mechanical' comes from a late Middle English word describing an art or occupation concerned with the construction of machines (Middle English is the English spoken from around 1150 to 1470 AD), from the Greek word *mekhanikos*, from *mekhos*, which means a '**contrivance**'. A contrivance is a thing which is created skilfully and inventively to service a particular purpose. The word '**machine**' has the same origin as '**mechanical**'.

CIVIL ENGINEERING

A civil engineer is an engineer (a person trained to put scientific knowledge to practical use) who designs and maintains roads, bridges, dams, railways, drainage works and similar structures. The word '**civil**' means 'relating to ordinary citizens and their concerns, as distinct from military or church matters'.

The Humber Bridge in East Yorkshire is a wonderful example of what civil engineers can design and create

Civil engineers at work, in the design office and on site

ORIGIN

From the Latin word *civis*, which means '**citizen**' (before the 20th century, a clear distinction was made between engineering for the people and their cities (civil), and engineering for war efforts (mechanical and marine, at the time). In today's world, although a mechanical engineer and a civil engineer have different knowledge, purpose and skills, they can work in either a military or non-military environment.

MARINE ENGINEERING

A marine engineer is an engineer (a person trained to put scientific knowledge to practical use) who deals with the design, development, production and maintenance of the equipment used at sea and on board sea vessels, including oil rigs and platforms. The word '**marine**' means 'relating to shipping or naval (of the navy) matters'.

This amazing platform has been designed and built, and is being maintained by, engineers and specialist professionals

A marine engineer inspects underwater structures

Military vessels

ORIGIN

From the Latin word *mare*, which means '**sea**'.

ELECTRONIC ENGINEERING

Electronics is a science dealing with the study and control of electric current. Electronics includes the design, development and use of devices and systems involving the flow of electrical energy, such as communications satellites, computers, industrial robots, rockets, radios and televisions.

Electronics is an example of a field of study which comes under the heading of physics, like mechanical engineering.

An **electronic engineer** is an engineer (a person trained to put scientific knowledge to practical use) who specialises in the field of electronics (the study and control of electric currents). Electronic engineers design systems and devices that use circuits (paths for the flow of electrical energy). Their work is important in developing things such as communications satellites, computers, industrial robots, rockets, radios and televisions.

A piece of amber, which the Greeks called 'elektron', and which is at the root of the words electricity and electronics.

ORIGIN

From the Greek word *elektron,* '**amber**' (amber is a hard, see-through, yellowish-brown substance formed from the sticky sap of pines and other trees). The Greeks noticed that when amber was rubbed or polished with wool, sparks were produced. These sparks are caused by electrons. Although the Greeks did not know this, their word for amber (*elektron*) is where we get the words 'electron' (the tiny bits of matter which make up electricity), 'electricity' and 'electronics'.

AERONAUTICAL AND AEROSPACE ENGINEERING

An **aeronautical engineer** is an engineer (a person trained to put scientific knowledge to practical use) who specialises in the science or practice of building or flying aircraft.

The word '**aeronautical**' means 'relating to aeronautics, the science and art of aerial navigation, or the navigation of the air by means of balloons, airship, aircraft and any other heavier-than-air flying machines'.

You will often hear 'aerospace engineering' also used when talking about designing and flying aircraft, building rockets and satellites, etc. Both words can be used to mean the same type of engineering.

However, there is a slight difference. The word 'aeronautical' was created when hot-air balloons were first invented, because there was no word in the English language to describe machines that could fly, as they had not existed until that point.

Since the first hot-air balloon, technology has evolved to the point where we can now fly into outer space. Therefore, a broader word was created to include not just aviation (the flying and operating of aircraft, from Latin *avis*, '**bird**'), but also all those activities relating to outer space flight.

Therefore, **aerospace engineering** is that branch of science and engineering concerned with both aviation and space flight. It therefore includes aeronautical engineering. The word 'aerospace' is made up of 'aero' which means air and 'space'.

This space station flight control room is full of aerospace engineers, and probably some astrophysicists too ('astro' means 'star', and these physicists are specialists in the physics of outer space)

A flight simulator to train airline pilots

ORIGIN

The word 'aeronautical' comes from the English word '**aeronaut**', from the French word *aeronaute*.

'**Aeronaut**' is an old English word for a traveller in a hot-air balloon, airship or other flying craft. This word comes from the Greek words *aer*, which means '**air**' + *nautes*, which means '**sailor**'. Therefore an **aeronaut** would have been '**one who sails through the air**' or '**navigates through the air**'. In the same way, an '**astronaut**' would be a person who sails through the stars!

Did you know?

The word 'aeroplane' and 'planet' share the same origin.

'Planet' derives from the Greek word *planetes*, from *planan*, which means '**wanderer**'. The Greeks, looking up into the night skies, could see small objects wandering across the heavens and named them as such.

Similarly, the word 'aeroplane' was invented in the late 19th century (since aeroplanes did not exist before that time). The word is made up from the Greek word *aer* which means '**air**' + *planos* which means '**wandering**' (related to the word *planan*, as in 'planet'). Indeed, an aeroplane definitely does wander through the air!

CHEMICAL ENGINEERING

A chemical engineer is an engineer (a person trained to put scientific knowledge to practical use) who deals with the technology of large-scale chemical production and the manufacture of products through chemical processes. A chemical engineer works principally in the chemical industry to convert basic raw materials into a variety of products, and deals with the design, operation and maintenance of industrial plants (manufacturing buildings) and equipment used in such processes.

Basically, chemical engineering is a type of engineering that deals with the use of chemistry in industry (manufacturing). As I mentioned earlier in this booklet, a chemical is a substance that is used, made or studied in chemistry.

For example, a chemical engineer would be at home in a petrol refinery (this is where crude oil is refined so as to be used for car and aircraft fuel, plastics and many other goods).

Chemical engineers can enjoy a wide choice of career as their skills and expertise are required in many areas such as in the manufacturing of pharmaceuticals (medicines), in food production, in mining and mineral processing (iron, steel manufacture etc.), in environmental engineering (such as air polution control, water and waster-water treatment), in the manufacture of electronic components, and much more.

www2.hull.ac.uk

Chemical engineering students

www.youtube.com

Chemical engineers in a manufacturing plant

ORIGIN

The word 'chemical' has the same origin as the word 'chemistry', from the Arabic word *al-kimia*, which means '**alchemy**'. Alchemy was the ancient practice of attempting to change common metals into gold. *Al* means '**the**' and *kimia* means '**art of transforming metals**'. Alchemy, through medieval times to the present, eventually developed into chemistry.

And finally, I would like to point out a really important fact: unlike machines from centuries ago, most modern machines not only use mechanical parts but also electricity, electronics, computers, etc. This means that when building things such as ships, aircraft, robots and computers, professional engineers from many different branches of engineering must work together to produce the final product.

M is for MATHEMATICS

MATHEMATICS (or maths) is the study of the relationships among numbers, shapes and quantities, using numbers and symbols.

Maths is used by all humans over the whole world throughout their entire lives. Mathematics is everywhere, even when we do not realise it. When working out how long it will take you to do something, or checking how much money you have to take the train, you are using mathematics. When estimating how fast a car is moving in order to decide whether you have enough time to cross, you are using mathematics. Even a small baby who is trying to put wooden shapes into the corresponding hole is at that moment learning about shapes and is using mathematics, before it can even walk!

If you read the origin of the word 'mathematics' below, you will see that thousands of years ago, the word meant 'the art or craft of learning'. I think this is amazing.

ORIGIN

From the Latin words (*ars*) *mathematica*, which means '**mathematical (art)**', from the Greek word *mathematike* (*tekhne*), from the base *manthanein*, which means '**learn**'. So the origin of mathematics means '(**the art) of learning**'. The word 'technology' has the same root, with *tekhne* meaning '**art, craft**'.

The field of mathematics has many branches, in the same way that science has. In this section, I aim to explain some of the main branches of mathematics (some of them are used by all human beings in one form or another, whether they have been taught at school or not).

Pure mathematics is the study of mathematics by itself, on the basis of theory, rather than for practical application. 'Pure' means not applied or practical.

Applied mathematics refers to mathematics used in practical subjects such as engineering and physics. It is concerned with the practical application of mathematics rather than the pure or theoretical aspect of it.

The important point you should remember is that *all* human beings use maths in one form or another, even if they have not been taught it in schools. When a little child is carefully measuring up the stairs in its mind so that it may try to carefully climb down, it is using maths. When someone observes that the food is burning and decides that there has been too much heat, or that the heat or the time on the cooker should be reduced, that person is using maths. When an artist is measuring how much paint they need to use for their painting, they are using maths. In those examples, none are making calculations with a pen or paper, they just 'know' it.

Mathematics is used in all human activities in one form or another, either by 'knowing' or by actual calculations (which require some learning, either basic or advanced).

Maths can be very easy to learn for everyday use. However, when we look at the technology necessary to build aircraft, bridges, trains and railways, or even fly to the Moon, we need to use more advanced mathematics, as we cannot just 'guess' at the speed or measurements. We need to be precise. And this is where you must learn mathematics in greater detail if you wish to become a professional, or simply if you would like to be competent at using it.

The most basic branch of mathematics that you should know perfectly for everyday living is called 'arithmetic'. You cannot progress very well to more advanced mathematics if you do not fully understand arithmetic. It should be taught thoroughly in primary schools and in secondary schools. It is worth learning.

The following pages will explain some of the basic branches of mathematics. Mathematics is divided into main divisions just like science is. Many more branches of mathematics can be found in each main division, but here I am just going to cover some of the more familiar ones which are usually taught in either primary school or secondary school.

ARITHMETIC

Arithmetic is the basic part of mathematics that involves adding, subtracting, multiplying and dividing numbers. ***All other branches of mathematics use arithmetic. You cannot progress very well to further maths without a good practical understanding of arithmetic and the ability to be 'quick' with it. It is worth learning and practising.***

Simple arithmetic:

Addition: 2 + 5 = 7

To add means to put together two or more numbers or amounts to calculate (work out) their total value. The plus sign '+' is used to represent this operation (action). The equal sign '=' is used to represent the total value and means 'the same as'. The numbers 2 and 5 added together is the same as, or equals, the number 7.

Subtraction: 10 – 2 = 8

To subtract means to take away a number or amount from another to calculate the difference. The minus sign '-' is used to represent this operation. In the above example, taking 2 away from 10 gives a difference of, and is the same as, 8.

Multiplication: 6 x 3 = 18

When you multiply two numbers, you increase the first by the same number that is specified by the second . In other words, when you multiply 6 by 3, you increase the number 6 three times which is the same as adding together three sixes: 6 + 6 + 6. As adding a number over and over would not be convenient, it is easier to use the multiply sign 'x' instead. Think about multiplying 35 by 268; it would take a very long addition to had the number 35 over and over 268 times. The 'x' sign solves that problem.

Division: 20 ÷ 5 = 4

To divide means to find out how many times a number contains another. In this example, 20 ÷ 5 = 4, you are finding out that the number 20 contains the number 5 four times.

ORIGIN

The word 'arithmetic' comes from the Greek words *arithmetike* (*tekhne*), which mean '(**art**) **of counting**'. From the Greek word *arithmos*, which means '**number**'. Notice how counting was considered an art.

ALGEBRA

Algebra is the part of mathematics in which letters and other general symbols are used to represent numbers and quantities. The basic operations of arithmetic (addition, subtraction, multiplication and division) are used in algebra, but letters represent unknown numbers, the idea being to figure out, using the known numbers, the unknown ones.

You may not realise it, but without 'officially' learning algebra, most people, including small children, are actually regularly using simple algebra.

Let us say that a small child has a £1 coin in its pocket. It wishes to buy some sweets. It sees a pack of sweets for 30p. The child would like to buy this pack of sweets and would like to know how much money it will have left at the end (this is an unknown quantity). It will work out in its head that 30p subtracted (taken away from) from £1 is equal to 70p. At first, the child did not know how much money it would have left after buying the sweets, but now it has solved the unknown quantity and knows that it will have 70p left. This is basic algebra.

£1 − 30p = ? (unknown quantity). The child works out that the unknown quantity is 70p, so it has worked out the solution.

Here is another slightly harder example:

A man walked 40 miles in 2 days. On the first day he walked 25 miles. How many miles did he walk the second day?

$25 + x = 40$
$x = 40 - 25$
$x = 15$

This is also algebra. The x represents the unknown quantity (it is not the same 'x' as a multiply sign, it is actually the letter x.) It represents the unknown quantity, the question mark ?, or the 'how many miles he walked on the second day'. Other letters of the alphabet are used in algebra, but the x is used very often.

Of course when scientists and engineers are dealing with precise machines or creations that require exact calculations, then more advanced algebra is used. But the principles are exactly the same.

ORIGIN

From the Arabic word *al-jabr*, which means '**the reunion of broken parts, bone-setting**' or '**to reunite, restore**'.
The original sense of this word, 'the surgical treatment of fractures – bone-setting' probably came through the Spanish language. The mathematical sense comes from the title of a book, *ilm al-jabr was'l-muqabala*, or 'the science of restoring what is missing and equating like with like', by the Arabic mathematician Al-Khwarizmi in the first millennium AD.

GEOMETRY

Geometry is the branch of mathematics that deals with the form and relationships of angles, lines, curves, shapes and solid objects.

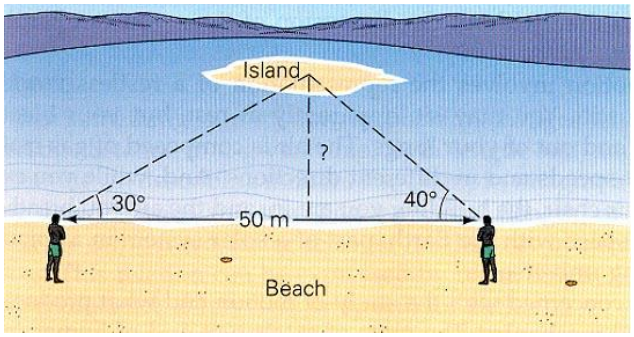
ORIGIN

From the Greek words *ge*, which means '**earth**' + *metria*, which means '**measurer**'. Geometry is certainly used to measure the earth and all its shapes!

TRIGONOMETRY

Trigonometry is the branch of mathematics dealing with the relations of the sides and angles of triangles and with the functions of angles (in mathematics, a function is a special kind of relationship between two things. Angles of triangles have special relationships with the lengths of the triangle which you learn about when studying trigonometry).

Trigonometry has many, many uses, but this may not always be so obvious until you actually start to use trigonometry to solve problems. Then you will see how useful it is. It is a subject worth learning.



The two swimmers can work out the distance from the beach to the island using trigonometry

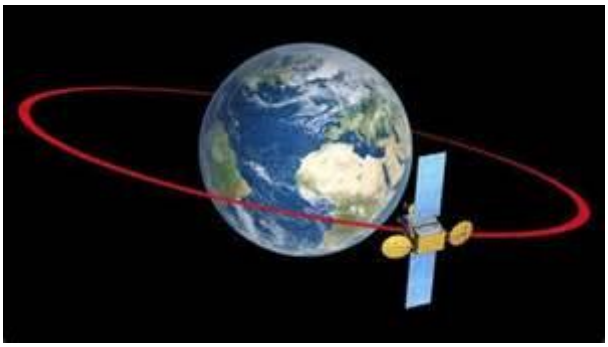
Trigonometry has been used for thousands of years in navigating sea vessels across the oceans. It is essential to navigation.

ORIGIN

From the word *trigon* (an ancient word for triangle), which comes from the Greek word *trigonon*, meaning '**three-cornered**' + *metria*, which means '**measurer**'.

CALCULUS

Calculus is a branch of advanced mathematics that deals with changing quantities, such as the rate of change of something. Calculus is also used in scientific fields to solve practical problems. For example, calculus can be used to determine the speed of moving objects, such as how fast the Earth moves around the Sun at a given time, or the speed of a falling object.



Calculus would be used to work out the orbit of a satellite

ORIGIN

From Latin *calculus*, which literally means '**small pebble**' (as used on an abacus). An abacus is a simple device used for calculating. It was extensively used for thousands of years before the invention of our modern number system, and it is still widely used today with merchants in Asia and Africa, as well as in schools.

A vintage Chinese abacus

STEM subjects and their relationship to the arts

I hope that you have found the previous section interesting, and that not only have you learned something new, but you might even have made some decisions about which career path you would like to take.

But for now, let us put STEM subjects aside and talk about the arts and the humanities. Can you try to imagine a world where there would be no art? A world without books, movies, painting, dancing, music, drawings, singing, and many other artistic or beautiful things? I struggle to imagine such a world: it would be pretty horrendous.

'**The arts**' (from Latin *ars*, which means '**art**') is another word used to describe the humanities – branches of learning concerned with human thought and relations (as distinguished from the sciences), especially literature, philosophy, history, etc. Literature refers to written works and philosophy has to do with the study of life including the study of knowledge and existence.

'**The arts**' are also activities such as painting, sculpture, dance, theatre, music, etc. that are created and done for the sake of beauty and expression. It is the expression or application of human creative skill and imagination, typically in a visual form such as painting or sculpture, producing works to be appreciated primarily for their beauty or emotional power.

Art can also be the works produced by such skills or the creative activity resulting in such works, or a skill at doing a specified thing, typically one acquired through practice.

Examples of art:

Photos: http://www.arts.uci.edu/

Now, if you take a moment to look around you and see all the different activities taking place, you will notice that all humans think and are creative. A small child sitting on a beach building a sandcastle is using its imagination and creative skills to build something. The child is being an artist and an engineer. And perhaps even a scientist, as it may be observing how the sand flows between its little fingers, but notices that when it mixes the sand with water, it becomes more solid and is easier to shape into a castle. The child has made observations and tests, and has filed the 'experiment' in its mind.

A child building a sandcastle

In this example of building a sandcastle, the child may work out how much sand it needs to build the castle, and after some trial and error, the child gets it right. Then perhaps it is going to speak to its parents to explain what it is doing. The child is using language to communicate. We can clearly see that this activity involves the use of science and humanities: language, experimentation, creative thinking, engineering, calculations, geometry (making shapes) and so on.

We could conclude that we cannot completely separate these two branches of knowledge. All humans have imagination and are creative.

We could also say that there is an artist, an engineer and a scientist inside each of us. We imagine and dream, we have goals and wishes. With the arts, all that imagination and creativity can be communicated in films, books, paintings, etc. However, it does not mean that those things can necessarily exist in real life right at that moment if we do not have the science or technology for it. That is where scientists and engineers come in.

To illustrate this idea, consider the famous American science-fiction TV series *Star Trek* which first aired on TV in 1967.

In the story, the crew of the spaceship *Enterprise* had little wireless devices to communicate to one another, from down on a planet up to the spaceship or across long distances. At the time, viewers loved the show, but no-one believed that we would ever be able to have such communication devices. The writers and dreamers of that show created a brilliant idea. And yet, fast-forward to the present day, and the mobile phone is exactly what people, just 40 years prior, did not believe could ever happen!

With the relevant and necessary discoveries by scientists, and the ability and skill of engineers to take those scientific discoveries and put them into practice, the mobile phone was invented.

www.androidauthority.com

A Star Trek® communicator

Modern mobile phones

Human creativity and imagination knows no bounds and is limitless, whereas science and engineering are limited because of the 'rules' of physics and the universe.

Through the arts, we can demonstrate ideas that do not follow the rules of physics as we know them at the moment, such as intergalactic space travel, flying carpets and castles in the air. But we can imagine them, write about them, create art about them, and through the STEM professions, by making new scientific discoveries or finding new ways of applying this scientific knowledge, we may yet make all of them a reality!

REFERENCES

Oxford Dictionary of English, 2nd Edition

Smith, J.K., 2009, *Fabulous Physics*. JK Publishing: East Grinstead

The Student Hat Dictionary, 2013, New Era Publications International ApS

ILLUSTRATIONS

Illustrations and photos obtained from the World Wide Web as royalty free images or with the appropriate reference

About the Author

Delphine Ryan studied aircraft maintenance engineering at the Manchester Metropolitan University and currently works in the aviation and defence industry. She spent several years home-schooling her three children and discovered that taking the time to fully understand the meanings of words and their origin using suitable dictionaries brings real benefits to any student, young and old.

Through volunteering as a STEM Ambassador, she became aware that the words relating to science, technology, engineering and maths were not always fully understood by students, and on some occasions, by parents and teachers. Therefore she decided to produce this informative booklet to set out the key meanings of the words in order to help students, parents and teachers when talking about or finding out more about STEM.

She firmly believes that if a student fully understands what science, technology, engineering and maths means, he or she can make an informed choice about a career path and potentially not miss out on exciting opportunities due to a prior misunderstanding.

If you have enjoyed reading this booklet, do pass it on to someone else who might also benefit from it!!