schools affiliate scheme

# news

**Issue 39**

**Autumn Term 2011**

**In this issue:**



CONNECTING TEACHERS TO THE WORLD OF MATERIALS, MINERALS AND MINING

## CHRISTMAS IS GETTING NEARER

Crikey, I can't believe we're nearly half way through the autumn term already so apologies for the late arrival of this newsletter!

In this issue I have tried to give you plenty of advanced warning about upcoming things of interest such as the Polymer Study Tours, DigIT! To BuildIT! project and Colin Humphreys Education Awards.

You may also find the information about two competitions of interest.  You can read about the Schools Starpack competition and how it can be linked to the D&T curriculum on pages 4 and 5 and find out about the UK Space Design Competition on page 8.

The Industrial Trust has been working hard for many years to build links between schools and their local industry.  Over the summer I met with Alan Young to discuss this excellent and worthwhile initiative and you can find out more on page 14.

In SAS news in this issue you can find out more about the Discovery Boxes which are now almost complete.  There are still dates available for visits this term and I am taking bookings for next term.

We will be attending the D&T with ICT show in November and the ASE meeting in January.  If you are planning to attend please come along and see us!

Finally, to finish things off nicely, the back page looks at chlorine.  Hope the rest of this term runs smoothly and that you have a great Christmas break!

IOM3
The Institute of Materials, Minerals and Mining


***This newsletter is produced by Dr Diane Aston, Training and Education Executive.***
If you have any comments or articles please contact Diane by emailing Diane.Aston@iom3.org or write to her at The Institute of Materials, Minerals and Mining, Grantham Regional Centre, The Boilerhouse, Springfield Business Park, Caunt Road, Grantham, Lincolnshire, NG31 7FZ

## COLIN HUMPHREYS EDUCATION AWARD

The Colin Humphreys Education Award is one of the Institute's Premier Awards and the nominations for the 2012 Award are now open!

This award is given in recognition of the contribution made to enhancing students' scientific or technological literacy through the teaching or support of materials, minerals or mining topics within 11-19 learning.

If you know someone that would be a worthy recipient of the award you need to complete a nomination form (available from www.iom3.org/content/nominations) and return this along with the other necessary paperwork to Catherine Tuke, IOM3, 1 Carlton House Terrace, London, SW1Y 5DB.

To assist the judges in their deliberations it would be helpful if the citation could be written under the following headings:

- What is the nominee expected to do as part of their normal role and in what environment are they working (for example, HE, FE, state secondary school or independent secondary school)?
- What has the nominee done above and beyond their normal role?
- How has the nominee shared best practice with their colleagues?

Nominees should also demonstrate evidence of sustained effort over a period of time.

The recipient will receive a medal which will be presented at the Premier Awards Dinner.

### 2011 Colin Humphreys Education Award

The 2011 Colin Humphreys Education Award was presented to Professor Paul O'Brien CEng FIMMM from the University of Manchester.

Paul has been involved in outreach activities for 30 years. He presented the chemistry of copper to over 1,500 children, in the UK and Singapore from 1984-1998. Following this work he devised a nanomaterials outreach lecture, 'How Small Can You Get', which led to an invitation to become the British Association Chemistry President in 2003. His President's Day looked at 'Living in a Materials World' and 'Sexual Chemistry'. He has worked with the Science Museum in London on a display of nanotechnology and participates in 'meet the scientist' events at the Manchester Museum of Science and Technology.

## DIGIT! TO BUILD IT!

The 2011 DigIT! to BuildIT! competition is now open!

DigIT! to BuildIT! is a project-based competition for schools mapped to the national curriculum. It aims to familiarise students with the extractives and minerals processing industry and the building products industry – the sectors which form the supply chain to the construction industry. The project is relevant to: Year 9 Geography; Science at GCSE; Geology A-Level and is also relevant to the Diploma in Construction and Built Environment, BTEC Construction and Built Environment First Diploma and First Certificate.

The project asks students to identify the sources of material used in the construction of a significant local building. Students are also prompted to recommend alternative 'eco-friendly' materials to show their understanding of environmental issues.

Free, high-quality learning materials are provided, as well as existing materials from industry, such as Virtual Quarry from the Mineral Products Association and other employer-developed materials.

For more information visit http://www.digittobuildit.org.uk

# POLYMER STUDY TOURS 2012

Following the success of the Polymer Study Tours this year, the organisers were keen to publicise the dates for 2012 early to give you as much chance as possible to get permission to attend! In 2012 the courses will be running as follows:

| | |
|---|---|
| Edinburgh Napier University | 17 to 20 June |
| London Metropolitan University | 24 to 27 June |
| Manchester University | 08 to 11 July |

The four day residential courses are a unique blend of lectures, workshops, laboratory sessions and industry visits. They have been designed to improve your knowledge of polymers in terms of their structure, properties, processing and sustainability.

A typical programme includes:

Day 1 Starts Sunday afternoon to allow travel to the venue

- Introduction to the course and plastics industry
- Education support from the Institute of Materials Minerals and Mining
- Dinner followed by an informal ice-breaker event

Day 2

- Lectures on Polymer Materials and Applications
- Workshop in the labs including hands-on processing and testing
- Dinner with guest lecture from local industrialist or academic

Day 3

- Industrial visits to local plastics processing companies
- Course dinner with short speech by an Officer from the Worshipful Company of Horners

Day 4 Course closes by 1600 allowing for travel arrangements

- Practical on polymer identification and testing
- Lectures on History and Design of Polymer Products, Sustainable Environment, Polymer Industry and Support for Schools
- Final session – evaluation, development and improvement

The courses will be celebrating their 25th birthday in 2012, but if this does not demonstrate their worth enough, this is what previous delegates have to say:

"I now have a clearer more comprehensive understanding of the important role that plastics play in society"

"I had been concerned that the course might be aimed at chemistry teachers and although I might find it interesting it would not benefit my product design classes, how wrong could I have been!"

"Our day in the labs enabled us to get hands on contact with a variety of processes that we had little experience of"

The courses are fully sponsored by the Worshipful Company of Horners, the BPF and companies operating the polymer industry. However, in order to secure your place a £50 deposit is required, which will be returned with your attendance certificate following completion of the course. You can find out more about the courses and register using the enclosed leaflet or by visiting www.polymer-teaching-resources.co.uk or www.iom3.org.uk/sas. If you would like to check availability before you book please email diane.aston@iom3.org.

## STARPACK AWARDS AND THE DESIGN AND TECHNOLOGY CURRICULUM

**Jim Jenner is a Design and Technology teacher at Northgate High School in Ipswich. Here he explains how he built the Starpack Awards into his teaching...**

Having taught Design and Technology for a number of years through the two disciplines of Resistant Materials and Electronics it was a refreshing change to be asked to take on a group of mixed ability year 10 Graphics pupils.

Although I had had little direct contact with Graphics at GCSE level I had experience as new colleagues and pupils were asking for advice and continually sharing good practice.

Northgate had in the past entered various national competitions and the pupils had been very successful on a number of occasions. Working together three members of staff teaching five classes of pupils put together a scheme of work to help pupils to get the best out of the Starpack Awards. The awards lend themselves very well to the Graphics curriculum and with the recent investment in a laser cutter our department was well situated.

We settled upon one of the briefs that involved the pupils designing packaging for a celebration cake. This was chosen as it allowed pupils to look carefully into the client requirements, colour schemes and current packaging designs. As well as these three key areas we decided as a department to focus detail on sustainability and net / development work. The Starpack Awards partnered us with a local business who in our case generously supplied us with the carton board that the pupils printed their designs on to.

All of the students who entered the competition got a lot from the experience. It was also a very valuable exercise as we managed to dovetail the requirements of the award scheme with our current scheme of work.

Unlike other competitions run by other industry-based organisations the Starpack briefs are flexible enough to allow some variation which means schools and teachers can tailor the work to their individual strengths.

Unfortunately our entries were not good enough to warrant success this year (we got through to the final last year!) but it acted as a valuable building block for our GCSE pupils.

## 2011 AWARDS

In 2011 there were 160 entries to the competition from 21 schools. Deciding the winners was a long and difficult job but Nigel Sladden, Managing Director of Logoplaste (top) rose to the challenge and got to work along with the other judges.

Queen Elizabeth Grammar School took the Benson Group Sponsored Award for the best overall entries in the Celebration Cake Box Brief.

The British Polythene Industries PLC Sponsored Award went to Bromsgrove School for the best overall entries in the New Children's Toy Pack or Product.

# SCHOOLS STARPACK
# PACKAGING DESIGN AWARDS 2012

- *Gain recognition for your school*
- *Prizes of up to £500*
- *Certificates for all winning students*

The Schools Starpack Packaging Design Awards, now in their 13th year, form part of IOM3's Annual Awards programme. The briefs provide excellent opportunities for individual Key Stage 3, 4 and AS level.

The winners of this year's Schools Starpack Awards were presented with their awards at the Packaging Society's headquarters in Grantham. From over 160 entries 5 gold, 15 silver, 23 bronze and 28 Highly Commended Stars were awarded, along with sponsored prizes for the best school in each of the three categories. Students' work was on display and the day also saw a presentation on interview techniques and CV writing.

## SNAPSHOT OF THE 2012 BRIEFS

**Brief A – Design a re-usable container for taking home fruit and veg from a shop or farmer's market.**
**Key Stage 3, 4 and AS level.**
Sponsored by British Polythene Industries PLC (BPI)
Using Plaswood or a sturdy replica, design an attractive lightweight re-usable container which will segregate and protect fruit and veg on their way home.

**Brief B - Cravendale Purfiltre Single Serve Bottle**
**Key Stage 3 and 4**
Sponsored by Logoplaste UK Limited
The challenge is to provide a usable resealable and recyclable container that has an eye catching design and stands out in the chilled drinks section of the supermarkets.

**Brief C – Fun Baking Kit**
**Key Stage 4 & AS Level**
Sponsored by the Benson Group
The aim is to create a new constructional shape for a baking kit carton which sets it aside on the supermarket shelf and appeals to the child market.

For a brochure giving full details of the briefs, guidelines and advice for teachers please contact Rachel Brooks by emailing Rachel.brooks@iom3.org or 'phoning 01476 513885. Alternatively visit www.starpack.uk.com/schools.

**The closing date for entries is 2nd March 2012**

*Starpack is organised by IOM Communications Ltd and endorsed by the Packaging Society, a division of the Institute of Materials, Minerals & Mining.*

# SAS NEWS

## Discovery boxes – nearly there!

You will be pleased to hear that after a long, hard slog, we are now on the final straight with the Discovery boxes. Acquiring the samples for the boxes has taken much longer than I had originally envisaged and I am still waiting for a couple of artefacts (hip replacements, knee replacements, ceramic bricks and tiles and some really funky ceramics stuff!). However, I have been overwhelmed by the generosity of the materials industry and particular thanks are owed to Rolls Royce plc, De Puy, Rayner, Vascutek, Ceramtec, Smile plastics, the Wood Technology Society, GKN Aerospace, Peratek and Shin-Etsu Handotai Europe. The support of these companies has allowed us to put together a unique collection of samples including:

- Single crystal turbine blades
- Intraocular lenses
- Carbon fibre composite wing stiffeners
- Various ceramics
- Various smart materials
- Various woods
- Hip and knee replacements
- Artificial arteries
- Silicon wafers and polycrystalline silicon
- Various fabrics
- Various polymers
- Various metals and alloys

We also owe a huge thank you to the Worshipful Company of Armourers and Brasiers who have sponsored the project. This has allowed us to get some really smart aluminium cases to keep the samples safe.

Each sample is clearly labelled and accompanied by a laminated card giving some basic information and details of the company that has provided it; a selection of these inserts is shown to the right. In addition, each box contains a range of presentations for you to use with the samples, links to the curriculum and detailed information leaflets about each sample or application. I hope that by doing this that everybody will have access to the information they need to be able to teach the materials topics in the curriculum confidently and enthusiastically.

I can only apologise that the boxes have taken so long to collate but I would far rather do the job properly than send out something that is only half finished. I am hoping to get the rest of the samples and literature together by the end of term so you should be able to borrow a box in the New Year. If you will be at the D&T show in November or ASE meeting in January come along and have a look for yourself as we will have a box with us as part of the display. We will be on stands A20 and BS7 respectively.







# MATERIALS IN AEROSPACE APPLICATIONS

Ever since the Wright Brothers first powered flight in 1903 materials engineers have been looking for better materials to build bigger aircraft that can fly further, fly faster and carry more people. The materials used in aerospace applications represent those at the peak in performance and it is only through the development and introduction of new materials that advances in technology can be made.

Heathrow Airport is the busiest airport in the UK and the third busiest in the world. It served 90 airlines with destinations in 170 countries and 67 million passengers a year pass through its gates. http://commons.wikimedia.org/wiki/File:Heathrow_Airport_014.jpg

Airliners are generally designed to do 50,000 to 100,000 flying hours. Long haul aircraft (for example trans-Atlantic flights) will typically do 700 journeys or cycles per year (one cycle represents a take-off, flight and landing), which translates to 2,500 to 3,000 flying hours. The characteristics for a short haul aircraft are somewhat different. These will typically undertake 1,000 to 1,500 cycles per year, but this is only equivalent to around 1,500 flying hours. As a consequence short haul aircraft need to be made more robust as the majority of stresses are experienced during the take-off and landing.

Safety is of paramount importance when designing an aircraft as there is little chance of survival if something goes wrong at 30,000 feet. The Comet was the first pressurised aeroplane, but the design of the windows had changed little from its predecessors. The stress cycle associated with the pressurisation and depressurisation of the fuselage caused fatigue cracking around the corners of the windows (the sharp corners act to concentrate the stress), these cracks joined up leading to catastrophic failure. This overwhelming need for safety has meant that manufacturers are often reluctant to introduce new technology until it has been proven.

The De Havilland Comet– the first pressurised passenger aircraft. http://upload.wikimedia.org/wikipedia/commons/8/84/De_Havilland_Comet_RAF_Museum_Cosford.jpg

## Materials for Aircraft Bodies

The first really successful aircraft was the biplane and it was very efficient. The components and structure were mainly made from wood (bamboo or spruce) surrounded by catgut or fabric. Piano wire was used to control the steering surfaces and support the wings. As the size of the aircraft increased these materials would no longer withstand the stresses associated with the higher levels of loading and new materials were introduced.

This Royal Aircraft Factory FE2b pusher biplane dates to the First World War. http://commons.wikimedia.org/wiki/File:Royal_Aircraft_Factory_FE2b.jpg

The most important parts of the aircraft are the wings, as these allow a large object, which is considerably heavier than air, to fly. The design of the wing is crucial for take-off and efficiency during flight. The wings must have excellent fatigue resistance as the loading conditions change during flight. On the ground the lower surface of the wing is in compression and the upper surface in tension, however this is reversed during flight. Often the materials used for the upper and lower surfaces have experienced different heat treatments, to give different properties as, in addition to good fatigue resistance, strength and stiffness, the lower surface must also be damage tolerant (from sand, gravel etc. flying up from the runway). The position of the wings on the fuselage also varies, for example short take-off and landing, military aircraft have their wings positioned high on the fuselage whereas most civil aircraft have their wings either centrally located, or low down on the fuselage (e.g. Concorde).

This winglet is fitted to the end of the wing of an Airbus A340-600 aircraft. http://commons.wikimedia.org/wiki/File:Airbus_A340-600_Wing.JPG

The addition of wingtip devices, often called winglets' to the outer ends of the wings increases the amount of lift produced and reduces the size of the vortices create at the wing tip. This allows the range of the aircraft to be increased as it is more fuel efficient.

The fuselage must also have good fatigue properties to cope with the pressure cycle associated with take-off, cruising at high altitude and landing. Aircraft are pressurised so that they can fly at high altitude whilst maintaining a comfortable atmosphere within the passenger compartment (the luggage area is not usually pressurised). However there is a trade off between altitude and efficiency as at high altitude the air is thinner and it is more difficult to maintain lift.

The choice of materials for the aircraft skin also depends on the speed that the aircraft will cruise at. Although the air temperature at the cruising altitude is very low frictional heating between the air and the skin can lead to certain areas experiencing high temperatures. For example, Concorde cruised at a speed of Mach 2.2 and at this speed the nose cone experienced temperatures of up to 128°C, the tail 105°C and the wings 91-97°C. At these temperatures light weight materials such as aluminium alloys, polymers and composites can suffer a loss in their properties and have to be substituted with titanium alloys.

The nose cone and the leading edges of the wings and tail of Concorde had to be made from stainless steel to withstand the temperatures reached through frictional heating. http://commons.wikimedia.org/wiki/File:Concorde.planview.arp.jpg

The materials traditionally used for aircraft skins include 2000 series aluminium alloys (based on the aluminium – copper system), 7000 series aluminium alloys (based on the aluminium – zinc – copper – magnesium system), aluminium – lithium alloys and titanium alloys (particularly for airframes).

In more recent commercial airliners these traditional materials have been replaced by modern composites. Around a third of the skin of the Airbus A380 is made from carbon fibre epoxy composites and the fuselage is clad in GLARE.

GLARE stands for glass laminate aluminium reinforced epoxy and it comprises alternating layers of thin aluminium sheet and glass fibre epoxy composite. The whole fuselage of the new Boeing 787 is made from carbon fibre epoxy composite.

The fuselage of the A380 is made from GLARE and other parts including the vertical tail and fixed trailing edge of the wings are made from carbon fibre composite.
http://commons.wikimedia.org/wiki/File:AirbusA380_ILA2006_corrected.jpg

The undercarriage or landing gear of the aircraft occupies about 5% of the total weight, which equates to approximately 3.5 tonnes for a typical 150 seat airliner. This essential component must be retracted during flight to reduce drag and it is constructed such that the legs retract in to the wings and the wheels in to the fuselage. The undercarriage must support the entire aircraft, at landing speeds of 120 to 150 mph, and this is essentially done on two struts. As a consequence of the enormous loading conditions the legs must have a yield strength in the region of 1.6 $GNmm^{-2}$, and special alloy steels are still used despite their weight. The aircraft's brakes are made from carbon and must be able to withstand temperatures in excess of 1000°C. Although the undercarriage is not used for the majority of the time over a 30 year life span the aircraft will taxi on runways a distance of 100,000 miles!

## Materials for Aircraft Engines

The engines are the power houses of the aircraft, converting chemical energy from the fuel in to mechanical energy and providing the thrust needed to fly. As with the aircraft body, the push for the development of the materials used in the engines has been the desire to increase the size of the aircraft and fly larger distances more fuel efficiently. Engines have evolved from the simple piston engines supporting propellers, to modern gas turbine and after burner jets. The latest innovation in engine design is the SCRAM jet which is capable of flying at extremely fast speeds at very high altitude.

Gas turbine engines are found on the majority of civil aircraft and work on the very simple principle of SUCK, SQUEEZE, BANG, BLOW. A large volume of air is sucked in through the fan on the front of the engine (typically about the same amount of air as there is in a squash court every second), about 80% of this by-passes the engine core and passes straight through, generating most of the thrust. Over the past 30 years advances in engine technology have allowed the thrust per engine to increase from 42,000lbs for the RB211 – 22B (found on Tristar aircraft) to 90,000lbs for the Rolls-Royce Trent 800 engine (found on the Boeing 777). The remaining 20% of the air passes through the engine core where it is squeezed through a series of compressors, mixed with fuel and ignited using a glorified spark plug (the bang stage), and the hot exhaust gas blown out of the back of the engine via a multi-stage turbine. It

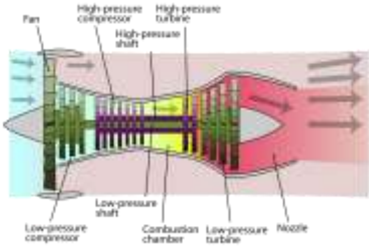
The undercarriage has to cope with extreme loads during take-off and landing.
http://commons.wikimedia.org/wiki/File:707_Undercarriage.JPG

is the turbine which drives the fan, which sucks air in etc. and so the cycle repeats.

The materials used in the engine components depend on the temperature of the gas flowing over them. At the front of the engine, at temperatures up to about 700°C, the components can safely be made from titanium alloys. The fan blades are designed to be lightweight but strong and stiff; they are made from titanium and have a corrugated cross-section

However, the gas temperature in the turbine region, towards the back of the engine, reaches a temperature in the region of 1600°C, so nickel based super alloys, or nimonics are used. These are complex alloys based on nickel with elements such as chromium, niobium and aluminium added to control the microstructure and properties. But it is not just the materials which are important in this area of the engine as even nimonics melt at approximately 1250°C. The design of the turbine blades is crucial as they contain a cooling system. The blades are hollow and the outer surface has a fine pattern of tiny holes laser machined into it ,which reduces weight but also allows cooler air from the compressor (at about 600°C) to be forced through the channels forming a protective blanket which prevents the extremely hot air from coming in to contact with the blade itself. The pictures to the right show a nickel-based superalloy high pressure turbine blade from a Trent 800 engine and its cross section. The processing route is also vital as the blades are produced as single crystals, to eliminate grain boundaries and minimise the risk of creep. Creep occurs when a material under a constant stress at elevated temperature stretches. The turbine blades are typically rotating at 10,000rpm at cruising speed and under a load equivalent to hanging an articulated lorry of each one; these are very extreme conditions. The blades are produced by the lost wax process and investment casting. Jet engines are still assembled by hand and as such the process is very costly.

In order to push the performance of the engines to the next level the temperature must increase further. The efficiency of the combustion process increases with temperature but this leads to problems with the choice of materials. Nimonics are at the limit of alloy performance and the way forward is to use intermetallics or even ceramics. Both of these groups of materials have extremely high melting points owing to their structure and bonding. However at the moment they do not have the strength and particularly impact resistance needed to survive in an aircraft engine.




Turbo fan engines work on a simple 4 stage process. http://commons.wikimedia.org/wiki/File:Turbofan_operation.png

The fan on the Rolls Royce Trent 900 engine is 2.9 metres in diameter. http://commons.wikimedia.org/wiki/File:Turbofan_operation.png

Turbine blades are designed with a series of hollow channels running along their length to provide cooling during operation.

## UK SPACE DESIGN COMPETITION

**Daniel Went from the Space and Atmospheric Physics Group at Imperial College London outlines an exciting competition for schools**

This is a free competition giving 160 UK secondary school students the opportunity to work as part of a large industrial team, designing a viable space settlement for over 10,000 inhabitants. Among other things, successful teams must consider a range of materials science and engineering issues ranging from what to build their settlement from in the first place to radiation shielding materials and, if necessary, the construction of solar cells and other equipment requiring unusual materials. Related issues such as the cost and practicality of using (and, in some cases, obtaining) different materials in space must also be considered.

Students working hard on their design during the 2011 competition

Twelve winning students are given a chance to visit NASA's Johnson Space Centre in America, paid for by our affiliated charity, the Space Science and Engineering Foundation.

The 2012 competition takes place over the weekend of 24-25th March 2012 and is hosted by Imperial College London. Applications for this competition are still open but the deadline for receipt is 13 November 2011.

You can find out more about the competition by visiting the website www.uksdc.org, monitoring our @uksdcomp twitter feed or by following the links below:

http://uksdc.files.wordpress.com/2011/09/uksdc2012.pdf

http://uksdc.files.wordpress.com/2011/09/pressrelease_teachers.doc

The winning company from 2011 with Jeremy Curtis, Head of Education at the UK Space Agency, in the middle

The winning company of the 2011 competition was Grumbo Aerospace, which comprised students from Pate's Grammar School, Sheringham High School, Lumen Christi College, City of London Academy and Chatham Grammar School for Boys.

## MORE ABOUT MATERIALS IN SPACE

The use of materials in space poses some quite unique issues. For example, the materials have to cope with exposure to large amounts of radiation and be able to protect the people inside from this, they have to be lightweight to be able to be easily sent into space, there must be ways of generating and/or storing energy efficiently and the materials must be able to withstand impact from high speed space dust or larger objects. If you are interested in finding out more about Materials in Space why not visit the following:

http://www.spaceflight.esa.int/users/materials/
http://en.wikipedia.org/wiki/Materials_International_Space_Station_Experiment
http://www.nasa.gov/mission_pages/station/research/MSRR.html
http://www.nasa.gov/centers/langley/news/factsheets/MISSE.html

The International Space Station is a much smaller settlement than you will be required to design. http://upload.wikimedia.org/wikipedia/commons/f/f9/Space_Station_above_earth.png

# ULTIMATE GUIDE TO COMPOSITES PART I

Over the coming academic year we will consider the structure, properties, processing and applications of composites. In this issue we will look at how composites are defined, in the spring issue the properties and processing of composites will be considered and in the summer issue the applications of composites will be explored.

## Introduction

Over the previous few issues the three main classes of materials have been explored, namely metals, polymers and ceramics. The fourth group, the composites are made by mixing together materials from two other groups with the aim of producing a new composite material with properties that are superior to either of the groups on their own. In most cases the constituent materials have quite different properties and they remain discrete at the macrostructural or microstructural level.

The fuselage of the Boeing 787 is made from carbon fibre epoxy composite. http://commons.wikimedia.org/wiki/File:Boeing_787_first_flight.jpg

Since composites are made by mixing different materials together and we have so many different materials to choose from, the number of possible composites is enormous. However, in practice, certain combinations tend to work better than others.

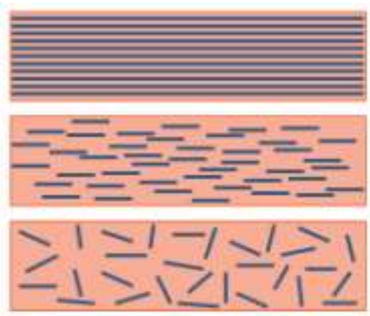
The development of strong and lightweight composite materials has allowed many advances in our technology to be made ranging from large civil aircraft to sports equipment.

Composite poles allow athletes to jump much higher than traditional bamboo poles. http://commons.wikimedia.org/wiki/File:Pole_Vault_Sequence_2.jpg

## How are composites defined?

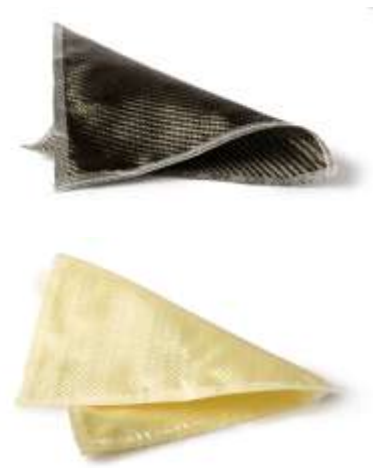
A composite material is defined by the materials from which it is comprised. These constituents are categorised as the matrix and the reinforcement.

The matrix is the background material which surrounds and supports the reinforcement by keeping it in position. The reinforcement might take the form of particles or fibres and the type, size, shape, amount and distribution of this will determine some of the physical and mechanical properties of the composite. Composites can be further defined by the nature of the matrix, for example metal matrix composites or polymer matrix composites.



The fibres in a composite may be (a) continuous, (b) discontinuous but aligned, (c) discontinuous and randomly oriented.

In particle-reinforced materials the particles may be distributed evenly throughout the structure to provide strengthening or they may be concentrated on certain features in the microstructure. Fibre-reinforced composites take a number of forms depending on the nature of the fibres. The simplest case is to have short chopped fibres which are oriented in a completely random manner. The properties of such a material do not tend to be directional as there are fibres oriented in all directions. These include traditional materials like fibreglass which are quite difficult to handle. In some cases the short fibres have a discontinuous but aligned arrangement within the matrix and this will confer anisotropic properties. Probably the best alternative is to have long, continuous fibres running through the material. These fibres could just be in one direction or a woven fabric could be used. The type of fibre used depends on the application but it could be made from glass, carbon, Kevlar or even hair!



Carbon fibre or Kevlar fibre cloth can be used to make fibre reinforced composites which are light and strong.

## Are composites new materials?

Composites are not really new materials. Natural composites include wood, which is comprised of a lignin matrix reinforced with cellulose fibres, bone which is comprised of carbonated hydroxyapatite and collagen and eggshell which is comprised of calcium carbonate minerals in a protein matrix. Engineered wood products such as plywood are also composite materials, but on a macrostructural rather than microstructural scale. .

The earliest man-made composites were used in construction and comprised of clay or mud mixed with straw for reinforcement. Wattle and daub construction has been used for over six thousand years. In this case the straw or hair-reinforced mud, known as the daub, is used to coat a wattle made from woven timber strips. This material has proved to be extremely durable and many buildings constructed hundreds of years ago using this technique are still standing.

Reinforced concrete contains a steel wire frame which improves the tensile properties of the concrete matrix. http://upload.wikimedia.org/wikipedia/commons/0/04/Concrete_rebar_0030.jpg

Composites are used extensively in the modern construction industry, the most popular being concrete. The most important constituent of concrete is cement which acts as the matrix material to bind the reinforcing sand and aggregate together. When water is added to this mixture a chemical reaction occurs and the cement hardens binding everything together. Concrete is a hard and relatively durable material that is particularly strong in compression. However, the properties of concrete in tension can be improved by reinforcing it with steel. In this case the aggregate in the concrete carries the compressive loads and the steel wires the tensile loads.

The smaller the scale of the reinforcement the more intimate the mixture and the more profound its effect. Nanocomposites are starting to be introduced now in a number of applications. Carbon nanotubes may be used in the place of carbon fibres to provide strengthening and clay platelets may be added to polymers to make them less permeable for tennis balls.

In the next issue we will explore how these materials can be processed and how this impacts upon their properties

### Where can I find out more?

http://en.wikipedia.org/wiki/Composites

http://en.wikipedia.org/wiki/Nanocomposites

http://en.wikipedia.org/wiki/Hybrid_material

http://www.compositesuk.co.uk/Information/IntroductiontoComposites.aspx

http://www.netcomposites.com/EducationIntro.asp

# STEM EXPERIENCES THAT MAKE THE DIFFERENCE FOR YOUNG PEOPLE

It has long been recognised that there is a growing shortage of engineers and scientists in the UK and that this is having a serious impact on the UK economy.  Business Secretary Vince Cable said recently "Businesses cannot grow because of a shortage of trained workers while our schools churn out young people regarded by companies as virtually unemployable.  The pool of unemployed graduates is growing while there is a chronic shortage of science graduates and especially engineers."(1)

Similarly Engineering UK identified the need to recruit an additional 587,000 engineers before 2017.  Engineering UK's own research shows that young people's enthusiasm for science learning dips in Year 8 and that more needs to be done to create excitement and revitalise young people's perception of engineering, and to provide a route-map that takes young people from early years learning right through to vocational training or their degree. (2)

With the challenge defined we can all work together to help excite and enthuse young people and demonstrate how STEM subjects can lead to fantastic careers.  The EDT, through the organisation's network of companies, schools and partners provide a continuum of opportunities that both encourage and enable young to make informed choice and fulfil their potential through STEM careers.

EDT was established over 25 years ago and is the leading provider of STEM enrichment activities for young people. Over 25,000 young people are expected to benefit from work related learning activities this academic year.  The schemes target 11-21 year olds and aim to provide a real life exposure to industry, business and higher education enabling students to make informed choices at key stages in their education.  98% of teachers involved with the EDT feel the schemes are relevant and beneficial to the students and school.

## Open Industry – Classroom Concepts Real World Contexts

Using links with hundreds of leading companies, EDT arranges in-company educational visits for you and your students into exciting, modern environments where your students will be able to link classroom concepts with real world contexts.  Out-of-the-classroom programmes can inspire young people by showing them the best in the application of science, technology,

EDT Inspiring future engineers & scientists
*Incorporating Industrial Trust*

### Alan Young is the Midlands Area Manager for EDT.

For more information about any of the programmes you can visit the website, www.etrust.org.uk or contact Alan directly by emailing a.young@etrust.org.uk or telephoning 0115 964028.

*(1) Vince Cable's speech to the Liberal Democrat's Conference September 2010*

*(2) Engineering UK report "The State of Engineering" June 2011*

engineering, maths, business and enterprise. Young people both learn and see the relevance of that learning for their future. Teachers learn too - with up to date examples of the application of their subject for use in future lessons.

Visits into companies allow young people to meet good role models, hear at firsthand about careers and qualification routes, and see what modern industry is really about. In designing the visits the EDT encourages companies use their graduates and apprentices to run the events – this is great development for their staff but also means your students will get to meet young people near their own age in a real working environment.

## What does a typical visit look like?

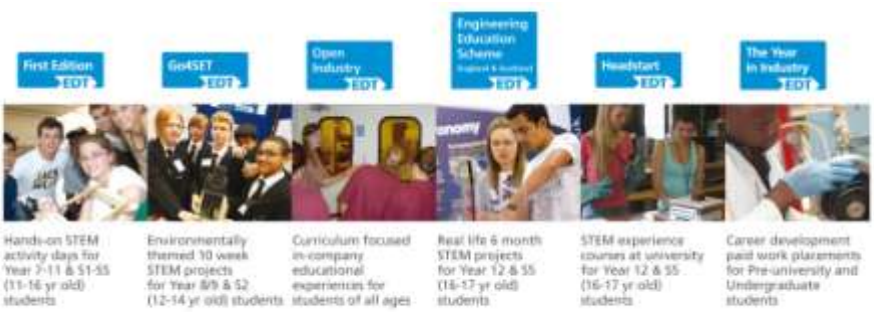
Open Industry visits are typically two hours long and have three key elements:

1. Introduction to the Company, and Health and Safety Notices
2. Classroom Concepts, Real World Contexts
3. Engagement with relevant Role Models

Starting from this simple model we can tailor each visit to make it unique. We achieve this by working with schools and organisations to agree what they want to achieve through the collaboration. A common feature of Open Industry visits is a tour of the company's facilities which enables students to experience modern industry first hand.

## The EDT Continuum of Schemes

In addition to Open Industry, EDT has 5 other schemes that together create a continuum of experiences supporting students aged 11-21 years of age.




## We Know Open Industry works, but don't take our word for it!

"The in-company educational experiences were bespoke and made the curriculum relevant to the students which will be invaluable when they answer GCSE exam questions. For example, to actually see systems and controls in industrial processes will enable them to use real examples they have experienced when answering questions, this will help them to gain marks. The experiences also show the students that anything is possible."

**Graeme Curtis, Head of Design & Technology, The Warriner School**

"Following the visit students took their first GCSE science module exams. The electricity marks are historically slightly lower than those for other modules, however this time the group who had the tour before taking the electricity exam performed really well. One student in particular achieved an A grade in their electricity exam compared to a C grade in their other module. She had really benefited from the visit and during the follow up lesson had been able to contribute well to the discussion, raising her confidence in her ability."

**Dawn John, Head of Science, Lord Williams School**

"… the target group in year 9 that were invited to Ratcliffe on Soar power station all achieved SATS levels 5 or 6 in science. I would like to think that this inspired them to strive harder in their studies… thank you for the effort you put into such a successful visit"

**Long Eaton School after a trip to a power station**

# CHLORINE

- Chlorine has atomic number 17 and atomic mass 35.45. It is one of the halogens and sits in Group 17 (VIIA) of the Periodic Table between sulphur and argon and with fluorine above and bromine below.
- Chlorine melts at -101.5°C and boils at -34.0°C and has a density of $3.2 g.l^{-1}$ at 0°C. At room temperature it is a pale yellow-green gas with a strong bleach-like smell.
- Chlorine tends to form diatomic molecules in which the bonding between the atoms is relatively weak.
- In 1774 Swedish chemist Carl Wilhelm Scheele synthesised and characterised chlorine but thought it was a compound. But it was not until 1809 that the gas was first identified as a single element and in 1810 Humphrey Davy named it chlorine from the Greek word meaning green-yellow.
- Chlorine mainly occurs in nature in the form of the chloride ion in salt. About 1.9% of the mass of seawater is chloride ions. Since most chloride salts are water soluble, chloride-containing minerals are only found deep underground in very dry conditions.
- Today chlorine is produced commercially by the electrolysis of aqueous sodium chloride (brine). This process also yields hydrogen gas and sodium hydroxide.
- The strong oxidising nature of chlorine means that it has been used extensively as a bleach and disinfectant. If chlorine gas is dissolved in lime-water it produces a solution of calcium hypochlorite. This was first used as an antiseptic in the mid-1800s. Chloroform ($CHCl_3$) gas was first used as an anaesthetic around the same time.
- Many of the applications of chlorine use it in the form of the chloride ion. Silver chloride was used in early photography, sodium chloride is used as a food additive (though it is known to have a detrimental effect on health if consumed in large quantities) and CFCs (chlorofluorocarbons) were used for many years in refrigeration and as a propellant in aerosols.
- One of the most important compounds of chlorine is hydrogen chloride and its aqueous form, hydrochloric acid. Hydrochlorination of alkynes using hydrogen chloride is an important step in the production of the monomers chloroprene and vinylchloride which become polychloroprene (Neoprene) and PVC upon polymerisation.
- Chlorine gas and many of its compounds are dangerous as they are toxic. When hydrogen chloride is inhaled it reacts with water in the body producing corrosive hydrochloric acid.

At room temperature chlorine is a yellow-green diatomic gas with a strong smell like bleach. http://upload.wikimedia.org/wikipedia/commons/f/f4/Chlorine_ampoule.jpg

The Khewra Salt Mines in Pakistan are the second largest in the world and the oldest in South Asia, with workings dating back to 320BC. http://upload.wikimedia.org/wikipedia/commons/7/72/Khewra_Salt_Mine_-_Crystal_Deposits_on_the_mine_walls.jpg

**Where can I find out more?**

http://en.wikipedia.org/wiki/Hydrogen_chloride

http://en.wikipedia.org/wiki/Silver_chloride

http://en.wikipedia.org/wiki/Silver_chloride

http://en.wikipedia.org/wiki/Hydrogen_chloride

www.webelements.com/chlorine

http://www.chemicool.com/elements/chlorine.html