Science & Engineering Events 2021

13/12/21 : Xmas drinks/lunch informal drop in at The Old Spot, Dursley.

9 members came along to the Old Spot in Dursley for a very informal lunch prior to Christmas. Lots of chat, nice food and drink, enjoyed by everyone.

25/11/21 : Talk by Martin Cuffe - Scenes of Crime - The Science Behind Investigations

Martin began his talk in the Methodist Church by explaining that he was not a police officer and outlined his career that has culminated in him being a Forensic Co-ordinator. That means he oversees the whole of a forensic investigation, deciding which experts need to be pulled in and how to use the manager and SOCO staff in his team. The basic concept behind forensic investigation is that every contact leaves a trace. In other words, any criminal is almost certain to leave some trace of his or her presence and it is this trace that the forensic investigator is looking to find. This may be through fingerprints, footwear marks or DNA or the more obvious CCTV or fibres from clothing.

A while back, the four police services of the West Country decided to combine their individual forensic departments into one central organisation that would cover the whole area. However, Gloucester decided that it would be more effective for them to maintain their own, in-house team. Martin Cuffe is part of that team.

He started by describing the different sections which together comprise a forensic investigation.

1. Scenes of Crime (SOCO): The team will be garbed in the white body suits familiar to most people from TV fictional crime programmes and this is in order that they can avoid the central tenet of their trade and leave traces, thus contaminating the crime scene. They take photos of every possible angle and pick up evidence, or more often, what may well turn out to be nothing whatsoever to do with the crime. At this stage in an investigation, it is unlikely that they will know precisely what is relevant to the crime and what is not so they do not take chances and take everything.
2. Forensic Analysis: This secondary activity analyses the material the SOCO team has collected. It will include dealing with the more obvious things like fingerprints, DNA, footwear marks.
3. Chemical Development: This is a more in-depth activity that recovers prints etc from less obvious sources. The process is a more invasive one and invariably causes damage to whatever is being checked for evidence.
4. Digital Forensic Unit: This unit deals with garnering evidence from mobiles, computers and any other technological gadget.
5. Video and Imaging Unit: As may be expected, this team deals with CCTV and photographs. Martin Cuffe explained in response to a question at the end of his talk that when processing such material, two copies are made on CD/DVD. They are stored separately. The purpose of this is to prevent tampering with the content. If there is any suspicion of tampering, the master copy can be compared to its clone.
6. Forensic Collision Investigation: This group looks into the causes of car crashes, sometimes for coroner's inquests so that families may know what happened and also in order to prosecute someone.
7. Central Forensic Subs: This department oversees the costs incurred by all the testing required in order to process evidence. It will decide whether a process is necessary or likely to produce a positive outcome or whether it is merely a waste of money.

All these groups work together, with the Co-ordinator at the helm, controlling each aspect.

All incidents will be dealt with by the forensic investigation team. Theft, assault, murder, drugs, sudden death, suicide, car crashes, post mortems … the team also undertakes presentations to the general public and trains the police. They use social media to present a friendly face to the public and for PR purposes.

Fingerprints

Dr Edmund Locard (1877-1966) was the man who realised and invented the concept that 'every contact leaves a trace'. An idea that Francis Galton (1822-1911) ran with. He was the man who discovered that fingerprints were unique. Fingerprints do not change during the lifetime of an individual, unless scarring or deliberate damage takes place. He realised the use this fact could have in criminal investigation and by 1894, the government had adopted fingerprinting as a reliable method of identifying a person and their presence at a crime scene.

Fingerprints have three basic shapes:

Once a print has been identified as falling into one of these broad categories, detail of whether the ridges split or join may be explored to refine the search for matches. Up until fairly recently, all fingerprints were taken by the use of ink and paper. The end result would be uploaded onto a data base. Now, the prints are live scanned and instantly uploaded.

Recovery of a Fingerprint

On smooth surfaces, a fine powder can be applied which will reveal a fingerprint. However, other surfaces, for example paper, binbags and sticky tape, have to be treated differently. They require a different methodology that may include being put into a vacuum chamber or illuminated by different types of light source. Fingerprints cannot be recovered from surfaces like brick, anything dusty or dirty, some fabrics or materials with texture (e.g. car interiors which are designed not to show fingerprints), wood and leather to name but a few.

The investigation will retrieve a print from the scene and designate it one of three categories: searchable, comparison only or no use. The reason for this specific action is so that all evidence is recorded and not just discarded. Searchable means what is says – that the print is good enough that it can be used to search the database for a match. Comparison only will apply to less clear prints and used as confirmation when there is a definite suspect. No use means there is just not enough detail on the recovered print for it to be used for either of the other categories.

Footwear Evidence

This type of evidence has become more important now that criminals are aware of the precautions they need to take to avoid leaving fingerprints or DNA. What they cannot avoid doing is walking on the crime scene. This is why police will seize the shoes of any suspect, including any that may be at his or her home. They take impressions of the shoes recording the pattern of the soles.

As with fingerprints, there are good and bad surfaces for recording prints. Good surfaces are tiled floors, laminate flooring, UPVC sills, mud and sand; bad ones include frosty lawns, carpets and public areas where a palimpsest of prints is likely to have built up over time. A SOCO team has to be very careful not to add their own prints to a scene as not all prints are immediately visible to the naked eye and only appear when treated with chemicals or photographed.

They also investigate surfaces which have been kicked or where, for example, papers have been swept from a desk and then walked on. It is also true that prints can be retrieved from victims who have been kicked or trodden on. As with fingerprints, the prints are coded by the laboratory and kept on a central database so that they may be compared with any suspect. It is also the case that bare footprints are as individual as fingerprints.

DNA

As with finger and footprints, an individual's DNA is unique (except in the case of identical twins). The whole genome is not used but only part of it, sufficient to create a 'barcode' for the person concerned. DNA can be retrieved from anything that has been touched (on which skin cells may have been deposited) as well as blood, semen, chewing gum, cigarette ends, headwear and gloves, tools or hair. Urine or faeces will only contain DNA if they also contain skin cells so these are not usually good sources to explore. The sample is used to check 16 markers plus the sex marker but the process is continually evolving in order to make it more foolproof.

Glass Evidence

Martin Cuffe explained that glass breaks in a very precise way and, as a result, the person breaking it will invariably have minute shards of glass on their person … shards that can be matched to the glass that was struck.

Fibres and Paint

As with DNA, clothing inevitably leaves traces on anything it touches. This can be used to place individuals at a crime scene. Paint is the same and this type of evidence is used when investigating car crashes.

Tool Marks

Every tool has individual marks on it that will be transferred to the surface on which it is used. These striations can be used as evidence linking a tool found away from a crime scene to the scene itself.

The whole point of the forensic investigation is to build up a picture of evidence taken from a crime scene or which can be traced back to it in order to prove guilt. Cuffe cited the example of a house break-in that took place in 2009. By linking the evidence left on a crowbar to a specific man and linking the car seen leaving the house to one of his friends, a chain of evidence was created which resulted in the successful prosecution of two men.

Questions were invited from the audience on the subjects of:
Footprints being as individual as fingerprints
Firearms – Cuffe said this was a massive subject but did make the point that there are very few firearms incidents in Gloucestershire. Most of those there are relate to guns being stolen.
Electronic records and how they are made tamper-proof.
Taking evidence from children – Cuffe explained that this requires a totally different methodology and that there are special centres where children may be dealt with. Appropriate adults are always present at such times. Generally speaking, the police do not like to keep juveniles in custody so different rules apply. The audience showed its appreciation and Martin Cuffe was thanked for his very interesting talk.

Patricia Main

28/10/21 and 23/11/21 : Visit to The Incinerator, Javelin Park.

With the COP26 climate conference about to start, October 28th was the perfect day for your editor to join Science and Engineering 's visit to Gloucestershire's controversial waste incinerator at Haresfield. You must have seen it, either as you pass junction 12 of the M5 or even in the distance from Stinchcombe Hill. Its use encapsulates the current debate. The contents of your grey wheelie

bin, hopefully everything not recyclable, which previously was tipped and buried as landfill, is now burned. Our local environment benefits but globally, CO_2 levels increase a bit from what is essentially a fossil fuel power station. Urbaser, Europe's third largest environmental services provider, in partnership with Gloucestershire County Council, operates the plant, commissioned in July 2019 after legal challenges. It was a climb of eight flights to the classroom and visitor centre, were Education Officer Di Green told us more. The site processes 97% of the county's previous landfill waste to provide a continuous supply of electricity for about 25,000 homes.

With PPE donned, we began the tour, realising why we were at the top of the building as we looked

down into the tipping hall. Here, a double-length container lorry, one of over 100 deliveries a day and full to the brim with waste, weighed in and out, cautiously backed into one of several narrow openings in the concrete wall and dropped a revolting residue of rubbish into a cavernous, below ground, bunker. There, a plethora of used nappies, food wrappings and the odd old sofa or mattress were mixed by giant grabs. The stink from the pit permeated the site. Every 10 minutes, the grabs hoisted a load up and out into the feed chute to the combustion grate.

Descending down we glimpsed, through shielded windows, a hellish blaze, 850°C plus. Burning on the grate takes an hour, and the residual ash is collected out of the bottom. Any larger bits of metal (the odd cutlery, garden tool or coins) are separated before the ash, 40,000 tonnes a year, leaves site by lorry for a specialist plant were even more metal is recovered.

What is left is used for road construction. The hot flue gas passes over water filled boiler tubes (photo left) to produce high-pressure steam for a turbine-generator (photo right) , electrical output 16.5 MegaWatts (MW). A net 14.5 MW is supplied direct to the grid, said to be equivalent to 17 land based wind generators. Steam is recycled in a closed system by use of an air-cooled condenser.

Flue gases are discharged to the atmosphere after cleaning and filtration. Ammonia is used to abate harmful nitrogen dioxide. Hydrated lime reduces acid emissions. Any dust particles are trapped in bag filters. These are cleaned as necessary and the residual ash treated elsewhere. The plant has strict emission limits set by the Environment Agency, who receive online updates every 15 minutes. Local communities have their own monitoring equipment, and have reported no significant increase in pollution, only noting a general decrease during the lockdown from the nearby M5.

Urbaser seem happy with the economics. 80% of income comes from the £100 per tonne charge for waste and the other 20% from sale of the electricity, which, we were told, goes direct to the County Council. Throughput is capped at 190,000 tonnes a year but even so the plant will pay for itself in less than 10 years. No figures were however available for the annual amount of CO_2 released to the atmosphere.

Brian Gornall

23/9/21 Visit to the Wave

On the 23rd September 2021 17 members from the Science and Engineering Group headed south to Easter Compton to experience a day out at "The Wave". We arrived at a large car park next to a farm shop where we were greeted by a member of staff. "You need to walk over there," she said. The destination was a building 1,000 metres away, reached by a level concrete footpath. As we walked we chatted catching up on our first S & E visit for over a year. Surfboards were being carried by their owners to and from the facility, some on skateboards.

We arrived at the club House, where we were welcomed. The civil engineering firm Hydrock had completed this first inland surfing destination in the world in 2019 at a cost of £30M. One of their civil engineers Adam gave us an informative talk. The owner wanted a site near Bristol where people could surf all year round. This site was chosen because of the geology, although this resulted in the facility being a long way from the car park. The large car park had been built many years ago to provide a show ground and parking for the farm shop and cafe. The planners would not allow a new car park. Being on a flood plain, the ground water contour was challenging. After removing 40,000 cubic metres of soil, the shape of the wave floor known as Bathymetry, was formed by 520 large differently shaped concrete slabs. These intricately shaped slabs were highly polished to improve the waves and to reduce algae growth.

The motor room houses 40 motors and 40 paddles, the design of these is rather secretive. These drive the water up a reef to create a series of waves. Many different waveforms are available. The

slightly chlorinated water enters the lake via a 300mm diameter pipe and costs about £30K to fill, taking 2 weeks. It is planned to empty the lake about every 5 years for maintenance.

We thanked Adam for his informative talk and then visited the lake to watch the surfers. We viewed both from the sides and from the central pier. There are up to 1,000 waves per hour, with short breaks every few minutes to allow the surfers to get into position. We were informed that typically a surfer could experience as many waves in an hour here as could be expected in one day at the seaside. The surfers choose which side to surf on dependent on which foot leads on their surfboard.

We felt that we were at the seaside with the sound of the waves breaking and so many people walking around in wet suits. The cafe welcomes barefooted surfers in wet suits. The facility was designed for youngsters with mental and physical problems. There is not a single step between the far away car park and the lake. It was easy to see how being there could help with anxiety.

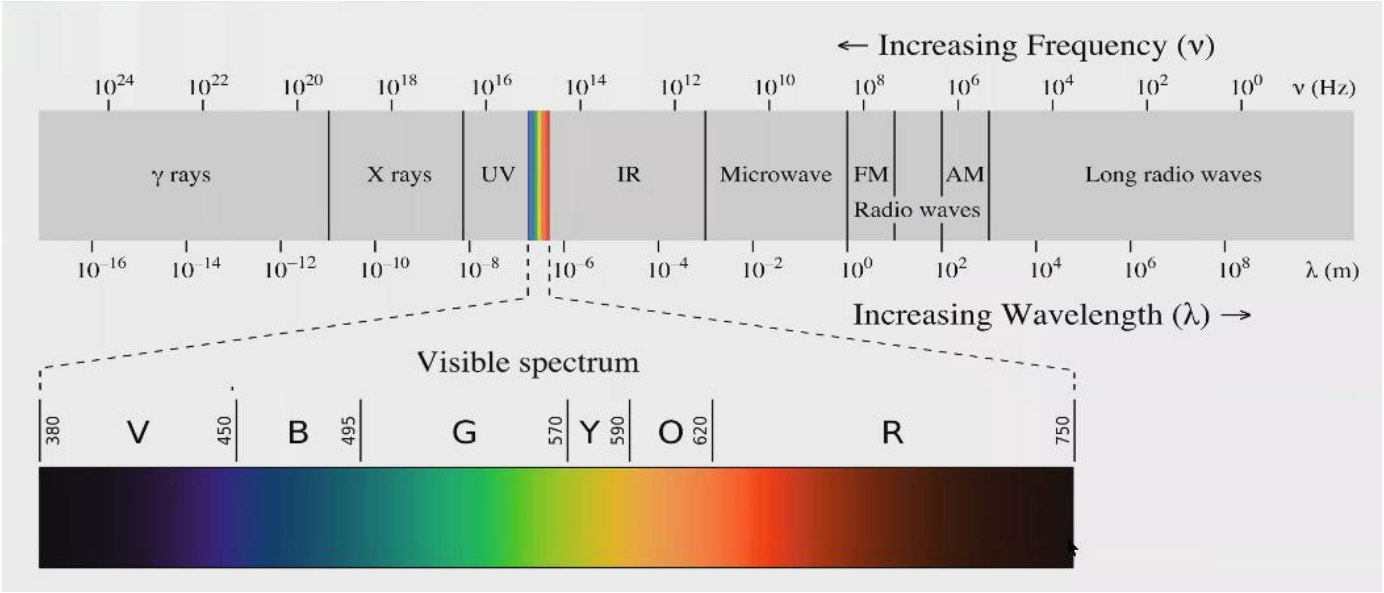
The site has camping facilities where serious surfers come and stay for more than a week at time. Beginners are given wet suits and boards, then instruction and stay at the shallow end on the much gentler waves, to learn how to balance.

We had a prolonged sit in the cafe enjoying socialising before making our own way home.

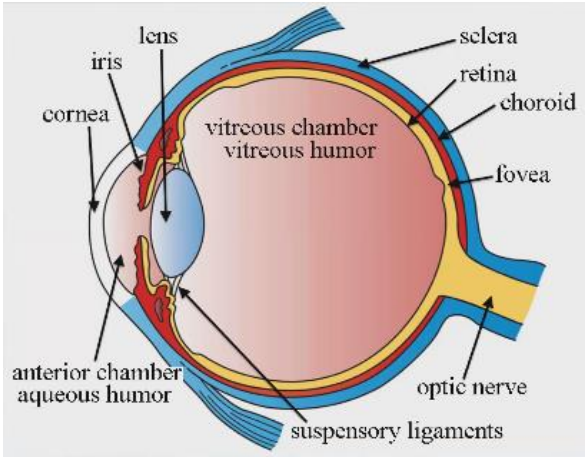
Paul Sheppard. Photos by Dave Messenger.

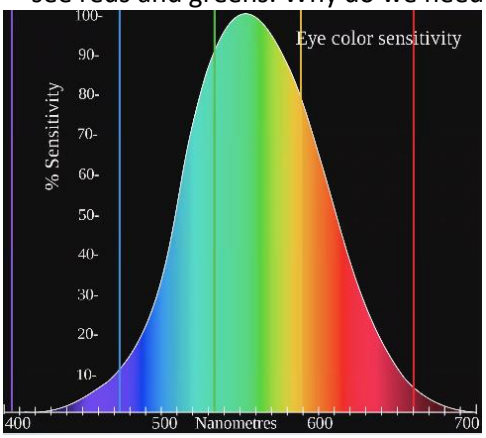
<u>27/5/2021 Zoom Talk: The perception of colour by Leigh Edwards</u>

A select group of Science and Engineering group members tuned in to Zoom to hear Leigh Edwards talk about colour. Light is one small part of the electromagnetic spectrum. The primary colours of light for humans are red, green and blue. Although humans can see the colours of the rainbow, other animals don't necessarily have the same range. For example, honeybees can see ultraviolet light. Humans are more sensitive to green colours, and less to red and blue.



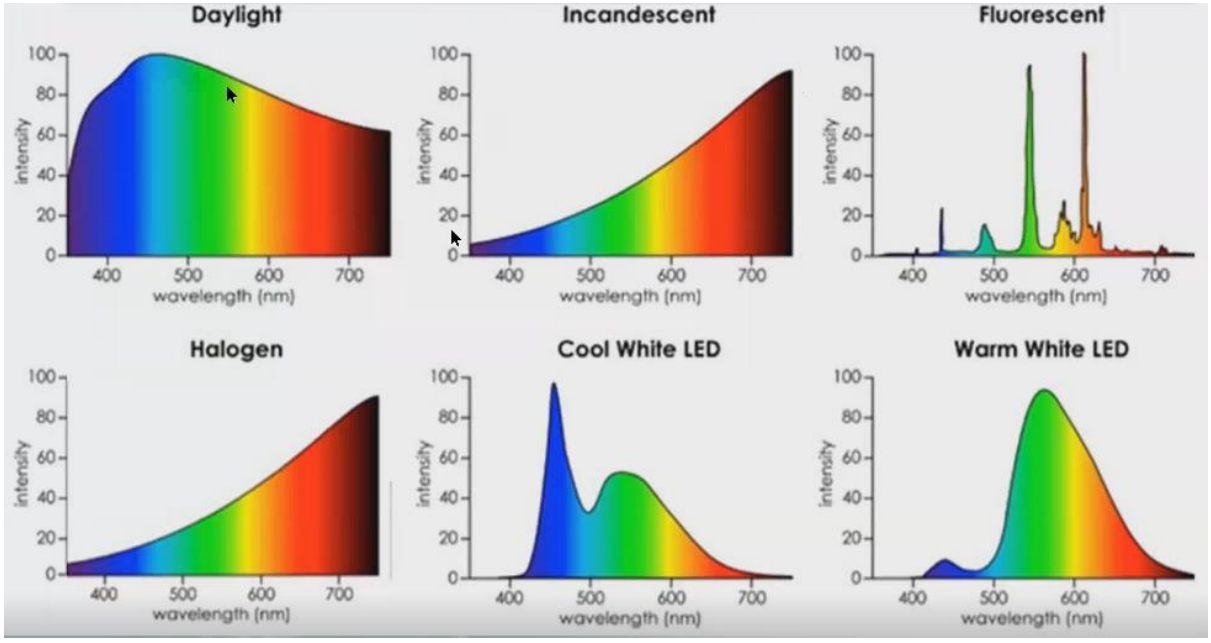
When white light strikes an object, the colour we see is what is reflected to our eyes, and not what is absorbed. So a green leaf absorbs all colours except green. The retina at the back of the eye is light sensitive and is about the size of a 10p coin. It contains rod cells and cone cells. Rod cells are sensitive to light levels, and cone cells are sensitive to colours, but don't work in darkness. About 12% of women have an extra cone cell that is sensitive to colours between red and green. Most people can distinguish between 10 million different colours. The human eye is most sensitive to green colours. Other animals are different – some birds (eg pigeons) can distinguish 10 billion colours. Dogs don't see reds and greens. Why do we need to see in colour – to be able to distinguish things, rather than just seeing in black and white.



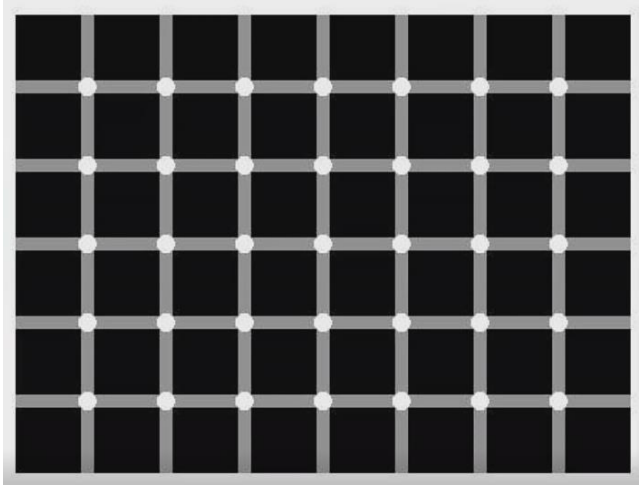


Colour blindness is genetic, with 8% of males and ½ % of females having colour vision problems. It is caused by an X chromosome defect, and as females have 2 X chromosomes, they have less likelihood of a problem. Test panels can be used to determine the different types of problems, with red-green being the most common.

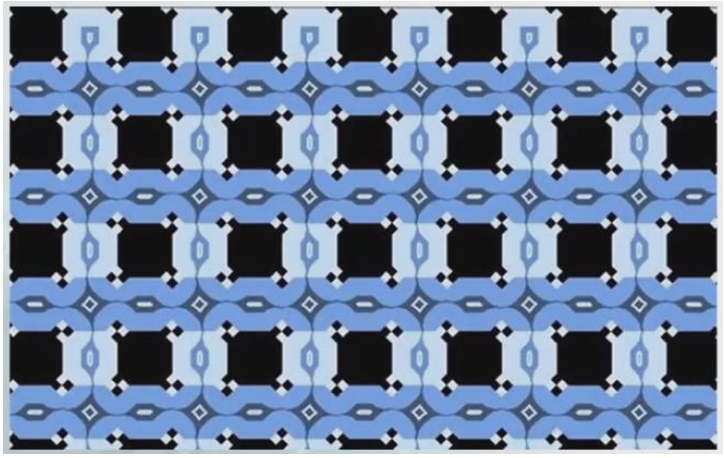
Different types of lighting emit different ranges of colours – see chart.



Different minerals are used to make colour pigments. The colour comes from imperfections in the crystal lattice. For example, minerals that have been used are Iron oxide, charcoal, mercury ore, lapis lazuli. Plants have also been used – e.g. woad
The talk finished by demonstrating some optical illusions.
Try counting the white dots! Or are they turning black?



There are only straight lines here.



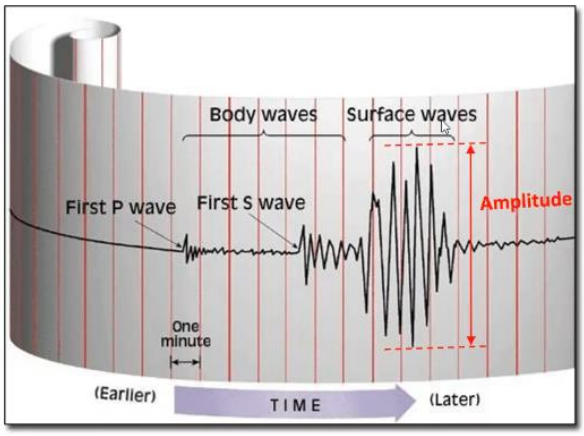
Graham Ellis

<u>21/4/2021 Zoom Talk: Earthquakes - why they happen and how they are measured by Peter Webb</u>

If you have wondered if a major earthquake could happen in this area, this talk was reassuring and showed why it is very unlikely.
The earth's crust consists of a number of plates that are moved by convection currents beneath the crust. They move at a rate of between 1 and 5 centimetres per year. Where the plates collide one of the plates goes beneath the other and is a zone of weakness in the crust. This is not a constant movement and eventually as pressure builds up one plate moves abruptly against the other and causes an earthquake. Also mountains are formed where the plates converge eg the Himalayas. Where the plates are

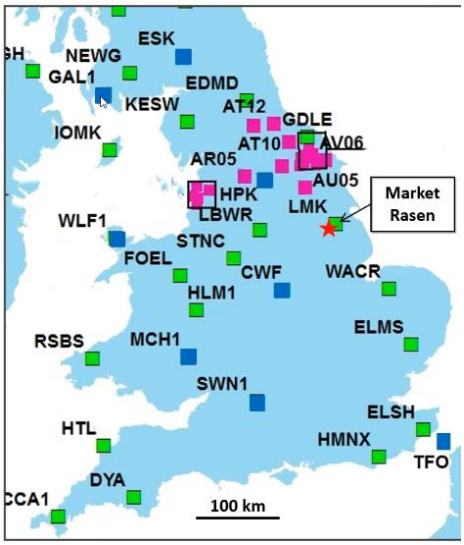
diverging, rift valleys are formed and molten rock wells up into the rift eg The African Rift Valley. When the locations of earthquakes are mapped, they can clearly be seen to be concentrated around the edges of the tectonic plates.

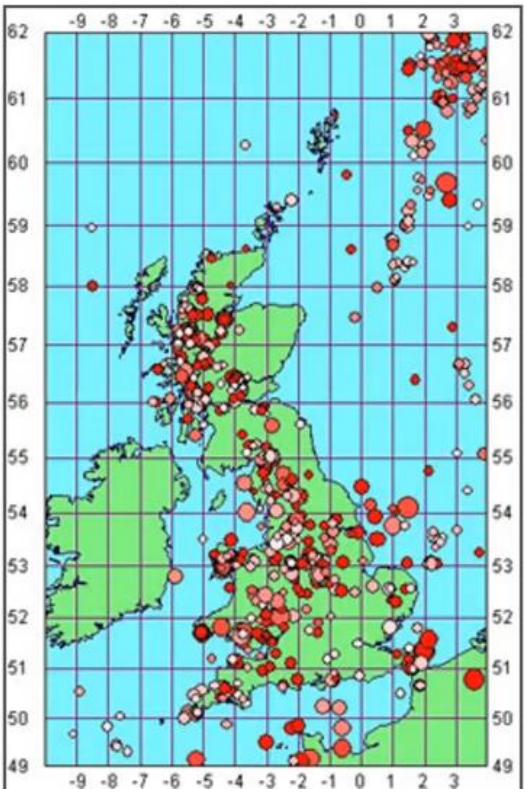
The place where the earthquake happens is the focus, and the area at the surface directly above the focus is the epicentre. The focus of the earthquake can be up to 70 kilometres below the epicentre. As the earthquake takes place waves radiate out and they reach the epicentre first. The movement at the surface can be vertical or lateral. The San Andreas Fault in California is a well-known area for lateral earthquakes as two plates slide against each other.



There are 3 types of waves generated by an earthquake. The first are P or primary waves. These only last for a short time and vibrate in a vertical plane. These are followed by the S or secondary waves, which last longer and vibrate from side to side. They move more slowly than the P waves and can cause a number of shakes.
The third kind of waves are known as the Surface waves and are subdivided into two kinds, the Rayleigh waves which have a circular movement in a vertical plane and the Love waves which have a circular movement in a horizontal plane.

Earthquakes are measured using 3 seismometers at a known location. One records in the vertical plane and two in the horizontal plane ie north south and east west. The earthquake is recorded on a drum of paper and so the magnitude of the earthquake can be determined.
The Richter Scale records the magnitude of the energy released and each earthquake has its own unique value. The Mercali Scale records the intensity of the quake based on the damage done. It is only useful in populated areas. From the records by using the readings from 3 seismometers the epicentre of the quake can be determined. Map (right) shows monitoring stations.





It is important to measure earthquakes for various reasons.
Insurance Companies use the data to decide the premium for policies in earthquake zones and Planning Authorities can be helped make decisions based on predictive models as to the damage that might be caused by earthquakes in the future.
In this country, small earthquakes occur once every few months, but are so small that they cannot be felt (See map left). Large quakes happen rarely, approximately once every 10 years and even these are minor on the global scale of earthquakes
An earthquake that some of you may have felt, occurred at midnight near Market Rasen on 27th February 2008. This was measured at 5.2 on the Richter Scale. The largest earthquake recorded in the UK was in 1932 and measured 6.2 on the Richter Scale. Its

epicentre was offshore on the Dogger Bank and only caused minor damage onshore.
So rest assured, we are not in danger of being devastated by a massive earthquake but may find that pots rattle if one occurs!

Barbara Davis

25/3/2021 Zoom talk by Sam Hatfield on "The quiet revolution in numerical weather prediction".

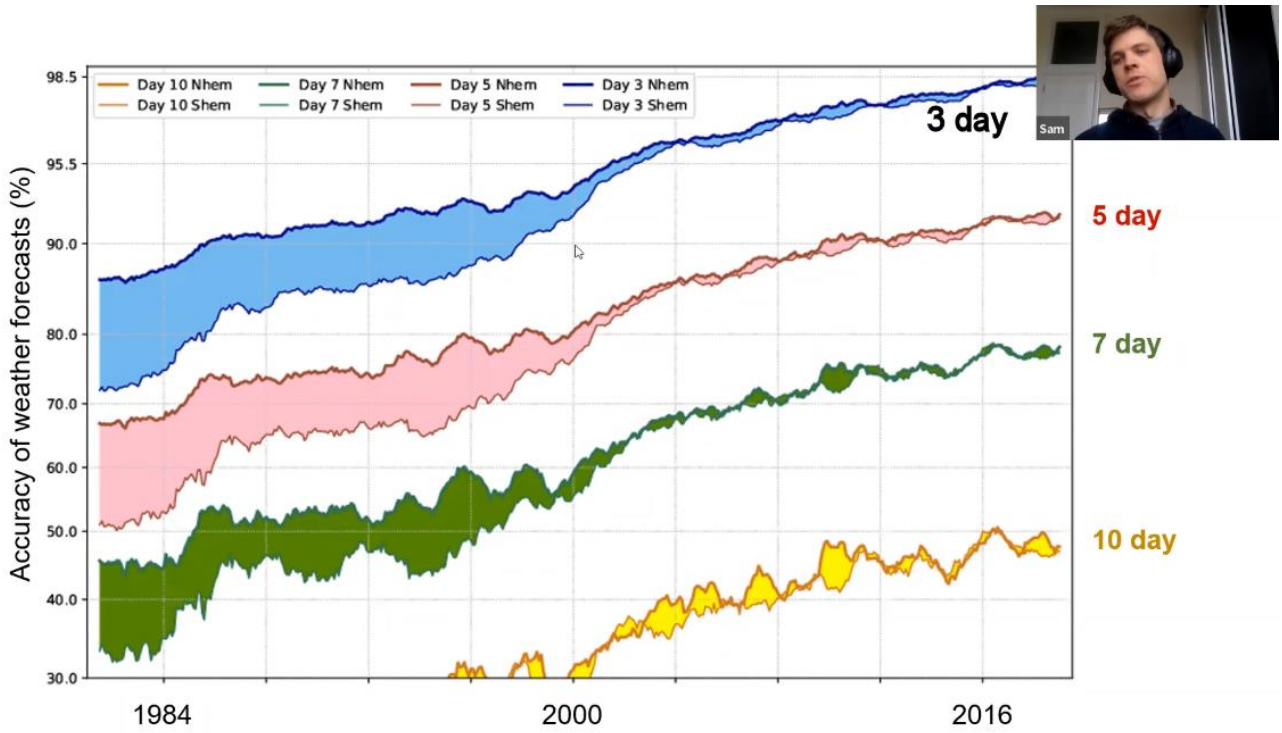
Sam, highly qualified in the world of meteorology, works at The European Centre for Medium-Range Weather Forecasts, Reading. He took us on a journey from the origins of weather forecasting up until today, and what to expect in the future. He named his talk "The quiet revolution in numerical weather prediction" as predictions have slowly improved over the last 50 years.

Humans have always been interested in the weather. The first major step forward was in 1667 when the barometer was invented. Humans discovered that air pressure changes and low air pressure might signify bad weather, and high-pressure good weather. The 17th and 18th Centuries saw the introduction of weather stations. Then followed weather buoys at sea, balloons and satellites all contributing to an improved forecast via synoptic charts.

Hurricane "Sandy" battered the east coast of America with powerful winds and storm surges. Damage was estimated at 70 billion dollars. This hurricane had been predicted 8 days earlier allowing contingencies to be put in place, cancelling trains and aeroplanes. Although 200 lives were lost this figure would have been far greater without the accurate prediction.

Lewis Fry Richardson (1881-1953) introduced an algorithm to create a forecast in 10-minute blocks. He created a system of grid squares over a map and used weather observations in each grid square to create the forecast from his algorithm. He repeated the 10-minute forecasts until he had a 6 hour forecast. This was labour intensive (it took him 6 weeks) as there was no electronic assistance at that time. It was initially inaccurate due to poor input data.

In 1949 the first large electronic computer was developed. This consumed enormous amounts of electrical energy with memory 100,000 times slower than a smart phone. Computers have continued to increase in size since. Sam pointed out that a computer having infinite size would still produce only a forecast and cumulative small errors could change the outcome dramatically. "The butterfly effect". A 7-day forecast today is as accurate as a 3-day forecast in 1984. (See chart).

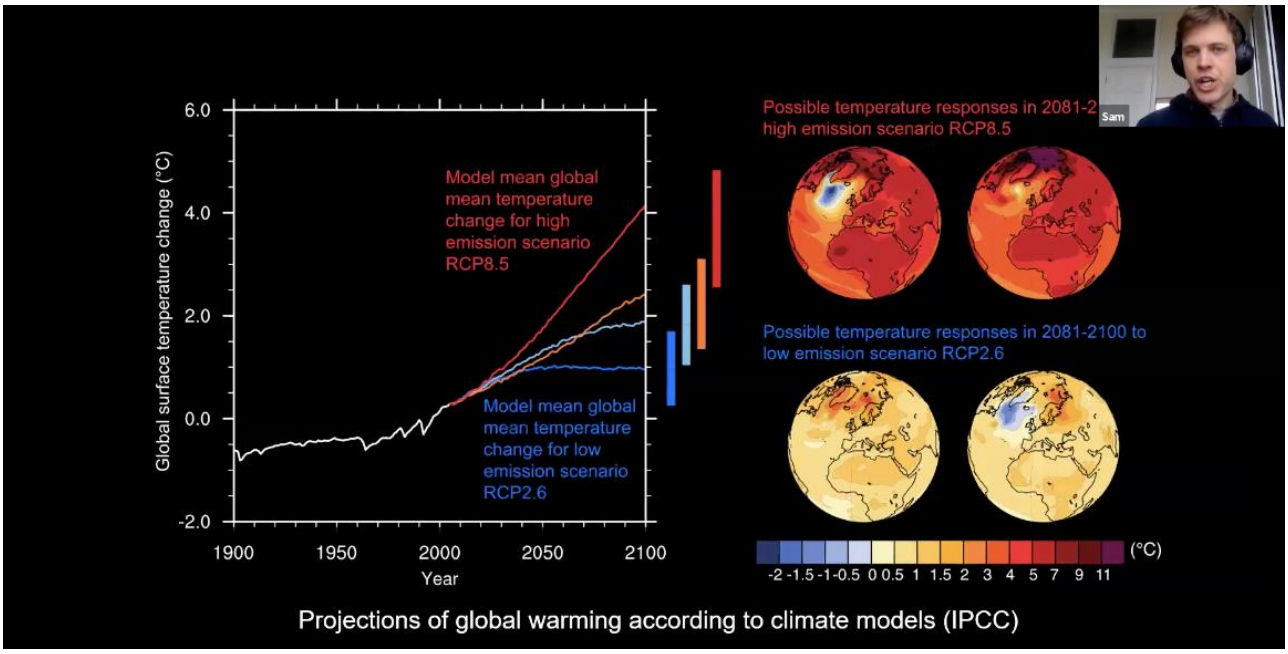


The quiet revolution of numerical weather prediction (Image: ECMWF)

The upper lines represent the northern hemisphere, and the lower are the southern hemisphere. They converge around 2000 as satellites improved the data recorded in the southern hemisphere. Roughly, there is an improvement in the forecast of 1 day per decade. At the moment 2 weeks is the best we can predict. Although the European centre has its own computers, they book time elsewhere - Japan has some of the most powerful meteorological computers today, so it is beneficial that Sam speaks some Japanese.

Seasonal forecasts 3 to 4 months ahead cannot predict the weather on a particular day. They may indicate a drought or monsoon that would be invaluable for farmers.

Climate change is inevitable, a useful chart shows that the increase in temperature is likely to be between 1°C and 5°C over the next 50 years.



Projections of global warming according to climate models (IPCC)

An interesting and well-presented talk illustrating the thousands of lives that have been saved through improved weather prediction. This prompted the 24 members to ask some interesting questions. We now know that the meteorological office no longer have the fastest computers. That the infamous Michael Fish broadcast introduced additional funding, and that newspapers change the words provided to them by the met office. Finally, Graham Ellis gave a vote of thanks for an excellent and interesting presentation.

Paul Sheppard

<u>25/2/2021 Zoom talk by Mike Hollingsworth on "How were medicines discovered"</u>

On 25th February, 17 members of the Science and Engineering group enjoyed an extremely well presented talk on "How were medicines discovered" by Mike Hollingsworth, U3A Subject Adviser for Science, who had been a pharmacologist at Manchester University.

Mike explained that he would be talking about the history of morphine, aspirin and penicillin. Pretty well all of us have been treated with at least one of these. He said that three factors usually applied in their discovery and development – Chance, Inspiration and Perspiration (hard work).

Morphine is an extract from the opium poppy. It was first described by Ebers Papyrus in 1550 BC; Hippocrates (called the father of medicine) described it, as did Al Razi a late 7th century Persian. In 1805, Frederich Serturner extracted crystals of it, which he termed Morphium, after Morpheus, an ancient Greek god associated with sleep and dreams (because he had ingested some himself, causing him to sleep for 24 hours)! The invention of the hypodermic syringe in 1850 allowed controlled doses.

The opium poppy was grown in India and used, to their disgrace, by the British in bartering for tea in China, leading to the Opium Wars of the 1840s and 50s. The German chemical company, Bayer, saw that it could be used for medicine and called the product they developed for treatment of tuberculosis "heroin".

Researchers in the 1970s investigated how the plant affected humans and how morphine worked, by stimulating in a test tube a piece of Guinea pig intestine, and later a pig's brain. They found that it acted on the nerves and reduced any feeling of pain. It was found that just 15 mg of a by-product, etorphine, is enough to bring down an elephant and would certainly kill a human being. In modern post-operative treatment, a patient can control by button a self-administered dose.

Willow tree (*Salix*)

Aspirin, the most widely used of the three, was identified by Hippocrates as an extract of the bark of the willow tree. It is more of use for the treatment of inflammatory-type pain. In 1758, it was used in clinical trials with his parishioners by Rev. Edward Stone. In 1830, the Swiss Johann Pagenstecher identified salicylic acid as the active ingredient. Felix Hoffman, a chemist with Bayer, found it treated his father's rheumatism without causing stomach pain. The name derives from A for Acetyl, SPIR from its plant origin (Spiraea) and IN to complete it. George Nicholas, an Australian pharmacist, made some during the First World War and, because the original name was of German origin, called it Aspro.

In the 1970s, John Vane determined how it worked – blocking enzymes, reducing pain and fever and reducing blood-clotting in small doses. for which he was awarded the Nobel Prize in 1982.

Mike opened his history of Penicillin by mentioning Louis Pasteur and a German scientist, Herman Koch, as doing pioneering work on the theory that germs were the cause of diseases – prior to that, infection had been thought to be carried through the air. This gave a scientific foundation to the work of Alexander Fleming in the late 1920s. One day he had spread some agar jelly on a glass dish with bacteria and nutrients. He left the lid off and went away on holiday. When he returned, he found that a fungus had formed on the edge of the jelly and the bacteria bordering it had died. He asked himself why.

Louis Pasteur

Ernest Chain and Sir Howard Florey, working at Oxford University in 1938, were able to identify the fungus and called it penicillin. They grew the culture in bedpans (!) and proved its effectiveness on mice. The first human on which it was tried, in 1941, was Albert Alexander, a policeman who had developed septicaemia from a pricked finger. As there were no facilities in the U.K., mass production was carried out in the U.S.A. by Pfizer, then a soft drinks company that understood fermentation.

Penicillin was first used on a large scale on 200 victims of a nightclub fire in 1942. By the end of World War II, enough had been produced to treat members of the armed services. A derivative, Benzylpenicillin, needed to be applied by injection and was found to be effective against a limited range of bacteria. Semi-synthetic penicillins were available by 1958 – some could be taken by mouth.

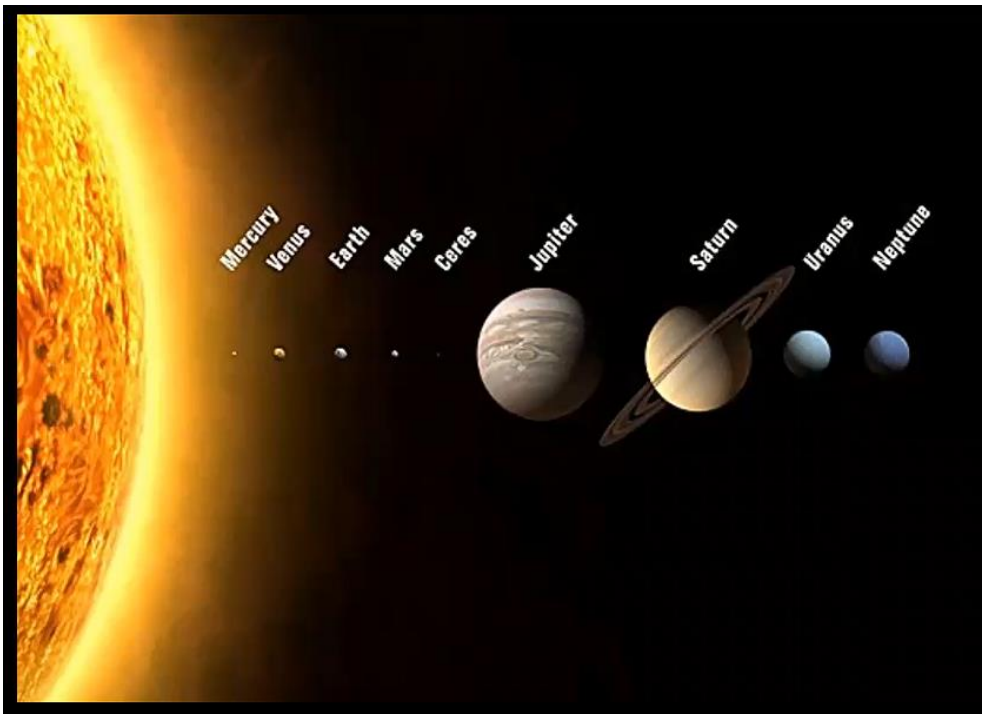
Penicillin prohibits the enzyme in the formation of the hard bacteria cell walls, thus preventing growth, but has no effect on human cells. Some bacteria, MRSA for example, are resistant to penicillins and it is necessary for them to act in concert with the human immune system to achieve destruction. The fear is that this situation may become critical in future.

After Mike Hollingsworth answered questions, Graham Ellis thanked him on our behalf for a most interesting talk.

John Morton

28/1/2021 Zoom talk by Martin Whillock FRAS about the Solar System

On Thursday at the end of January, we were miraculously transported through the Solar System and onward through the Milky Way to other galaxies and the visible edge of the universe. It only took 13.5 billion years or in lockdown time 40 minutes. It was the most exiting trip most of us have had recently apart from going to the Vaccination Centre. Martin Whillock FRAS from York who gave us the lecture wasn't very sure where Cam and Dursley was but he was very knowledgeable on the layout of the Solar System. We had a flying tour of the sun and the planets starting with Mercury through Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Little Pluto got a mention, as it was called a planet when it was discovered in 1930 but is now classified as a dwarf planet along with a number of other worlds.



We were informed by lots of statistics and images. For example, nearly all the mass of the solar system is in the Sun. Most of the rest is in Jupiter and the other worlds are only a very small proportion. In terms of liveability, Mercury is a bit warm with sun-side temperatures of +470°C and dark side temperatures of -138°C. Venus also has temperatures of +460°C and to make it more attractive the atmosphere pressure is 90 times a standard earth atmosphere. The lovely bright light it shows in our sky is reflections from the Sulphur Dioxide and Carbon Dioxide atmosphere. Lovely.

Fortunately, our Earth is temperate, protected by a magnetic field and suitable for life. Martin stressed it was the only place we knew of with life, even intelligent life. He thought the universe might well have other intelligent life but that we wouldn't meet it. He explained that Earth was

unusual in having a significantly large moon in relation to its mass and this provided seasons, tides and an iconic symbol in the sky.

We moved onto Mars, the predominant red colour caused by the extensive iron oxide. Temperatures were getting a bit more tropical here with night time temperatures only falling to -63°C but no real atmosphere. Martin told us of the highest mountain in the solar system, Olympus Mons at 17 miles above base level and the largest canyon, Valle Marineris at 4.5 miles deep and 3000 miles long.

Moving quickly to Jupiter that is 1000 times the size of Earth but mainly hydrogen gas. Jupiter has 67 moons of which the main ones are Europa, Io, Callisto and Ganymede. Next on the tour was Saturn with its 60 moons and magnificent rings. The rings are composed of rock and ice particles of different sizes but the depth of most rings is only 30ft even though they are miles wide.

Uranium and Neptune were quickly ticked off. Uranus discovered by telescope and Neptune by mathematical calculation.

Looking further out we delved into the Milky Way, our own galaxy and saw pictures of Andromeda which is what our galaxy would like if we could stand outside it. We delved into the constellation of Orion and his belt and in particular, the nebula or cloud of gas and dust that is one of the bright points of the belt. The "Pillars of Creation" shown here are 4 light years top to bottom.

Martin showed us pictures from the Hubble Telescope. The first space base telescope launched in 1990 providing new accuracy and depth in images. When it was pointed at a very small piece of sky, the size of a full stop as seen from Earth surface, a piece of sky that was previously thought to be empty; it imaged 1500 new galaxies. The universe is demonstrated by science to be 13.7 billion years old and we can look back about 12 billion light years.

The session generated some questions such as is there an outside to the universe and if the universe is expanding at the moment, will it start to contract at some stage. Martin side-stepped such so easy philosophical questions but was clearly able to answer questions relating to tidal locked moons and worlds and the formation of planets. He and some members stressed how interesting the Herschel Museum in Bath was and recommended that members should visit. Herschel discovered Uranus in 1781.

Mike Doughty