Leicester Grammar School's

YOUNG SCIENTISTS journal

More inside...

ISSUE 1 LENT TERM 2017

A Message from the Team:

"Even if the open windows of science at first make us shiver . . . in the end, their fresh air brings vigour and the great spaces have a splendour of their own". In the first issue of the Young Scientist's Journal in Leicester Grammar School's history, this saying of Bertrand Russell is precisely our philosophy: to open the windows of the wider world of science to the students within the microcosm of our school and to encourage them to explore topics, beyond the four walls of the classroom. Let me first explain to you, the brief history of how this magazine came into being. The venture started out with three students, Maria, Prab and I (also Maria!), united from all corners of the A-Level curriculum by a common desire to research, analyse and create. The Young Scientist's Journal is a global science magazine and so we were excited, if somewhat daunted, by the prospect of pioneering our own series of articles in school. Apart from the support and advice from Mr Reeves, our head of Physics, we were left largely on our own, in unchartered waters, to make a Science Journal for ourselves. Of course, we would need help. Through talking at the East Midland's Science Teachers' Conference and in our school assembly, we were not only able to cement the vision of what we stand for but also spread the word about this brand new project. One of our most exciting moments was having our own YSJ stall at the Big Bang Fair on 25th February, which received an astounding 3000 visitors to, where we were able to publicise the YSJ to students and teachers alike in the local community.

As LGS' YSJ team, we aim to promote the exploration of scientific topics and nurture a love for all things science related within an exciting, rapidly growing community of young thinkers. We also see it as extremely valuable preparation for university and careers in the scientific sphere. Factual recall is simply not enough in today's world, lateral thinking is being prized more and more and is, indeed, a fundamental aspect of science. We want students to discover what science really means to them, to explore topics which truly fascinate them and to delve into a level of detail, which goes far deeper than the school curriculum. Furthermore, our community is not restricted to the science fanatics alone and we have made it clear from the start that we need the writers, book-lovers, photographers, designers and media experts to make our magazine a success. I, for one, as a Classicist, am no expert in the land of quarks, leptons and bosons but have been equally excited by the plethora of investigations and reviews that we have received, spanning a whole range of subjects from cryptozoology to dyslexia to telemetry toasters. And it is at this point that I would like to thank all those who were involved in the creation of the first issue. When we organised our first meeting of the YSJ, quite honestly, we feared that no one would turn up, but the amount of enthusiasm and interest that so many students, spanning right across the year groups, have shown is fantastic. What began as mere rumblings in the minds of three sixth form students has now become a fully formed magazine, which we feel extremely proud and privileged to present to you. But this is only the beginning. We hope to expand our team, reach new heights with every issue and to kindle a community of passionate young people that will continue through the life of the school. So, please enjoy the host of weird and wonderful articles in this first issue and may there be many, many more opened windows to come. "

Maria Telnikoff — Chief-Editor

Articles in this issue:

Who are We?

We are a collection of Leicester Grammar School students who have come together to produce a variety of pieces of writing about the world of STEM. As a school, we have become a hub for the Young Scientists Journal, an international peer-review written and edited entirely by young people.

Contact Us

Anyone interested in joining the YSJ to help to write, edit and publish is more than welcome to meet us at our meetings during lunchtimes (specific details will be in the daily notices). We welcome submissions from all year groups on any scientifically-related topic; so come along to a meeting or email us at:

lgsyoungscientists@gmail.com

See more of the Young Scientists Journal at:

ysjournal.com

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Front Page Photo:

"I wonder where this leads to"

By Grace Mold, Year 6

Winner of "Discovery" Photography competition in Years 6-8 category

Dyslexia

A thoughtful discussion into Dyslexia's effects on a person and their thinking patterns by Tejas Easwar

Dyslexia is a common learning difficulty that causes problems with reading, writing and spelling. A common misconception is that dyslexia is associated with lack of intelligence, however this is inaccurate. Around one in every ten people will have dyslexia.

It was first recognised a hundred and thirty years ago in Germany, by an ophthalmologist named Rudolph Berlin. He had become inquisitive about a few patients who had difficulties with reading. He observed these patients were unable to read properly, nor use words in the correct order consistently. He introduced the word 'dyslexia' as a substitute for the word blindness. Dyslexia comes from the Ancient Greek dys (δυσ-) meaning difficult and lexia (λεξια) meaning reading. However this is not the first term used to describe people with literacy and learning difficulties. A plethora of words were used to describe this problem, such as strephosymbolia. It wasn't until 1994 that the Department for Education and Employment officially recognized the condition however.

Common signs and symptoms

It is worth noting that each case of dyslexia is individual and depends on the affected person. Therefore not all symptoms considered to be linked to dyslexia, necessarily mean you have it. Neither does it mean all dyslexic people have all these symptoms.

In general symptoms tend to include:

- Slow or inaccurate reading and writing
- Difficulty with comprehension
- Poor spelling and handwriting
- Mixing up similar words
- Milestones reached later
- Difficulty with speech
- Poor coordination
- Left and Right hand mix ups
- Illogical sequences of ideas
- Short Concentration span
- Struggles with planning and organising
- Scholastic under achievement

On the other hand, it's not all doom and gloom having dyslexia. Research has shown that those with dyslexia are more imaginative and thus excel: in arts, architecture, engineering, entrepreneurship, strategy and inventing new things. There are so many successful dyslexic people, most notably Sir Richard Branson, a self-made billionaire who founded the Virgin Group. 40% of all self-made millionaires are dyslexics and half of all rocket scientists working at NASA are dyslexic.

> **"Being dyslexic can actually help in the outside world. I see some things clearer than other people do, because I have to simplify things to help me and that has helped others"**
>
> *— Sir Richard Branson.*

Causes and Treatments

Dyslexia is mainly caused by a phonological processing problem. This means people with dyslexia do not have a problem with seeing the word itself but rather manipulating and understanding it.

Genetic causes are the main cause of the condition. There has been much evidence that dyslexia can be passed through family by a defect in the gene, called DCDC2. Acquired dyslexia occur in a minority of cases. They are caused by an incident after birth. Most common causes of acquired dyslexia are due to brain damage, strokes, brain injuries or other such traumas.

Currently there are no official cures for dyslexia. The most effective way to supress it as much as possible, is by learning to deal with it. Whether it means working harder and longer to learn something, or finding strategies to overcome the problems. Seeking help and talking about it is always easier than struggling and coping. No two dyslexics are the same: their difficulties, challenges and what they are good at, all vary. This is the underlying reason why treatments cannot be realistically produced. However, finding what you excel at, will help build confidence, and ultimately help. Persistence, patience and repeated effort will help develop strategies to deal with the condition.

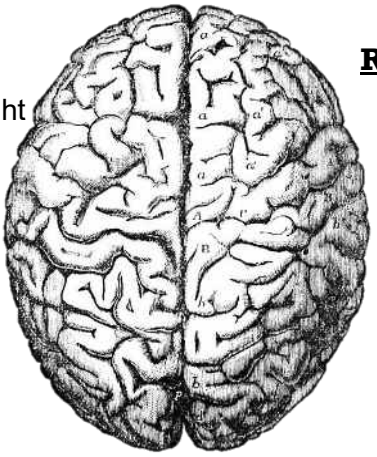
The Creative Aspect

It is well known that many dyslexics are very creative; Leonardo Da Vinci, Steven Spielberg, Walt Disney, Picasso to name a few. But why does this happen?

Our brains are designed with two main hemispheres; the left and the right. The left side of the brain is linked with numeracy, science and other such skills. Whilst the right side is related to more artistic and creative skills. MRI scans have shown that those with dyslexia rely more on the right side of their brains, than those without the condition (bottom right). Therefore, when reading, the electrical signals take a longer trip through their brains. This also means that while thinking, they use the more creative side of their brain, rather than the more accurate and analytical left side.

Left Side

Analytical Thought
Language
Science
Logic
Maths
Reading



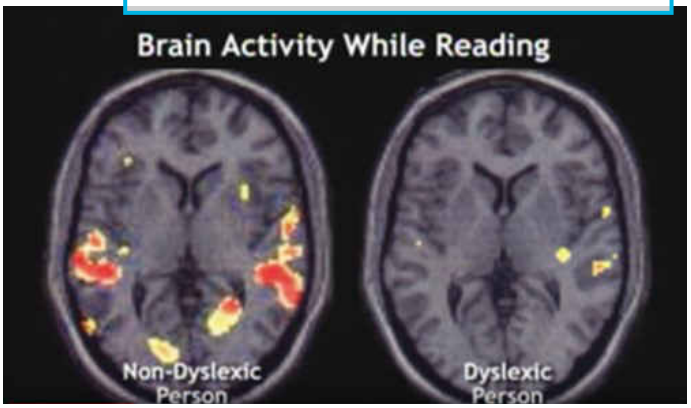
Right Side

Creativity
Intuition
Music
Arts

However those with dyslexia can physically alter their brains through hard work and perseverance. By using techniques that help decode, read and isolate areas of difficulty, those with dyslexia begin to use their left side of their brain more efficiently and their reading improves. Eventually the brain of a dyslexic will become almost normal, as the left side is actively being trained, thus dyslexia can be conquered.

Tejas Easwar

This MRI scan shows that during reading, comparatively a dyslexic has less activity in their brain and nearly all the activity is on the right side .

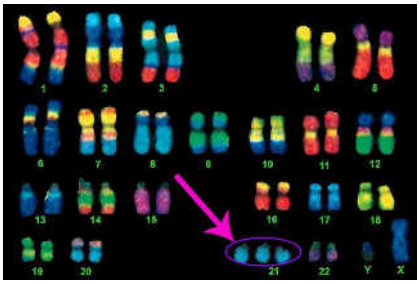


Tackling (the issue of) Down's Syndrome

Meghna Thakrar explores the reality of the commonly misconstrued condition that is Down's Syndrome and the up-and-coming research into it.

35 years ago, the average life expectancy of someone suffering with Down's syndrome was a mere 25 years. Now, it's 60. With 60,000 people in the UK alone suffering from Down's, the numbers are far from decreasing. However, with treatments constantly developing Down's syndrome is becoming globally recognised.

So what is the science behind this curious condition? Down's syndrome is essentially a genetic disorder caused by the presence of an extra chromosome. There are normally 46 chromosomes in a body cell, divided into 23 pairs of chromosomes; however, an error in cell division can cause three chromosome 21s to be present instead of the usual two (trisomy 21). This error, known as nondisjunction, occurs when an additional chromosome 21 is transferred to the sex cell. This is the most common cause of Down's syndrome, with 95% of sufferers developing the condition in this manner. And yet the cause of this remains unknown. The remaining cases are made up of 'translocation', where part of the additional chromosome is 'stuck' onto another chromosome, and 'mosaicism', in which some body cells are affected.



It is important to recognise that each individual living with the condition exhibits different symptoms and has differing characteristics to other sufferers. Those with the condition possess varying degrees of learning difficulties and yet are still able to lead normal lives with just with some difficulty. In modern day society, this idea is recognised and with more exposure, new treatments are constantly being developed.

Although there is no precise 'cure' for Down's syndrome, different therapies, such as speech therapy, and exercises can allow sufferers to lead more productive lives. Well-developed screening tests have also proven to be successful, for example, cell-free fetal DNA analysis, which tests the fetal DNA circulating in the mother's blood.

Despite progressions in treatment, scientists are still working on preventing the condition from occurring in the first place. It is thought that the drug 'Piracetam' may help in improving areas of the brain to process information but this drug is still to undergo monitored clinical tests.

Therefore, whilst progress is being made rapidly and the condition is finally being accepted, there is hope that there will one day be a cure.

Meghna Thakrar

What are black holes and are they a threat to humanity?

Suditi Chattopadhyay consolidates information on black holes to address the several questions the general public have on the complex matter.

A black hole is region of space where gravity is so strong even light cannot escape. They are similar to a vacuum in terms of the way they work because vacuums clean up all the dirt in the house and black holes clean the debris left in space. However, unlike vacuums which use suction, black holes use gravity to pull things towards it instead. The gravity is so strong in a black hole because lots of matter has been squeezed into a very small space.

There are three types of black holes, stellar, supermassive and miniature. Stellar black holes are formed when a large star has a gravitational collapse. Normally, a star has gravity pulling everything together and at the same nuclear reactions give heat energy to the star. This way the gravity and pressure are balanced. A problem develops when the nuclear fuel runs out. A supernova (when a star becomes really bright and undergoes an explosion which ejects a lot of its mass) occurs in the outer layer and the centre of it turns in on itself. This happens because now gravity is too strong and is no longer in balance by the nuclear reactions: creating a stellar black hole. A supermassive black hole is the largest of the three types. They are found in the centre of most galaxies and there is one in the centre of the milky way. Physicists are still unsure how these came to form but they think it might be a result of a dense cluster of stars collapsing. Lastly, there is no clear evidence to prove the existence of a miniature blackhole however, they may have been formed at the dawn of universe around 16 billion years ago. One theory of the Big Bang's origin is that it was due to lots of matter being squeezed into one point and, due to the pressure, this exploded and spread out really fast. Some matter spread faster than others so this was compressed into miniature black holes.

A simulation as to what the event horizon may look like.

There are three parts of a black hole, the inner event horizon, the outer event horizon and the singularity. The outer event horizon is the outer layer where gravity is strong but matter can still escape, the inner event horizon is the black hole's middle layer and here the gravity is very strong and no object can escape after it has entered this area. The singularity is the centre of the black hole where gravity is at its strongest.

Black holes are invisible because all light is pulled in by the strong gravitational force, so how can scientists see them? Since technology has allowed us orbit the region of the back hole, scientists can detect a black hole by monitoring the effects it has on the stars and the gasses around it because of the strong gravity. Also, a bright light is made when a black hole comes really near a star is which is another indicator and although this not visible to the naked eye, scientists use telescopes to see it.

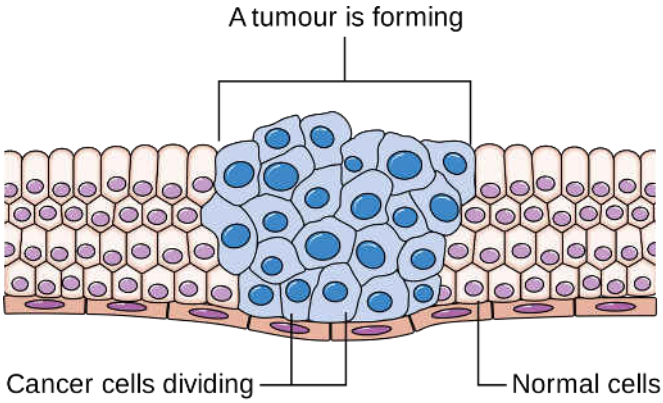
Black holes are not a threat. The closest black hole is the one at the centre of the Milky Way. It is approximately 2700 light-years away and will have a negligible effect to the solar system due to how far away it is, even though it is millions of times the mass of the sun. The Sun is not a threat of becoming a black hole either because it is simply not big enough. It is predicted that in many billions of years it will get rid of its outer layers and stop producing nuclear energy. It will become a dense ball made of oxygen and carbon (a white dwarf).

Suditi Chattopadhyay

The facts about Cancer

Christopher Snow informs us about the wide-spread condition that is central in today's healthcare treatment: Cancer.

Cancer is a condition where cells in a part of the body grow and start to reproduce uncontrollably. These cancerous cells can destroy and invade healthy tissue surrounding it, which include organs. The cancerous cells can then go on to spread to other areas around the body; the process of this happening is known as metastasis.



The three most common types of cancer in the UK are lung, bowel and breast cancer. However, there are over 200 different forms; each type having its own symptoms and treatment. Early signs of cancer can vary as there a several locations and types which cancers can form. But commonly, sufferers may have random lumps and rashes, changes in bowel movements and unexplained bleeding.

However, there is always a possibility that these symptoms are not caused by cancer, as there are many other non-cancerous health conditions that connect to these symptoms too. The exact causes of cancer are still not comprehensively known apart from that DNA mutation is involved; many people try to reduce their risks of developing the condition by eating healthily, exercising regularly and not smoking.

Treatment varies depending on the type of cancer: Chemotherapy is used against cancer that cannot be surgically removed and kills the cells in the area around the tumour. Radiotherapy (X-rays) are also used to kill tumours. Cancer normally develops over several years, but when found early on, the success rates of treatments are significantly higher.

Lung Cancer

This is one of the most common cancers in the UK partly due to its link to smoking. Approximately 44,500 people in the UK are diagnosed every year. Symptoms for lung cancer are not prevalent early on. If left till later stages, people experience symptoms of:

- Coughing up blood
- Persistent breathlessness
- Unexplained tiredness and weight loss
- Difficulty breathing

There are two forms of lung cancer, when the cancer starts in the lungs: Non-Small Cell which affects 80% of cases; Small Cell which is less common form but is more aggressive. Lung cancer is normally found in older people, aged around 70-74. It is rare for people aged 40 and under. Despite 85% of cases involve smokers, people who have never smoked can still be at risk.

As is general for most cancers, if it is caught early on, when the tumour is small, surgery can be performed to remove it. If physical health results in surgery not being feasible, radiotherapy is used to destroy cancer cells. If the cancer has spread too far for the first two treatments, chemotherapy is used, which is a higher risk for the patient, but a more aggressive treatment.

A radiotherapy machine used to fire X-rays at tumours to fight the spread of the cancer

Lung cancer is reasonably treatable for a cancer, but unfortunately 1 in 3 people who are diagnosed live only for a year. However, 1 in 20 who are diagnosed live for 10 years and have a better chance of recovery from the three treatment options listed, than sufferers of other forms of cancer.

Bowel Cancer

Bowel cancer is found in the large intestine. This form of cancer is more commonly found in men and women over 60. The noticeable symptoms are constant changes in bowel habit and abdominal pain. The symptoms can be minor and due to their simplicity, they can be easily misdiagnosed. The symptoms can also be random so it is important for people to be wary of the symptoms as they grow older.

The factors found to increase chances of developing bowel cancer include:

- Age – Around 9/10 cases will occur in people aged 60 or over
- Diet – Diets high in red or processed meat and a low fibre intake, increase risks.
- Weight – Bowel cancer is more common in people who are overweight or obese.
- High alcohol intake and smoking.
- Family history – if members of your family have been diagnosed with bowel cancer aged 50 and under, then you may be at higher risk of developing it too.

Again, like lung cancer, there are three main treatment options, however due to the discrete nature of bowel cancer, chemotherapy is usually needed to battle the tumours as they are usually found in late stages of cancer.

Breast Cancer

This form of cancer affects all women but risk increases with age. Around 1 in 8 women are diagnosed with the cancer at some stage in their lives. If caught early, there is a good chance of recovery. Symptoms include:

- A change of size in one or both breasts
- Discharge
- Presence of a lump or rash

Breast cancer can be both invasive and non-invasive (whether it spreads the cancer to other parts of the body). Furthermore, there can be forms which are significantly more aggressive and inflammatory, but each individual case can differ as with most cancers. Therefore the treatments can vary vastly, but surgery generally tends to be more common as it is potentially less damaging than chemotherapy or radiotherapy.

For more information please visit the official NHS website: http://www.nhs.uk/conditions/cancer

Christopher Snow

The Big Bang Science Fair

An overview of the events at this year's Big Bang Science Fair, from the point of view of one of the school's STEM ambassadors, Keerat Singh.

February 25th 2017 marked the third - and by far the most successful - Big Bang Fair event held to date at Leicester Grammar school. With over 3000 visitors passing through the school, it is sufficient to say the corridors were filled to breaking point! Yet this did not seem to stop anyone from enjoying themselves and experience all that there was to offer. Speaking of which, LGS was honoured to play host to many prestigious institutions such as: the Universities of Leicester, Sheffield and Nottingham; the Royal Society of Chemistry, who ran a wide range of brilliant exhibitions; Medical Mavericks; representatives of the Young Scientists Journal; representatives of St. John's ambulance and the Leicestershire police tactical unit; the library zoo (for want of a better description); a helicopter; and not to mention the numerous, hard working STEM ambassadors, who have told me that the fair was an "unforgettable experience", but the list goes on.

[N.B. It is important to mention that the STEM ambassadors were LGS sixth form students who had volunteered to help in this event after thoroughly preparing for it for the past six months!]

(Above) One of the STEM Ambassadors' stands involving "slime", a non-Newtonian fluid made from corn-starch. (Left) Letting visitors light a bubble of methane on fire in their hands!

The exhibitions arranged by the STEM students, myself included, were also wide ranging. I worked with Daniel Scudamore on the Van de Graaff generator, which was extremely popular and never failed to entertain both children and parents alike. This was especially true when the children got the chance to "electrocute" their parents, something I am sure we would all find quite entertaining! Another experiment which was equally popular, was one involving balloons and skewers. However, this station required at least two people to man and another two to blow up

balloons. This meant that, whilst I did (grudgingly) agree to blow up balloons for close to half an hour, overall I enjoyed being able to work at multiple STEM exhibitions, trying new and different experiments.

From the rest of the exhibitions, some personal favourites of mine were the meerkats in the library, something I felt fortunate to see as I have never done so before. Also, the discussions I had outside with the tactical unit officers, who were more than happy to talk about some of their experiences, were truly unique moments. However, although not particularly scientific there were some very memorable events that the day. One of which, was when the small electric shock from the generator I was working with caused a young girl to cry; luckily, Miss Allcoat jumped to the rescue and made the young girl laugh once more. My favourite part of the day was being able to relax, after what was an interesting, yet somewhat difficult experience, and think over all I had learnt with a pleasant Chocomilk in the staff room. This combination of reflection and Chocomilk did come close to topping my list, but, in the end, it was the words of one parent. She was delighted after her son had been successful with the generator, and then told me she sincerely hoped I was successful in whatever I choose to do in future, with a grand smile. Thus, this Big Bang Fair at LGS has impacted all involved in many positive ways, but it is the contentment you feel after connecting someone to the world of science that stays with us long after.

Special thanks go to all the LGS STEM ambassadors, staff and especially to Ms. Patterson and Dr. Fulton who were instrumental in running and planning the event. My thanks also extends to the multitude of zealous and dedicated institutions, mentioned above, who spent their own time and energy to passionately represent the very embodiment of science, technology, engineering and mathematics. They were, and continue to be, an inspiration to many of the visitors to LGS, including myself, and enabled the Big Bang fair at LGS to be so successful and smooth in its course.

Keerat Singh

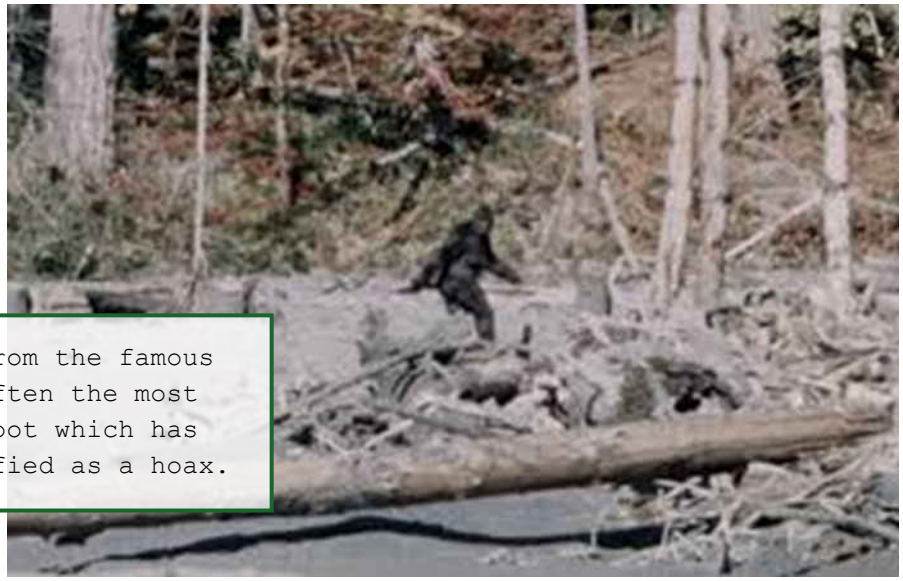
A science show to demonstrate some of the fundamental laws and discoveries in science, as well as some fire for "added effect".

Cryptozoology: More than Pseudoscience?

Andrew Higginson investigates into the validity of the pseudoscience upon which many urban legends rely on to be considered feasible: does Cryptozoology have any merit?

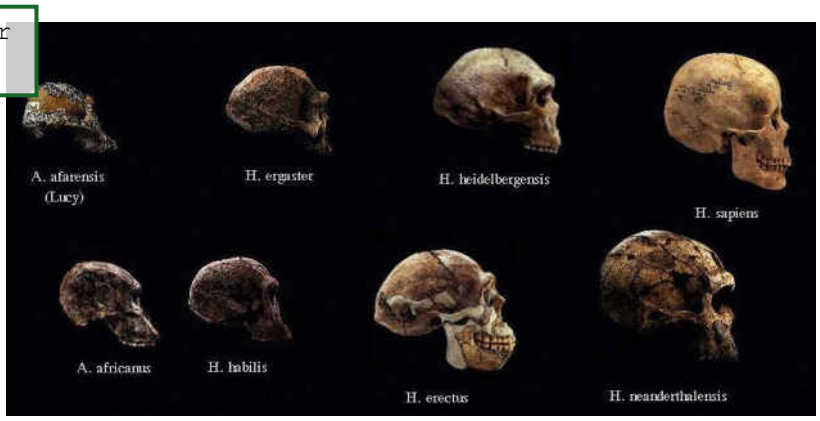
Cryptozoology is the study of creatures from folklore and eyewitness accounts, creatures not technically deemed to *exist.* Some notable famous examples include the Bigfoot, Yeti and Loch Ness Monster, but sightings of all kinds of strange creatures are reported all around the World; from isolated tribes in the Congo, to farmers in Arizona. It is a pseudoscience, not considered by the general scientific community to be worth their time. However, this subject had fascinated me for a while, and although I would agree that there is no solid evidence to support the existence of Bigfoot or a surviving Plesiosaur in a Scottish lake, I think that many interesting and valuable lessons can be learned from it; about the planet we live on, the human brain, the effects of mythology, and our capacity to be fooled by our own eyes. I think that all ideas deserve a fair hearing from science, and cryptozoology is far from the most crazy or unbelievable pseudoscience on offer. Cryptids (the name given to these creatures), while they do not exist, *could* exist within the parameters of human scientific knowledge. No fundamental rules of physics have to be broken to compensate for their existence. If they were real, then observation by the scientific method would be enough to validate them. Cryptids are generally considered to be just undiscovered animals, large and bizarre though they may be, and for this reason I find the concept generally more worth entertaining than all-out nonsense about ghosts and demons. This is not an argument for the existence of the Yeti; it is simply a few points on both sides of the debate, and my general thoughts on the matter. At the end of the day, the reader must make up their own mind, and if you are going by the scientific method, it is extremely unlikely that any of these creatures will ever be found, as they probably don't exist. But that doesn't stop them being interesting.

Let's talk about folklore. Human mythology and storytelling is some of the richest written or spoken material on earth; often revealing huge amounts about the culture it came from and the general outlook of the human mind. For example, there's a reason that so many different cultures around the world seem to victimise wolves in their legends, because historically a wolf pack would have been nothing but bad news. Livestock would have incredibly vulnerable, but even more so young children. So folklore associated wolves with evil, and perhaps this was just a natural process, or a more conscious decision to create stories to tell children that would keep them out of danger. After all, what child in their right mind would run out into the forest alone if they had been told terrifying stories about wolves, and even other monsters? This is where the cryptozoologists start to get excited. If wolves were incorporated into folklore because they were a real life threat, then why not Bigfoot? It seems an eerie coincidence



An alleged picture of Bigfoot, from the famous Patterson-Gimlin film of 1967: often the most widely quoted "evidence" of Bigfoot which has not yet been definitively identified as a hoax.

A comparison of the skulls from our early relatives/ancestors



that every native North American culture had stories about a very similar creature: a wild man of the woods that walked upright and was covered in hair. Even the word Sasquatch, another popular term for Bigfoot, comes from the language of the Salish people of British Colombia. Similarly, all around the world, whether it be the Yeti in the Himalayas, Sasquatch in Canada, Almasty in Mongolia, Yowie in Australia, Orang Pendek in Sumatra or even the trolls and giants of Scandinavia, cultures separated by great oceans, often isolated for thousands of years, with completely distinct languages, beliefs and traditions, all have stories of, essentially, a wild man of the woods. Surely that cannot be discounted?

But alas, just when everything seems possible, science likes to come in and slap you around the face, back to cold hard reality. Dragons are also common to European and Asian folklore. Does that mean that dragons exist? Cultures around the world also have common tales of ghosts, demons, deities and monsters, yet science does not recognise these things. Sadly folklore alone, while it may be fascinating, is not anything close to empirical evidence. Sorry Yeti hunters. There are many other, more rational explanations for these myths. They could be simply aspects of early human spirituality, stories invented by us, just like tales of magic and mysticism. The lack of any definitive evidence for the existence of Bigfoot trumps all other arguments, because until a fossil is discovered, or a dead body, or even a live specimen captured, there can be no debate. A positive claim requires positive evidence to support it, and something as extraordinary as an eight foot tall undiscovered bipedal primate living in the wilds of North America requires, for proof of its existence, similarly extraordinary evidence.

But science isn't just there to crush your dreams into the dirt under the unrelenting boot of rational thought. A compromise of sorts can be reached. For example, tales of wild men may not be completely unfounded in reality. After all, for a lot of human history, we were not alone. Denisovans, Neanderthals, the tiny *Homo floresiensis* of Indonesia, these species in our genus were once as alive and abundant as *Homo sapiens*. But though they undeniably went extinct long before 2017, perhaps the memories of living alongside them tens of thousands of years ago persisted? That is what many anthropologists and scientists now agree on as being a solid explanation for the common legends of "wild men." Bigfoot and his cousins around the globe may not be still alive today, but perhaps they are simply leftover memories, ancestral recollections of a time when humans were not the only advanced bipedal apes walking the planet. If so, folk tales of wild men offer not just eerie stories to tell by a campfire at night, but a genuine window into the world of early humans, of millennia long gone, and exactly how we coexisted with our fellow bipeds. There may then be some scary truth in the fact that in the vast majority of these stories, wild men are far from friendly. Often they are associated with the kidnap of women and children, and the aforementioned warnings not to venture out alone into the forest sound more sensible than ever. However, one only needs to look at the world today to see that humans were ultimately victorious in our conflicts against others in our genus. After all, we are the only ones left. Humans were faster, more agile, better able to use tools (and therefore weapons), vastly more aggressive, and hunted in large packs. There is a lot of evidence to show that, far from being the aggressors, Neanderthals and so on were effectively wiped out, often violently, by us. Perhaps it is ironic then that we still have scary tales of wild men hiding in the forest, when in reality, it was the other species of Homo who must have feared venturing out alone. Because after all, they might have run into monsters.

"Discovery" Photo Competition

Leicester Grammar School held a photography competition with the title "Discovery".

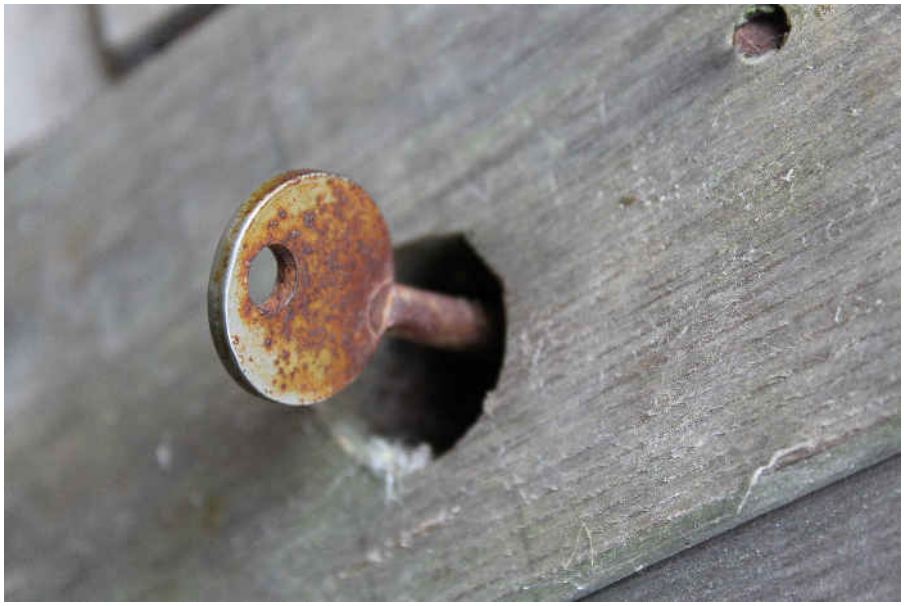
"Looking Forward"
By Caitlin Musto, Year 9
Winner of Years 9-11 category

The photographs submitted were from a vast range of specific topics. Some chose to take the title literally with an exploration theme. Others decided to use the title of "Discovery" in an abstract sense.

The entries included vast landscapes, intriguing objects, and much more. These pictures are just a few of the many marvellous photos submitted by students, that made it into the shortlist.

"Jurassic Coast"
By Freya Montgomerie, Year 7

"Impressions"
By Nicholas Njopa-Kaba, Year 7



"I wonder where this leads to"
By Grace Mold, Year 6
Winner of Years 6-8 category

"Australia"
By Thomas Al-Chalabi, Year 7

"Pathway To The Unknown"
By Kim Hew, Year 8

The Plight of the Sagia Antelope

Taras Bains gives an insight into the Sagia Antelope, a generally unheard of species which requires urgent attention.

Many of you have probably never heard of the saiga antelope, or only ever seen them in David Attenborough's Planet Earth 2, however they are currently facing a serious struggle to survive, and are on the verge of becoming extinct. These animals may look like something from a fictional story, but have actually been around since the Ice Age. In the 1990's over a million roamed the plains of Central Asia, however is less than 30 years, the population has dropped by over 95 percent to a dwindling 50,000 individuals. The International Union for the Conservation of Nature, has classified them as being critically endangered. The saiga antelope may now face imminent extinction unless something is done to combat this problem. The saiga current face many huge anthropogenic threats, form habitat loss due to livestock to being hunted for their horns.

The saiga antelope is a migratory species that normally reside in the arid steppe grasslands of Central Asia. Their traditional home range ranged from the Eurasian steppes of Poland and Ukraine, across the Central Asian countries to China. However in the modern day they are extinct in China, and now only exist in Kazakhstan, Mongolia, Southeast Russia, and Uzbekistan. They generally live in small herds of 30-40 antelopes, however during the migration season they can form herds of up to ten thousand individuals. Some would say this is one of the most stunning phenomenon in nature. However due to their significant decline, these sorts of numbers are extremely rare to see. These animals are also extremely resilient and versatile, as they are able to withstand soaring temperatures of 30 degrees plus in Kazakh summers, to bitter temperatures of minus 40 in their harsh winters.

All of the major threats towards these animals, originate from humans in one way or another. The primary threat to the saiga is hunting and poaching. The saiga are hunted for a variety of reasons; the horns of the male saiga are thought to cure fever in Chinese traditional medicine, therefore most of the saiga killed illegally in Central Asia is exported to China. They are also hunted by local people for their meat as many those living in the saiga range generally are poor farmers, who when there harvest fails have nothing to eat. This has led to a steep decline in populations across the continent, as well as creating huge difference in the ratio between male and female, making it harder for saiga populations to replenish themselves. Another threat is, due to anthropogenic induced climate change, the heavy desertification of the Central Asian steppes. This makes it harder for the antelope to find food, as it grows less well. It has also led to increasingly harsh winters, which have led to many saiga antelopes dying out. However the most major threat to these creatures is the fatal diseases transmitted by livestock, mouth and hoof disease.

Since the dissolution of the Soviet Union, there has been increased livestock farming. The saiga antelope have no natural immunity to these diseases, as the livestock are not native to central Asia, and consequently spread diseases, which

are alien to the native saiga populations. Therefore even if one saiga antelope is infected, it can cause destruction to vast swathes of saiga populations. In April 2016, over 200,000 saiga antelope died from a bacterial infection, from the bacterium Pasteurella multocida, resulting in hemorrhagic septicaemia. A mass mortality like this has never been seen before in the natural world, and although this being common in grassland ecosystems has never resulted in a 100 % mortality rate like the one the saiga experienced. Another outbreak of disease occurred very recently in February this year, where 2500 saiga have already died, and the rate of death is increasing as the epidemic picks up speed. The disease was transmitted by sheep and goat, and is called sheep and goat plague. These same livestock also degrade their pastures by extensive grazing upon them, therefore limiting the amount of food for the saiga.

Although the saiga are protected by legislation within the range countries, enforcement of these laws is extremely weak due to the countries' lack of capita and investment for the management of saiga populations, coupled with a failing rural economy, due to climactic fluctuations. Therefore much of the effort to conserve this species comes from conservation charities, e.g. the World Wildlife Fund, Flora and Fauna International, and the Saiga Conservation Alliance. The saiga is also listed on CITES, to aid the conservation of this Eurasian species. A complete moratorium was placed on the commercial hunting of saiga in 1990. However this did not do much to curb the illegal poaching of these animals, as again there was widespread unemployment and poverty.

Saiga Conservation Alliance

Taras Bains

Technology: Where is it Heading?

A brief discussion about new implementations of technology in industry.

See through walls

An Israeli company have produced software that can detect movement and objects through walls. It was used in detection for breast cancer before but now can be used in homes. The sensor can be placed into the phone system to detect pipes when drilling through walls, detecting when someone is approaching a wall or even when someone has fallen over in a bathroom.

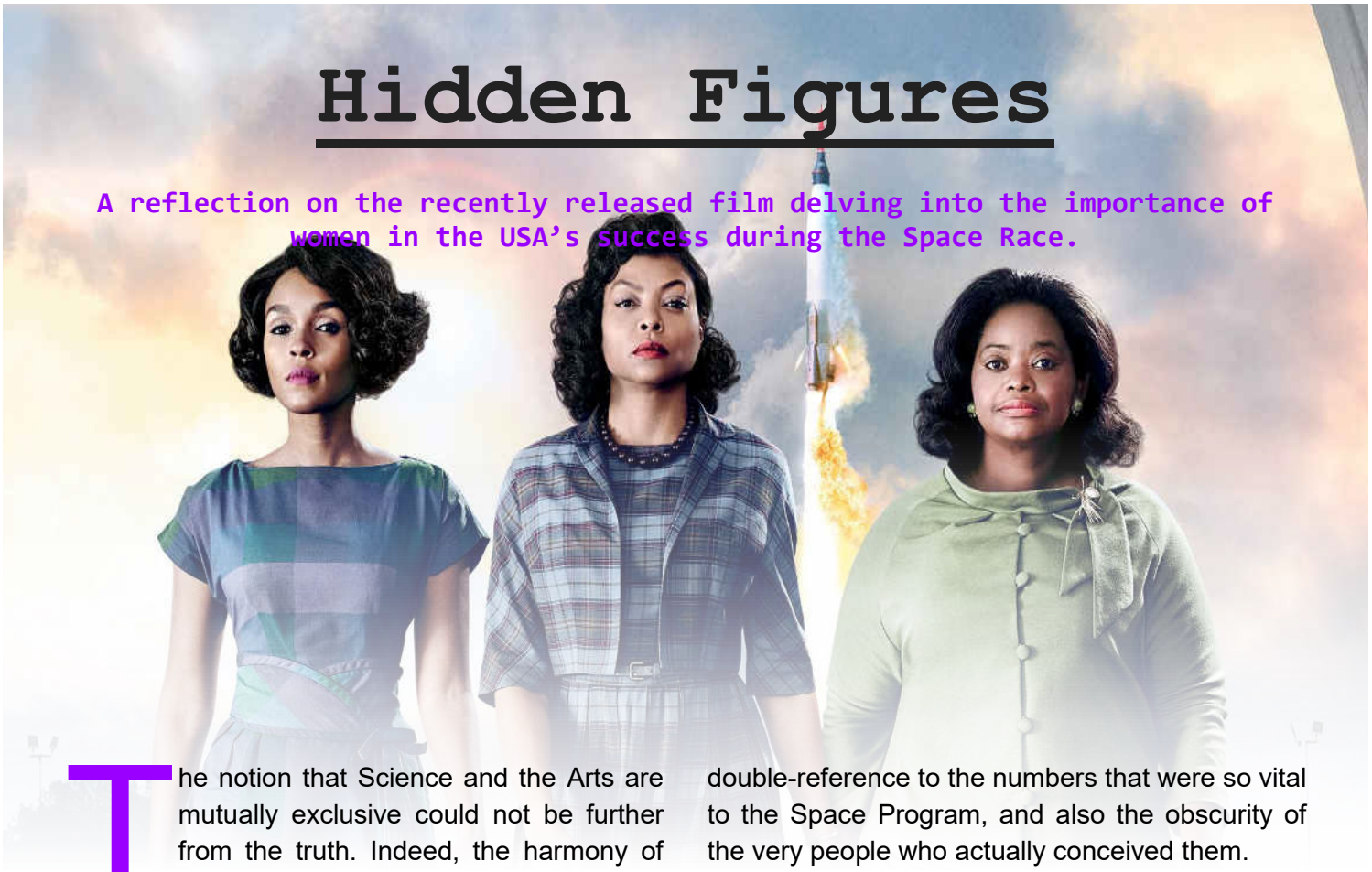
VR in Hospitals

Virtual Reality (VR) has taken a few more steps into reality, but this time instead of the gaming industry, it is has taken a step into the hospitals. Some young children have worries of Magnetic Resonance Imaging (MRI) Scanners and doctors are helping children overcome their fears by placing the VR Headset over their heads and the virtual reality video shows a 360° experience of what an MRI Scanner is like when going through the machine before the actual moment.

Vivek Bulsara

Hidden Figures

A reflection on the recently released film delving into the importance of women in the USA's success during the Space Race.



The notion that Science and the Arts are mutually exclusive could not be further from the truth. Indeed, the harmony of the two fields is illustrated by the film Hidden Figures - the captivating account of female mathematicians at NASA whose stories (until now) have been obscured in history.

Hidden Figures follows the chronicles of three female African-American mathematicians - Dorothy Vaughan, Katherine Goble (later Johnson) and Mary Jackson. Each of the three went on to make a profound contribution to the fields of computing, astrophysics and aeronautical engineering respectively, whilst engaging in perpetual combat against segregation at the dawn of the Civil Rights Movement. The title aptly encompasses the nature of their work - It is a double-reference to the numbers that were so vital to the Space Program, and also the obscurity of the very people who actually conceived them.

On 6th March, members of the Cape Canaveral trip and LGS Space Club attended an evening cinema trip to watch the film. Below are some thoughts and comments from those who went:

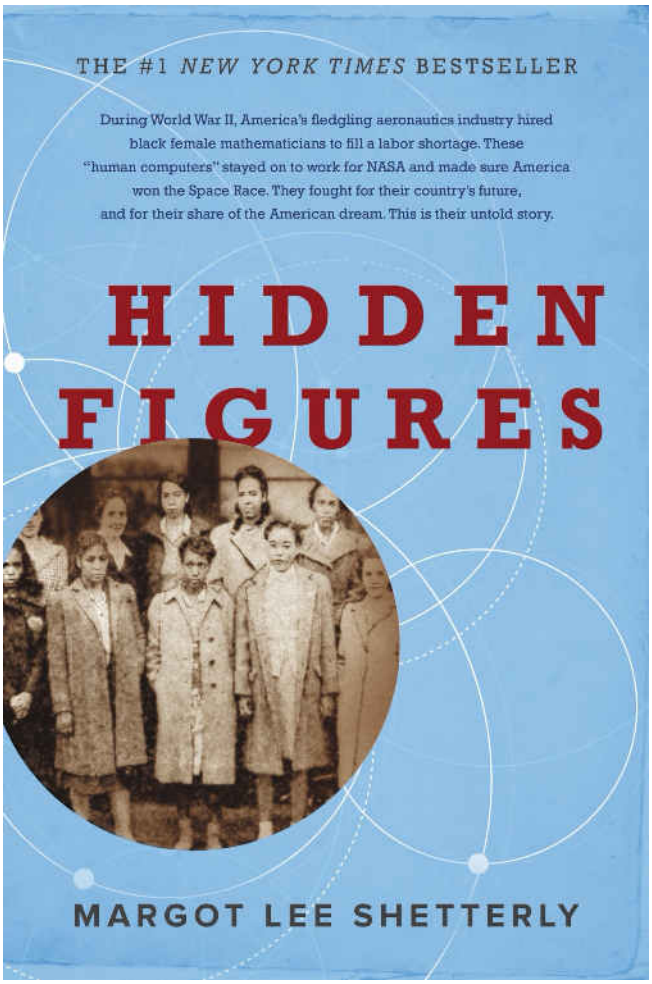
"An inspirational film - it really highlighted how much unappreciated work went on behind the scenes of NASA. Without those extraordinary women, America wouldn't have managed to be such a crucial player in the continued exploration of space."

"It really makes you think about the people behind the scenes, not just the people you saw on TV."

The three NASA mathematicians whose lives are depicted in this film: (from left to right) Mary Jackson, Katherine Johnson, and Dorothy Vaughan

But behind the film also lies the momentous book that inspired it, written by Margot Lee Shetterly. The author's father was an African-American research scientist at Langley, who greatly inspired the book's creation. Cogent yet creative, this is a powerful and dynamic account that happens to be even more inspirational because of the real people it encompasses.

The book offers many glimpses into the work of aeronautical engineers and human computers, interweaving the Physics of spaceflight in a clear and cogent way. We are shown how an aeroplane wing generates lift, the evolution of aircraft that could exceed the speed of sound, the development of the Saturn V rocket and eventually the mathematical conundrum behind John Glenn's orbital flight in 1962.



As well as including some very understandable and accurate science, the book uncovers the extraordinary personalities of the people involved. We follow the incredible stories of Dorothy, Katherine and Mary, as well as those of several white women, bringing to light the universal struggle for equality in that era. Despite the discrimination and isolation that stood against them, the book brings to light the extraordinary perseverance of the African-American community in such bleak surroundings. The story reveals some brutally honest realities, but is infused with great optimism. The messages gained are powerful and ubiquitous - that background does not define potential, that great change is heralded by small actions, and extraordinary feats are possible through the collaboration of a team.

"An epic film that made me believe I can achieve anything."

"It may have been set in the 1960's but the subjects of ambition and hope are still with us today. It is a reminder that shows that we all are a team, no matter what race, sexuality or gender."

We would thoroughly recommend Hidden Figures for the fascinating science it displays, but also for the way it ingrains science into a societal, cultural and human context.

LGS Space Club and Cape Canaveral trip members

Full Dive Virtual Reality

Steven Jin collects ground-breaking research into the concept of true and total immersion in a virtual world.

Have you ever heard VR technology? Virtual reality (VR) typically refers to computer technologies that use software to generate the realistic images, sounds and other sensations that replicate a real environment (or create an imaginary setting), and simulate a user's physical presence in this environment.

A person using virtual reality equipment is typically able to "look around" the artificial world, move about in it and interact with features or items that are depicted on a screen or in goggles. Most 2016-era virtual reality experiences are displayed either on a computer monitor, a projector screen, or with a virtual reality headset (also called head-mounted display or HMD). HMDs typically take the form of head-mounted goggles with a screen in front of both eyes. Programs may also include 360° audio through speakers or headphones.

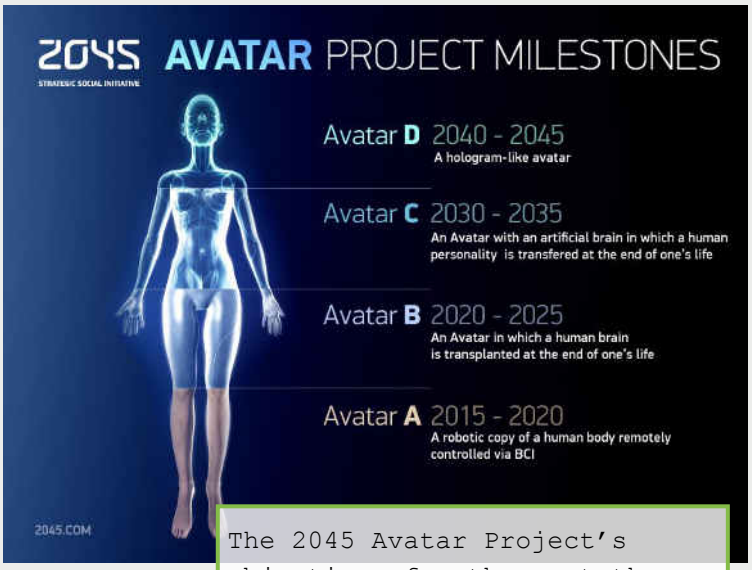
However, if you think about that carefully, the VR we are using now is just a special way to look at your device's screen. What is a truly 'virtual' reality environment?

For that, we should look at "full-dive" VR.

If you don't know, "full-dive" VR means inputting and outputting data directly to and from the brain. At this point, reality is defined by the 5 senses: sight, sound, touch, smell and taste. Unlike VR we are using now, we may feel more realistic experience when we enter a full-dive VR world, where all of these senses are simulated, not just sight and sound. Of course, this technology is still in progress. The day when it will come to fruition is still unknown.

Technologies that would need to be developed for us to achieve full-dive VR include significantly more advanced Computing hardware, Fiber Optics, and Brain Interfacing, but these fields are ready to break through.

One of the people pushing this forward is 32-year-old Russian mogul Dmitry Itskov, who made his fortune as founder of the Web publishing company, New Media Stars. He is the creator of the non-profit 2045 Initiative and Avatar project, which seek to transpose human consciousness into artificial bodies within the next 30 years. Yes, you read that correctly: fully fledged cyborgs. For Itskov, furthering human evolution by combining our consciousness with technology is not only possible, but imperative; it is the only way to solve the crises that will one day face us all.



The 2045 Avatar Project's objectives for the next three decades as laid out by its founder Dmitry Itskov.

Electrical brain stimulation

Electrical brain stimulation (EBS), also referred to as focal brain stimulation (FBS), is a form of electrotherapy. It is a technique used in research and clinical neurobiology to stimulate a neuron or neural network in the brain through the direct or indirect excitation of its cell membrane, using an electric current. It is used for research or for therapeutic purposes. A comprehensive review of EBS research compiled a list of many different acute impacts of stimulation depending on the brain region targeted. The following are some examples of the effects documented:

- **Sensory:** Feelings of the body tingling, swaying, movement, suffocation, burning, shock, warmth, feeling of falling, levitation, sounds, hallucinations.

- **Motor:** Eye movements, locomotion, speech arrest, automatisms, laughter, chewing, urge to move, crying without feeling sad.

- **Autonomic:** Blushing, change in blood pressure and breathing, nausea, sweating.

- **Emotional:** Anxiety, feeling of unreality, fear, happiness, anger, sadness, transient acute depression.

- **Cognitive:** recalling memories, "going into a trance", conduction aphasia, hemispatial neglect, alexia, déjà vu, reliving past experiences, agraphia.

"Humanity essentially faces this choice: Slide into the abyss of global degradation, or find and realize a new model of development, a model capable of changing human consciousness and giving new meaning to life."

— part of a letter from Itskov (right) to the UN Secretary General.

Successful Human Brain Control Experiment

Playing video games can sometimes feel mindless -- just firing away at keys, staring at a screen. But what if your movements were actually controlled by your co-workers' thoughts?

It sounds quite “out there”, but that's exactly what happened recently at the University of Washington. On August 12, 2013, computer science and engineering professor Rajesh Rao controlled the brain signaling of his colleague Andrea Stocco, who was sitting in an office on the opposite side of the campus.

To make it happen, Rao wore a cap with electrodes hooked up to an electroencephalography (EEG) machine. The high-tech apparatus reads electric activity in the brain. It was hooked up to a computer that transmitted the data, via the Internet, to Stocco's computer. Across campus, Stocco wore a purple swim cap attached to a transcranial magnetic stimulation coil. The coil attached to the swim cap just above Stocco's left motor cortex, the area of the brain that controls movement of the right hand. Stocco also wore noise-cancelling ear buds.

Once decked out in their brain communication caps, Rao looked at a video game on a computer screen. He imagined what he wanted to do with his finger, but was careful not to move his hand. His computer took in the information and transmitted it, via the Internet, to Stocco's computer, which then translated Rao's commands into an electric pulse that reached Stocco's cap.

Almost as soon as he thought about moving his index finger to the "fire" command key, Stocco -- who was not looking at a computer screen but had a keyboard in front of him -- moved his right index finger to the proper key. He later compared the feeling to a nervous tic.

The communication would work even if two people don't speak the language, because the brain signals are the same.

Although this experiment seems nothing related to the full-dive VR, it is a good start. Something like reading signals from a brain and sending it to another human’s brain Is successful now. Of course, it could only perform simple actions such as moving arms or pressing a button, but by adding functions gradually, full-dive VR will surely become practical to us someday in the not-so-distant future.

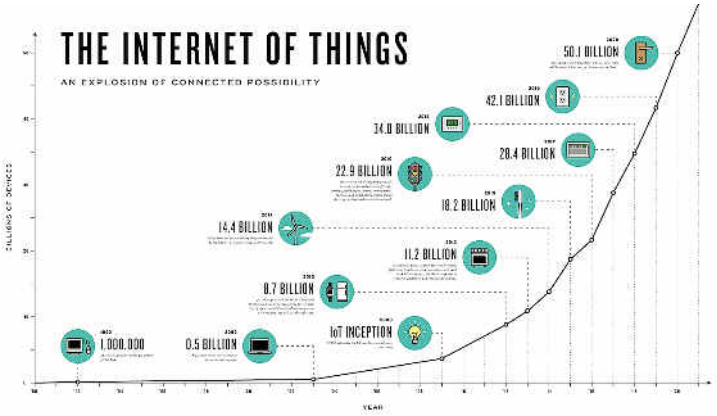
Steven Jin

Rajesh Rao, left, and Andrea Stocco sat in rooms on opposite sides of the University of Washington campus during the experiment.

A Telemetry Toaster

The Internet of Things has been expanded to the humble toaster; Sarah Beadle explains its significance in the future of consumer technology

Technology is quickly growing as more people discover new ways to help our lives and advance past previous achievements. Scientists and engineers are coming up with more devices which we are able to use at home. The idea of being able to connect our homes to the internet has stuck.



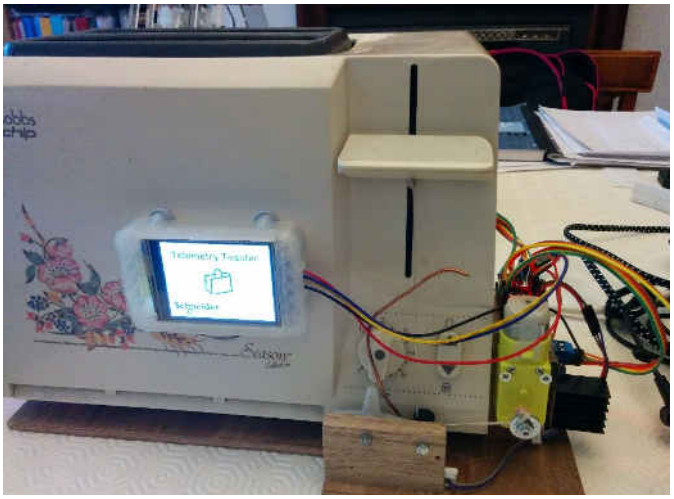
'The Internet of Things' claims that the future of internet everything is nearing. But is this really a good idea? For example if you had a toaster connected to the internet you could accidentally start a fire or someone could hack your toaster. The internet has proved to be a dangerous place for people finding ways to steal information such as pin numbers, personal details and passwords. We have created somewhere where nothing is safe. Is it right to control our houses and lives with this?

We can easily make toast through the internet. A toaster can be wired to a Telemetry Outstation which has a network connection and so can be connected to the internet. From there it can be connected to a central control system – a computer. This computer which could be in a company or in the cloud is able to then connect to an app on someone's phone through the internet. The toaster would have to be made very secure to prevent hacking. There isn't much point in making an internet toaster however we could have dishwashers and washing machines which could be connected to the internet and used at night to save energy or money. They can respond to changes in electricity pricing and turn on when it is least expensive.

The electricity generation system is coming under pressure. We have more devices requiring more energy but the infrastructure is limited and we must use less fossil fuels because of climate change. If the devices in homes and factories can automatically respond to the changes in available power then we might not need to build new power stations or burn more fossil fuels, for example wind and solar energy is not always available. To do this we must connect devices to the power grid and this is where the internet of things comes in, with both advantages and the opportunities for problems. This is the 'Smart Grid'.

With these connections we can do more than respond to energy pricing. With technology in your home connected to an app on your phone you are able to monitor what is going on in your home and even adjust the heating. Products such as Nest are available to do this, but their reliability is a problem. If these problems are solved, and with good security the future home will be a place where you can live with ease.

Sarah Beadle



4th Generation Nuclear Fast Reactors and How They Differ from Previous Designs

Arun Goyal displays the transition in reactor technology and the effect a redesign of reactors could have on the grand scheme of Nuclear Power

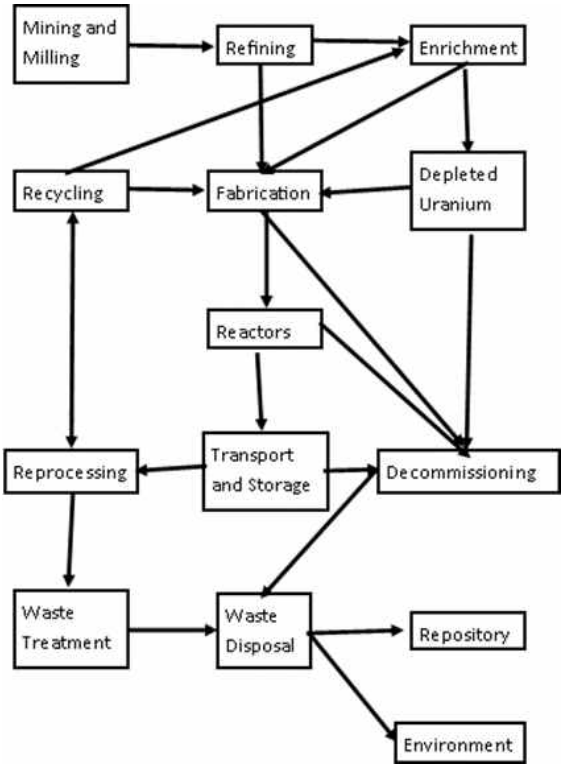
Gen 4 Nuclear Reactors AKA Fast Reactors are the latest set of reactors being built for power generation in the near future. The construction and commissioning of these is set to begin in 2020 and they will provide a safer and more effective form of nuclear power generation. The research and development into these new reactors is being headed by the Gen4 International Forum (GIF) which has 14 founding members, all as signatories on the GIF Charter.

The technological goals of fast reactors are:

- **Sustainability**
  - Long term fuel supply
  - Minimise waste and long term stewardship burden
- **Safety & Reliability**
  - Very low likelihood and degree of core damage
  - Eliminate need for offsite emergency response
- **Economics**
  - Life cycle cost advantage over other energy sources
  - Financial risk comparable to other energy projects
- **Proliferation Resistance and Physical Protection**
  - Unattractive materials diversion pathway
  - Enhanced physical protection against terrorism

Sustainability

The sustainability aspect of a fast reactor is based around how much power can be extracted from the uranium that is input and how much waste materials are produced. For the current generation of nuclear reactors, this is very low with around 97% of the waste extracted from the reactor cores being re-usable after reprocessing. This leaves a very open fuel cycle (Depicted Right) that produces lots of waste and costs a lot of money.



For Gen 4, the fuel cycle is closed more than previously. Fast reactors make use of the fast neutrons that are ejected from the uranium nuclei during fission. Whereas with the current generation of reactors where the moderator slows them to a speed which can be absorbed more easily by the uranium nuclei, there is no

moderator in a fast reactor to do this. This makes it such that the majority of the neutrons in the reactor have the minimum energy required for absorption into the nucleus of most actinide nuclei, causing them to become unstable and decay further by nuclear fission. As a result, there will be a much smaller fraction of the spent fuels as actinides which are the primary cause for the long decommissioning times due to excess radiation. The fission of these actinides will also release more energy, therefore producing more power for the amount of enriched uranium used in the core.

Safety and Reliability

Fast reactors have a series of passive safety features in their structures to allow them to withstand almost any type of nuclear emergency without releasing radiation into the surrounding areas. This allows the staff and engineers of the reactor some time to develop a solution to the problem without any risk to the local environment. This is done by obeying the laws of nature and the behaviours of the materials used to construct the core. By implementing the safety features in this way, there is a much lower chance of damage to the core. Emergency offsite responses are not required for fast reactors because of the time available for solutions to be developed. For most designs, the reactors are rated to allow as long as 3 days for this.

Proliferation Resistance and Physical Protection

Previous generations of reactors had large quantities of actinides among their waste products. These could be used to develop and build large quantities of nuclear weaponry which goes against the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) which states that countries with nuclear weapons cannot provide nuclear materials to countries with nuclear weapons unless placed under safeguards and all countries with nuclear weapons must purse negotiations towards ending the nuclear arms race.

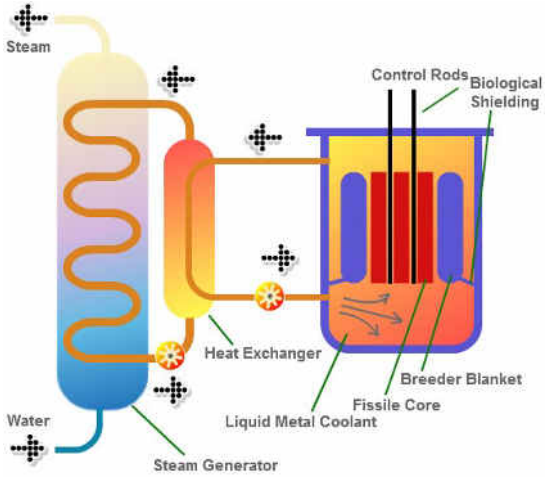
As stated above, Fast reactors use fast neutrons to cause fission in the remaining actinides, reducing the quantities that are produced and therefore reducing the volume of radioactive material available for armament in these weapons.

Economics

The Gen 4 International Forum stated that their key economic goals for fast reactors would be a financial risk equal to that of other energy projects and a cost advantage over other energy sources over its lifetime. For fast reactors, 1 core can last anywhere from 15 to 20 years without refuelling, generating between 150MW and 1500MW of electricity. For the average reactor currently in use, a core will last around 683 days before refuelling, generating around 1000MW of electricity. With fuel enrichment, reprocessing, refining and transport, these new reactors will dramatically reduce the operating costs or the reactors. They also require less maintenance with their passive safety features, further reducing the operation costs as less people will be required to operate the reactor.

Types of 4th Generation Fast Reactor

The new fast reactors all operate with coolants between 510°C and 1000°C compared with the cooler 330°C of modern reactors and have a power output of 150MW to 1500MW, 1 core lasting from 15 to 20 years without the need for refuelling. There are 3 types of fast reactor. They are Gas-Cooled, Sodium-Cooled and Lead-Cooled, all of which have a closed fuel cycle.

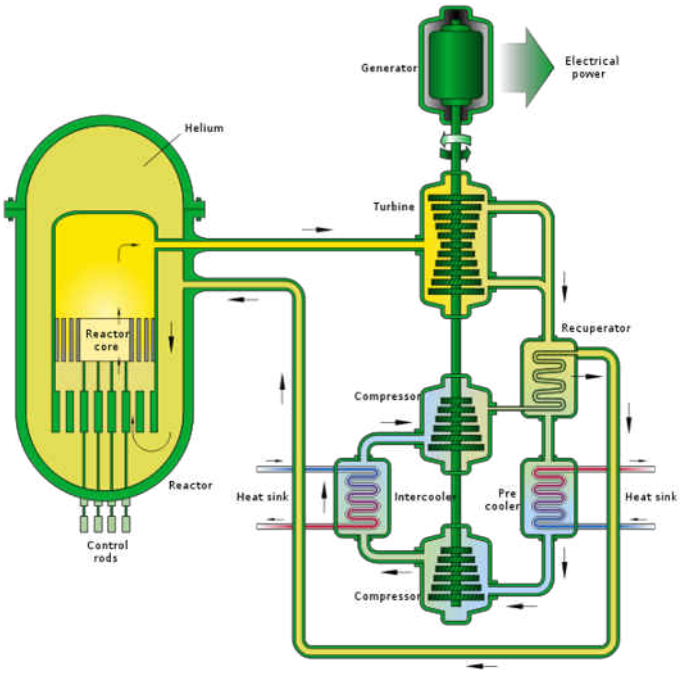


A general, simple diagram for the new generation fast reactors

Gas-Cooled Fast Reactor (GFR)

A Gas-Cooled Fast Reactor is a high temperature, helium cooled fast reactor with closed fuel cycle. It combines the advantages of fast reactors in long term sustainability and waste minimisation with those of the high temperature systems, having a high thermal cycle efficiency and industrial uses for the generated heat in hydrogen production. With an outlet temperature of 850°C, it is an evolution of the Very-High-Temperature Reactor, having a more sustainable fuel cycle in that it causes the long lived actinides produced by fission to decay in themselves by fission, therefore releasing more energy from the fuel.

This type of reactor is based around a 2400MWth reactor core containing an assembly of hexagonal fuel elements, each containing a ceramic clad and mixed-carbide-fuelled pins in a ceramic hex-tube. These hex-tubes are made of a silicon carbide fibre reinforced silicon carbide. The helium leaves the core through an outlet with a temperature of 850°C, passing through 2 heat exchangers where the heat from the primary helium coolant is transferred to a secondary gas cycle containing a mixture of helium and nitrogen which drives a closed cycle gas turbine. The waste heat is then from the gas turbine is then used to raise steam in a steam generator, this being used to drive a steam turbine.



Currently, a Gas-Cooled Fast Reactor has an electrical efficiency of approximately 48%. This means that with an input of 2400MW_{th} and output of 1152MW_e is generated.

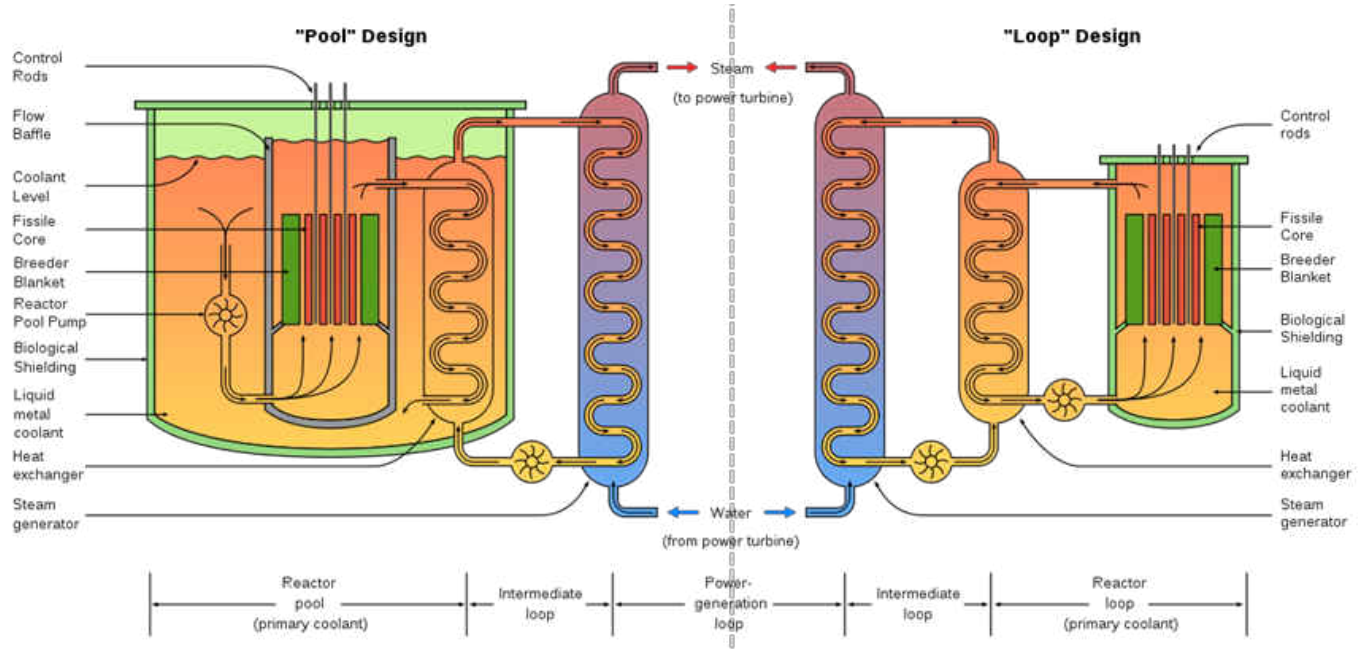
Sodium-Cooled Fast Reactor (SFR)

The Sodium-Cooled Fast Reactor uses liquid sodium as a coolant, allowing high power density with low coolant volume and operation at low pressures. As sodium reacts chemically with air and water, a sealed coolant system is required.

With this type of reactor, various plant sizes can be built with power outputs ranging from 50MW to 1500MW, having an efficiency of approximately 42% with the outlet of the reactor core being between 500°C and 550°C

A key difference between a Sodium-Cooled Fast reactor and other fast reactors is that different fuels are used to power different forms of this reactor, depending on its size and the scale of the power generation. For small reactors generating upto 150MW, Uranium-Plutonium-Minor-Actinide-Zirconium metal alloy is used as fuel. Intermediate sized reactors for power generation in the range of 300MW to 1500MW use oxide or metal fuels with a pool style reactor as above. Larger reactors with a loop design can generate between 600MW and 1500MW, using mixed Uranium-Plutonium oxide fuel.

A Sodium-Cooled Fast Reactor, has many safety features to ensure that it functions safely and to fail in a controlled manner if it were ever to fail. The first system in place in order for this to work is to have a long thermal response time. What this does is provide the operators with a period of time to find solutions to a problem if 1 was ever to occur that causes a change in the temperature of the reactor core. The reactor would also have a reasonable margin to the coolants boiling point, sodium boiling at 882.8°C. The primary system must also operate close to atmospheric pressure as this will keep the reactor's operation stable if there was ever to be a leak in the reactor's core. An intermediate sodium system could also be



used between the radioactive sodium in the primary system and the power conversion system. A secondary power conversion system of water, steam or nitrogen could also be considered to improve the efficiency of the reactor.

Lead-Cooled Fast Reactor (LFR)

Lead-Cooled Fast Reactors use molten Lead or Lead-Bismuth Eutectic as a coolant operating in the region of 550°C to 800°C. It uses chemically inert liquids with very good thermodynamic properties and low pressures to produce electricity and hydrogen whilst processing heat. Apart from using fertile uranium as a fuel, this type of reactor can also be used to consume actinides from spent Light-Water Reactor fuel and as a breeder for Thorium matrices.

An important feature of this reactor is the use of molten lead as a relatively inert and low pressure coolant. It is a sustainable material, being abundant and therefore available in the case of deployment of a large number of reactors. It also has quite a high efficiency with 44%.

The construction of a Lead-Cooled Fast Reactor is similar to that of the Sodium-Cooled Fast Reactor's loop design, key differences being in how the heat is exchanged between the primary, radioactive lead and the secondary lead system.

Arun Goyal