Inspired to Achieve

Independent Research Projects 2021

Fullbrook6

Big enough to challenge, small enough to care

Inspired to Achieve Programme

The Inspired to Achieve programme at F6 is aimed at students who are striving to achieve A and A* grades at A Level and sets out to help develop academic and interpersonal skills; provide an avenue to explore key interests within subjects, all whilst providing an opportunity to further students' **curiosity**, **challenge** and **creativity**.

Alongside attending cyclical workshops, students have completed an Independent Research Project. This provided an exciting opportunity for students to research and write about a topic of their choice.

Please enjoy reading the fantastic research projects completed by our year 12s this year.

Why Is IVF Not Available To Everyone?

Emily

At the moment in the UK there is a crisis related to funding for the IVF process. This leaves individuals needing this treatment go to drastic measures to raise the money to be able to access it. However, finance is not their only worry as the requirements to be accepted for the treatment is becoming more unreasonable. It has led us to question whether the government should be stepping in and increasing the necessary funding.

Should Mechanical Doping Be Introduced Into Athletics?

Finlay

In the last decade, the performance levels of athletes across the world have significantly improved, predominantly due to the developments in technology and vast levels of research carried out by scientists. In athletics, the introduction of carbon-plated "super shoes" by Nike has led to records being broken left, right and centre. This essay will discuss the scientific research carried out to produce the shoes, the opinion of elite athletes on the developments in technology, as well as the issues which have arisen due to the introduction of these shoes into elite competition.

How Does Music Affect The Brain? The Science Behind Different Music Preferences

Kyra

I was interested into looking into musical preference as independent research project as this was an area, I found truly intriguing and so wanted to find out more about this nature or nurture argument. I have read different journals about this question but none of them appeared to come to a definite conclusion so I wanted to collect a range of secondary research and complete my own primary research for my artefact. My project looks at the different factors that influence musical preference, both to support the nature and the nurture argument. It gives a final answer as whether musical preference is due to random choices or if there is science behind it which I found incredibly interesting to discover by the end of my research.

Bias within the American Judicial System

Justine

My project explores the reasons for, issues with, and causes of bias within the court system in the United States. It includes details of the types of bias that can be present both consciously and unconsciously and the role the jury has before, during and after a trial. As well as; the role of sworn testimonies and each attorney involved, a solution for wrongly convicted criminals and also what has been done in response to the injustice of the American courts, all of which relate to how they could create, mostly unintentional, bias during a trial. I decided to research this because I am interested in the treatment of each person who stands in a court room, no matter the reason, and the effect potential bias has on both the individual and the outcome of their trial, but also because I was able to learn new things about something I am interested in without it being related to my subject choices.

The Impact Of Gene Editing On Humanity

Ollie

Gene Editing the human genome has been talked about for many years. However, with the recent discovery in 2012 CRISPR-Cas9 technology, editing the human genes change the world of medicine forever. The opinions on Gene editing are vast, I researched into the challenge's gene editing introduces, understanding the ethical, economical, and medical issues associated with implementing this technology. However, due to the extensive legislation that will be in place and after assessing

the revolutionary usages in medicine, it is clear that Gene Editing has to be utilized to ensure the safety of humanity. We mustn't halt innovation in the fear of misuse, "it is not the tool that determines the end point, it's the user." Alta Charo, Bioethicist at the University of Wisconsin-Madison.

What Fuel Holds The Future Of F1 And Motorsport?

Ryan

In this research paper, I will aim to conclude which fuel alternative is most promising for the future of F1 and motorsport as a whole. I will explore their benefits and drawbacks in detail, as well as investigate the actions already being taken by these franchises, their economic reasoning and effects in addition to whether they keep the sports in line with their historic core principles and mantra.

How Has The Coronavirus Affected Human Interaction Over The Last Year?

Essa

My project is about how the coronavirus has affected our way of communication as humans but mainly the language development of us as humans, arguing that social media has affected our way of communication for a long period time.

How Can Wind Tunnels Assist Development Of Vehicles?

Louis

Aerodynamics is the study of the properties of moving air and the interaction between the air and solid bodies moving through it. This is a major factor taken into account when designing vehicles such as cars places and rockets. To be able to develop these at a quick rate wind tunnels are used. They offer a place to test the changes caused by new different body parts for these vehicles, to see whether they have a positive impact on the airflow. For my project I designed and built a small-scale wind tunnel in which you can place model cars and objects such as aerofoils. Load cells are used to measure drag and downforce to see the forces acting on each object.

Why Is IVF Not Available To Everyone?

Emily

With the ever-growing waiting list for In Vitro Fertilisation (IVF), there is the concern that the necessary funding is not being raised by the government. Currently in the UK the waiting list is either too long or the treatment is too expensive for certain people to even get on the list. At the moment the system is based on an impractical criterion, both financially and physically. Leading us to question is the system set up to fail and why the government is not helping society change this issue.

What is IVF?

When a patient is diagnosed with problems it can be a very daunting process and they do not know what their options are, but with the help of their clinic they will find out their options. Out of all the available techniques most clinics will suggest IVF. The process of IVF involves 6 main stages: supressing the patient's natural cycle, boosting their eggs supply, monitoring their progress, and maturing their eggs, collecting their eggs, fertilising the eggs, and transferring the embryos (NHS, 2018). By using drugs, such as Estrace which is used to supress the patient's menstrual cycle so you are boosting their eggs supply, as this medication encourages the ovaries to produce more eggs compared to normal (ConceiveAbilities Team, 2018). By using ultra sound the doctor will then have to monitor the development of eggs, this technology allows them to see if more eggs have developed and if that is the case, they will use medication to mature your eggs. Once the eggs have been matured a needle is inserted into the ovaries to withdraw the eggs. They are then combined with sperm for a period of a few days to allow fertilisation to take place. Once fertilisation occurs, 1 or 2 zygotes are placed in the womb. For the patient to find out she is pregnant they have to wait around 2 weeks for a result to come out on a pregnancy test. Depending on the clinic the patient may do a normal urine test or some may do a more accurate blood test. The good quality embryos that were not transferred into the womb are frozen so they are available if the first cycle is unsuccessful. If the first cycle was unfortunately unsuccessful the patient has to wait around four to six weeks until they attempt the new cycle. Where some of the frozen embryos are fertilised and transferred into the womb. NHS, 2018). The most cycles a patient will ever have is three cycles and one full cycle of treatment can take on average 3-6 weeks, but due to uniqueness of each patient the length can vary. This 18-week process is both extremely physically and emotionally demanding for the women undergoing the treatment, which is why the NHS and NICE recommends counselling should be offered before, during and after treatment, regardless if it has been a positive or negative result; the support helps couples understand the implications of the treatment (NHS, 2018). Counselling is essential following IVF; many patients undergo this process alone and do not have family and friend support to assist them. Speaking to other patients who have been through the treatment or councillors will offer support to the patient

Who is eligible for IVF?

To access treatment for IVF, extortionate and complex guidelines must be met. NICE have guidelines that state IVF should only be offered to women under the age of 43 who have been trying to get pregnant through regular unprotected sex for 2 years. The patient will also be considered if you have had 12 cycles of artificial insemination (a fertility treatment that involves directly inserting sperm into a woman's womb). However sometimes, even after meeting these complex guidelines, patients may still not be able to enrol on this treatment through the NHS. The final decision is made by the local clinical commissioning groups (CCGS), their criteria is stricter than what NICE look for. In some areas the CCGs will have an additional criterion which includes: not already having children, being a healthy weight, not smoking and being a certain age. In some areas the CCGs will only fund treatment for women under 35 years old.

What happens if you are not eligible?

If a patient is unsuccessful in being granted NHS funded IVF, the payment could be as much as £5,000 for 1 cycle and there is likely to be additional costs for medicines, consultations, and tests. However, prices vary depending on the location the clinic (NHS, 2018). For example, the centre for Reproductive & Genetic Health, (located in London) charges an excessive £15,195 for the whole of cycle 1, freezing and the transfer of embryos, if the first embryos failed (CRGH, 2021). Whereas, a fertility clinic in Exeter charges £9510 for the same process (Anon., 2019). The only difference between both clinics is their location as they both give exceptional care and treatment.

In addition to these costs, majority of clinics will offer patients additional but controversial procedures which the Human Fertilisation and Embryology (HFEA) have offered. However, they have little evidence of how effective these treatments are and only in some clinical scenarios have they been proved effective (CRGH, 2021). One of these procedures is the Intracytoplasmic Morphologically Selected Sperm Injection (IMSI), this technique uses a high-power magnification to help visualise the inside of sperm which allows specialists to pick the sperm with the highest chance of achieving a successful fertilisation. Despite evidence that the procedure is associated with higher pregnancy and lower miscarriage rates, there is still a lack of evidence of how beneficial IMSI for patients, as some scientists believe the medicine did not impact the pregnancy's and could have happened by chance (CRGH, 2020). Individuals who suffer from fertility problems already face the obstacle of accepting they may never have the chance of becoming a parent, and to put them through an extensive process which is not only physically but also financial demanding, is almost unethical. As demand increases, acceptance to this treatment is becoming harder for patients. The system in place wrongly leaves behind specific groups of individuals who suffer from fertility issues, and this needs to change.

The Left Behind

In 2013, NICE concluded that women who fit the criteria and are aged 39 of under are eligible and should be offered three full cycles of IVF, and those aged 40-42 should be offered one full cycle. However, it has recently been discovered that in England only 13% of fertility clinics are being offered the full three cycles. Majority of clinics are offering only one full cycle and providing no funding, this leaves behind individuals who are financially unstable and do not have the options to resolve fertility issues. Currently, in the UK, Scotland is the only nation who is providing the full three cycles to those who fit the NICE criteria. Other nations are getting away with not offering the full treatment as they have found a loop hole surrounding the NICE definition of one full cycle. NICE made it clear that one cycle should include: fresh transfer and freezing and future transfer of the embryos created, however they did not make it clear to as how many embryos are able to be transferred in one full cycle. This has led to fertility clinics all over the UK to set their own limit of the number of embryos that are able to be frozen and transferred (Brian, 2019). Leading to certain clinics exploiting vulnerable individuals into repeatedly paying extreme amounts for their version of a 'full' cycle. This process has excluded a particular part of the population and has forbidden who do not have the financial funds to have IVF treatment.

Financial funding is not the only characteristic that is leaving out specific individuals and not allowing them treatment. Individuals are unlikely to gain NHS funding and be accepted for treatment by the local clinical commissioning groups if they fit into any of these categories: if they smoke, overweight, underweight or if they already have children. As stated earlier some CCGs set an age cap on their requirements and have additional restrictions which include the males age and weight. In 2017 HEFA released data revealing that those aged under 35 have a 29% rate of having a successful treatment and it falls to 9% for those between the ages of 40-42 (Brian, 2019). Although, the statistics state that you have a better chance the younger you are, who should have the power to determine whether you are eligible for the treatment. If a patient is over the age of 40 and is willing to pay the exceeding amount for treatment why should the clinic have the right to say no? With a statistic as slim as 9% is it worth the risk. If the IVF treatment was successful being pregnant at the age of 40 poses its own risks: gestational diabetes, having a big baby, needing a caesarean, having a still birth and chromosomal abnormalities (Tommy's, 2020). All these factors will most likely lead CCGs to deny treatment as it could be both emotionally and physically harming to the patient. However, the issue now is not capping the requirements so patients above 40 cannot have treatment, in some clinics across England the age cap has been set at 35. According to HuffPost UK, one in nine CCGs in England block women under the age of 40 and in many cases they groups have made a rule that women need to be referred for IVF before their 35th birthday. Out of the 191 clinical commissioning groups in England 20 have decided their own age limits the CCGs groups in: Fareham and Gosport, Isle of Wight, North East Hampshire and Farnham, North Hampshire, Portsmouth, Oxfordshire, South Eastern Hampshire, Southampton City and West Hampshire will only give treatment to patients aged 35 if the

treatment starts before their birthday (Gray, 2020). This goes against the NHS guidelines what offer IVF up to the age of 43 and goes against NICE age restriction of 40-42 (NHS, 2018).

To society, financial funding and age limits are the most known reasons on why people across the UK do not have access to IVF. However, in recent years it has been revealed that a 'postcode lottery' has been occurring which prevents certain areas from getting the right amount of treatment and if they are accepted for treatment it is too expensive for them to have it. This is leading to people borrowing money, re-mortgaging homes, selling possessions and crowd funding so they can try and raise money for private treatment (Brian, 2019). The creation of the IVF 'postcode lottery' works depending on where your fertility clinic is based, some areas are entitled to more funding than others. This could cause NICE guideline approved patients who live around 20 minutes away from each other not receive the same or any treatment due to them being at different clinics. Some CCGs view infertility a low priority compared to other illness, which is why the 'postcode lottery' has been allowed to continue (TFP, 2020). The 'postcode lottery' is causing a fertility divide between the north and south of England; as currently on 24 CCGs are offering the full 3 cycles that NICE recommends, and 21 of them are up north (Health Awareness, 2019).

Conclusion

Overall, I believe that the fertility clinics around the UK have become corrupt and have forgotten that the individuals requesting treatment are in pain and suffering; which makes them increasing their prices inhumane. I agree that there should be a specific requirement list as individuals who already have children should not be accessed government funding. However, those who have just missed the criteria requirements still have to pay excessive amounts which must be changed, and the government need to increase the access to IVF funding through the NHS. The government need to rethink their funding division process as they need to grant the NHS more so more individuals are given the chance of becoming parents. To grant the NHS more funding is not the easiest thing to do, however they could instruct the CCGS to pay half of the costs so the treatment is more accessible to patients. For a solution to be created the government needs to work closely with the CCGs and fertility specialists within the NHS to see what the best route forward is.

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Should Mechanical Doping Be Introduced Into Athletics?

Finlay

Within the last two decades, sport has witnessed immense changes due to the introduction of technology, whether that is the use of the 'high tech super suits' in swimming in 2009 or the implementation of Video Assistant Referee (VAR) into football. Within athletics, the introduction of carbon plate 'super shoes' has caused huge controversy, with the opinion of elite athletes being split on whether they should be allowed to be used in competition or if they should be classed as a new form of doping.

What is doping?

According to the World Anti-Doping agency, doping is classed as the use of any material which is 'performance enhancing' or is 'against the spirit of the sport'. Essentially, doping only occurs through the consumption of illegal substances, which are banned due to the benefits from using them whilst training, as well as the harmful long term effects of their use. Within all sports, athletes are punished after consuming illegal substances. Whilst I believe the use of these shoes should not be served with the same punishment as drugs, I would argue against the use of them in major competitions or in any competitive environment.

What is a "super shoe"?

In 2013, Nike set up a project to produce the next leading running shoe: the 'vaporfly 4%'. Factors considered in the production of the shoe included how to improve cadence, energy return and running economy (an individual's ability to convert your oxygen consumption into a forward motion efficiently). Vast research on elite athletes concluded that the shoes could improve these factors by 4%, hence the name. Within the shoe there are 3 key features which help improve an individual's energy return. The first feature is the lightweight upper – if the weight of the upper is less, the energy exerted by the body to keep your legs going through the gait cycle is reduced. The second part of the shoe is the carbon plate, which helps the foam (the third component) compress and expand more quickly, returning more energy to the runner (lab tests put this at over 80% energy return and the highest ever recorded).[1] The carbon plate also helps stabilise the runner's ankle, reducing rotational force and lessening the workload for the calves, in theory helping runners stay fresher for longer through the race and recover more quickly afterwards. It also keeps the athlete's toes straight, further reducing

energy loss. The third component, the midsole foam, improves the responsiveness of the shoe. Accompanying the firm carbon plate, the bouncy and energy absorbent foam allows the individual to spring off the ground more efficiently, leading to an increased cadence with a reduced energy expenditure (energy used by the body to complete the running motion).

The shoes were made primarily to aid the performance of the athletes who had joined their ***'Breaking 2'*** project which was established in 2014. Nike recruited 3 elite athletes, Elisa Desisa of Ethiopia, Eliud Kipchoge of Kenya and Zersenay Tadese of Eritrea, whose aims were to become the first athletes to run a marathon in under 2 hours. Eliud Kipchoge broke the official world record for the marathon in Berlin in 2018 with a time of 2:01:39. He even came close to breaking the 2-hour magic mark in a Breaking2 trial in Monza, Italy, at 2:00:25 (although World Athletics didn't officially sanction this record due to the conditions the event was run in). Records weren't only being broken, they were being shattered by both male and female athletes. Along with Kipchoge breaking the official men's marathon world record, Brigid Kosgei broke the women's marathon world record, previously held by Paula Radcliffe, at the Chicago Marathon, finishing in 2:14:04 in 2019.

Issues surrounding the use of the shoes:

Mile	4:12.33			14.267	22.961	Sifan Hassan	NED	12 Jul 2019	Herculis
2000 m	5:23.75		j	13.819	22.239	Genzebe Dibaba	ETH	7 Feb 2017	Miting Internacional de Catalunya
3000 m	8:06.11			13.8051	22.2172	Wang Junxia	CHN	13 Sep 1993	Chinese National Games
5000 m	14:06.62			13.2110	21.2610	Letesenbet Gidey	ETH	7 Oct 2020	
5 km (road)	14:44		Wo	12.65	20.36	Sifan Hassan	NED	17 Feb 2019	5 km Herculis
	14:43		Mx	12.67	20.39	Beatrice Chepkoech	KEN	14 Feb 2021	5 km Herculis
	14:41		Mx[g][k]			Beth Potter	GBR	3 Apr 2021	Podium 5k Sub-15.30
10,000 m	29:17.45			12.728	20.484	Almaz Ayana	ETH	12 Aug 2016	Olympic Games
	29:06.82					Sifan Hassan	NED	6 June 2021	
10 km (road)	30:29		Wo	12.230	19.683	Asmae Leghzaoui	MAR	8 Jun 2002	
	29:43		Mx	12.546	20.191	Joyciline Jepkosgei	KEN	9 Sep 2017	Birell Prague Grand Prix
One hour (track)	18,930 m			11.763	18.930	Sifan Hassan	NED	4 Sep 2020	Diamond League
Half marathon	1:04:31		Mx	12.192	19.621	Ababel Yeshaneh	ETH	21 Feb 2020	Ras Al Khaimah Half Marathon
	1:04:02		Mx	12.28	19.77	Ruth Chepng'etich	KEN	4 Apr 2021	Istanbul Half Marathon
	1:05:34		Wo	11.996	19.306	Peres Jepchirchir	KEN	5 Sep 2020	Prague Half Marathon
	1:05:16		Wo	12.055	19.400	Peres Jepchirchir	KEN	17 Oct 2020	World Half Marathon Championships
	1:04:28		Mx a	12.201	19.636	Brigid Kosgei	KEN	8 Sep 2019	Great North Run
Marathon[a]	2:14:04		Mx	11.734	18.884	Brigid Kosgei	KEN	13 Oct 2019	Chicago Marathon
	2:17:01		Wo	11.481	18.477	Mary Jepkosgei Keitany	KEN	23 Apr 2017	London Marathon

5000 m	12:35.36		14.8070	23.8296	Joshua Cheptegei	UGA	14 Aug 2020	Herculis	Monaco	MON	[8]		P
5 km (road)	12:51		14.51	23.35	Joshua Cheptegei	UGA	16 Feb 2020	Monaco Run 5 km	Monaco	MON	[9]		P
10,000 m	26:11.00		14.2389	22.9153	Joshua Cheptegei	UGA	7 Oct 2020		Valencia	ESP	[10]		P
10 km (road)	26:24		14.12	22.73	Rhonex Kipruto	KEN	12 Jan 2020	10K Valencia Ibercaja	Valencia	ESP	[11]		P
Half marathon	57:32		13.671	22.002	Kibiwott Kandie	KEN	6 Dec 2020	Valencia Marathon	Valencia	ESP	[12]		P
One hour (track)	21,330 m		13.254	21.330	Mo Farah	GBR	4 Sep 2020	Diamond League	Brussels	BEL	[13]		P
Marathon[a]	2:01:39		12.932	20.811	Eliud Kipchoge	KEN	16 Sep 2018	Berlin Marathon	Berlin	GER	[14]		P
	1:59:40.2	[b]	13.136	21.156	Eliud Kipchoge	KEN	12 Oct 2019	Ineos 1:59 Challenge	Vienna	AUT	[15]		
100 km (road)	6:09:14		10.0972	16.2499	Nao Kazami	JPN	24 Jun 2018	Lake Saroma Ultramarathon	Yūbetsu	JPN	[16]		

Tables correct as of 1st June 2021 (Courtesy of Wikipedia and World Athletics)

Numerous athletes were outraged by the introduction of these new shoes, feeling that they were being cheated of the opportunity of winning major competitions because they were sponsored by a company other than Nike. In 2021, every major sports shoe brand has a carbon plated running shoe. However, there are those who still believe Nike athletes have the upper hand on competitors sponsored by rival brands, given that the company's research is possibly a year or two ahead of rival brands. The success of these shoes can be seen predominantly in longer distance races, ranging from 5k up to a marathon. The further the race is, the larger the impact the shoe has on performance. On track, the introduction of

'super spikes' has seen national and world records in races such as the 5000m being broken as well. In the last 3 years over 9 world records have been broken in the male events in races, and over 15 have been broken in women's events. [2]
Athletes sponsored by brands such a Brooks and Hoka One One have been seen wearing Nike's carbon-plated "Dragonfly" spikes. Athletes have been permitted to use the spikes make by the American sports brand despite having a loyalty to contesting brands as they want their athletes to get the best result possible. Until brands catch up with Nike, this type of thing will be common in elite competition.

The great cost of these shoes (the Nike Alphafly NEXT%'s cost £259.95 and the Nike Vaporfly NEXT%'s cost £209.95 on Nike.com) has led to accusations of the shoes only being available to those who are middle/upper class and have a larger disposable income. Despite the concept that running is one of the cheapest sports, the equipment required to succeed is becoming more and more essential. There are concerns that the use of these shoes may stop athletes with worse financial support from being able to enter professional competition.

The response from rival companies:

In the last 2 years, all companies rivalling Nike have released their own carbon-plated shoe:

- Adidas Adizero Adios Pro
- Asics MetaRacer
- Saucony Endorphin Pro
- Brooks Hyperion Elite 2
- New Balance FuelCell RC Elite
- Hoka Carbon X
- On Running Cloudboom

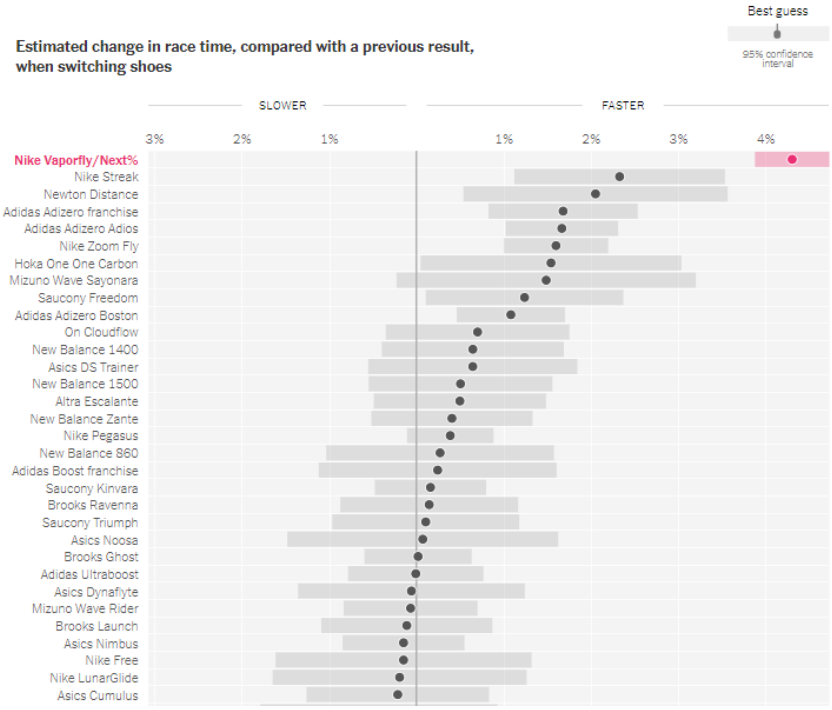
Despite now having carbon-plated shoes, the standard of these will possibly be worse than that of Nike due to the level of research undergone. It is extremely difficult to catch up to a company who are 8 years' into their research in the space of 2-3 years.

The science and research carried out independently:

More independent non-Nike lab tests were conducted. Some scientific, some less so, including former 800m world champion Nick Symmonds of the USA conducting his own treadmill experiment to prove the advantage the shoes gave in lowering heart-rate when running at 6.52/mile in *Nike Alphaflys* compared to the *Hoka Clifton 4*'s. [9]
Another individual called Ross Tucker, a highly-regarded sports scientist, completed an in-depth article highlighting the benefits and drawbacks of the introduction of technology [4]. He stated that ***"The key attribute of world class runners is that their Oxygen Cost of***

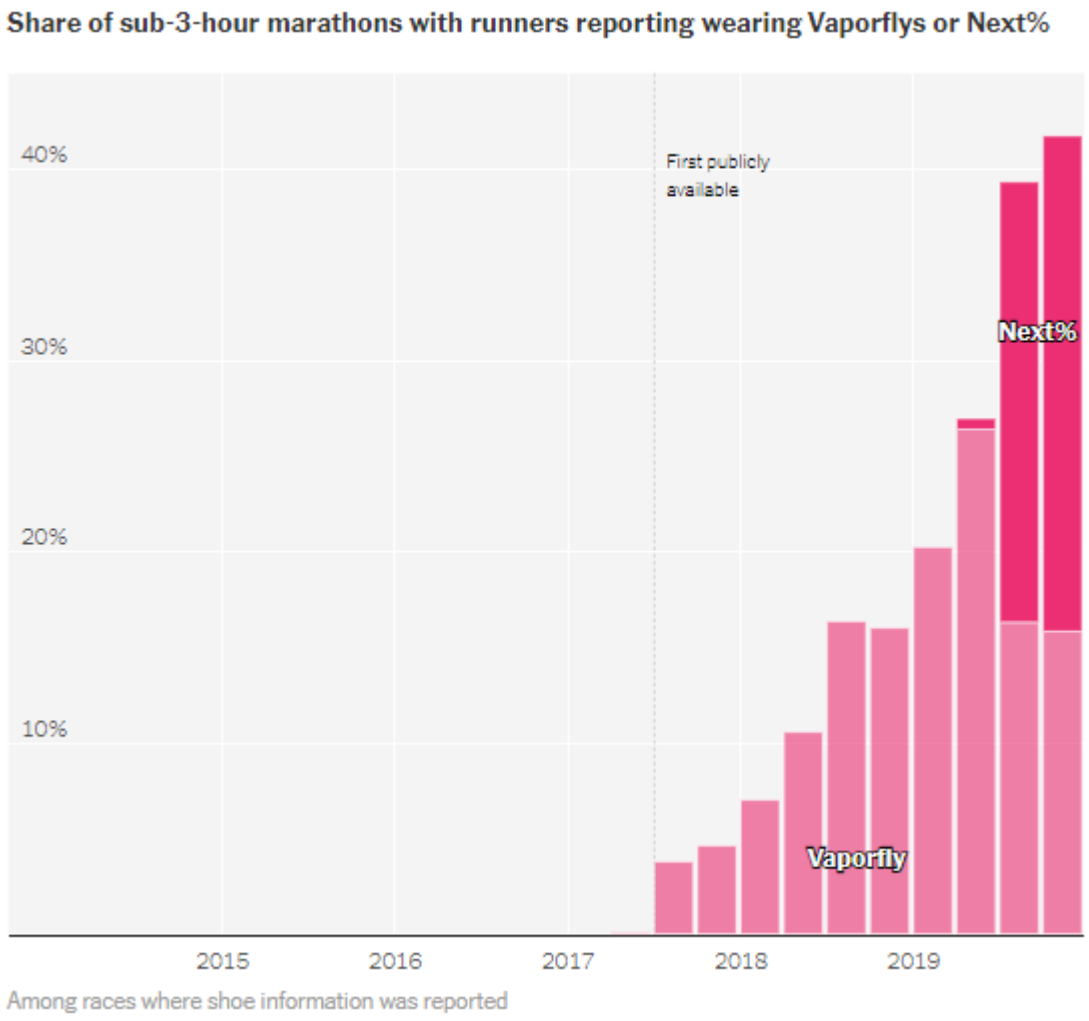
Transport (COT) is reduced by 6% or more when they lace up a pair of high stack height shoes with carbon plates. This response, shown by studies to exist in 10% of elite runners, negates the need for a VO2max or running economy in the 95th percentile, and is a characteristic of every Olympic medal winner tested in the last two decades". Also, interestingly he focused on the fact that rearfoot strikers (people who land towards the back of their foot) benefit more than those who are forefoot strikers: ***"The consistent theme of the studies is that rear-foot strikers get larger benefits than forefoot strikers, and this study also showed that those with shorter ground contact times get a larger positive benefit (not surprising)."***

A study carried out by Slippery Rock University's Ben Gordon concluded that "The carbon fibre plate acts as a lever to roll the athlete's foot forward and contributes to performance by getting them to roll through the gait cycle more efficiently. When you combine a soft responsive cushion and a carbon-fibre plate for stability that doesn't compress as much, those things together maximize energy return and have been shown to reduce metabolic cost." [5] New York Times used platforms such as Strava, a social network where individuals can share their physical efforts for friends and others to view, to evaluate the changes in personal bests since the introduction of the shoes in 2018. They estimated that the shoes have up to a 5% improvement in performance, whereas the closest competition supplies a 2-3% improvement in performance. [6]



The report also estimated the probability of recording a personal best when wearing the shoes for the first time, as well as recording the number of personal bests at the Chicago

Marathon and the percentage of those that were run in either Vaporflys or Next%'s. The results are shown in the table and chart below:



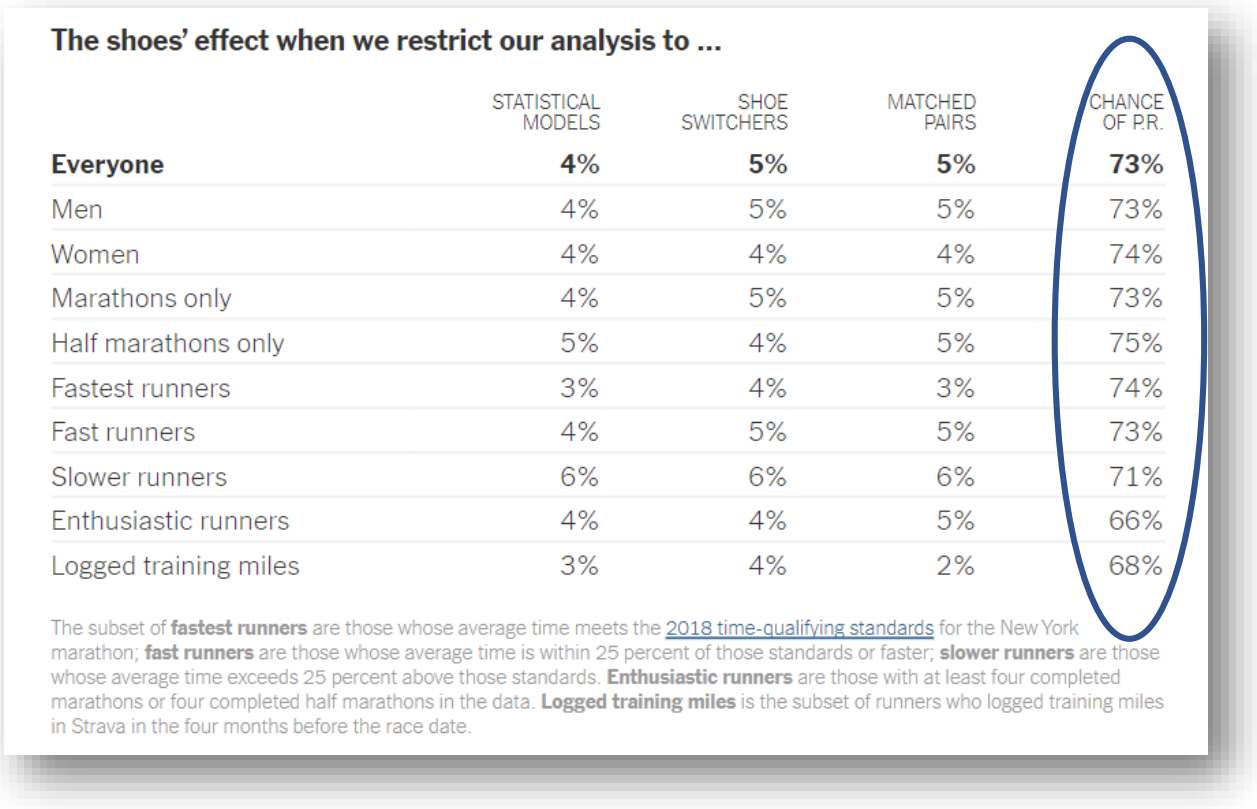
World Athletics Rules:

In 2019, the rules regarding shoes were that they "must not be constructed so as to give athletes any unfair assistance or advantage." It did not specify what such advantage might be. Many complaints about the lack of restrictions led to World Athletics introducing new rules.

[7] As of April 2020, the following rules were introduced:

- The sole must not be thicker than 40 mm.
- The sole must not contain more than one rigid plate (made of carbon plate or other material) covering either the entire length of the shoe or part of the shoe. The plate can be in more than one part, but they must not overlap.
- The shoe must not be a prototype: it must have been on the market for at least four months.

- Carbon fibre shoes aren't allowed to be used on track as of 2021 (carbon plated racing spikes are allowed however)



The shoes' effect when we restrict our analysis to ...

	STATISTICAL MODELS	SHOE SWITCHERS	MATCHED PAIRS	CHANCE OF P.R.
Everyone	**4%**	**5%**	**5%**	**73%**
Men	4%	5%	5%	73%
Women	4%	4%	4%	74%
Marathons only	4%	5%	5%	73%
Half marathons only	5%	4%	5%	75%
Fastest runners	3%	4%	3%	74%
Fast runners	4%	5%	5%	73%
Slower runners	6%	6%	6%	71%
Enthusiastic runners	4%	4%	5%	66%
Logged training miles	3%	4%	2%	68%

The subset of **fastest runners** are those whose average time meets the 2018 time-qualifying standards for the New York marathon; **fast runners** are those whose average time is within 25 percent of those standards or faster; **slower runners** are those whose average time exceeds 25 percent above those standards. **Enthusiastic runners** are those with at least four completed marathons or four completed half marathons in the data. **Logged training miles** is the subset of runners who logged training miles in Strava in the four months before the race date.

Ross Tucker was very keen to criticise the complacency of World Athletics: ***"Despite the awareness that it was possible to change the sport using the shoe, no policy existed. A vacuum. Into which Nike stepped, with development beginning on a shoe in 2013, first producing the Vaporfly that powered Kipchoge to within sight of a 2-hour marathon, then helping to break just about every city marathon record, dozens of world records at distances ranging from 10km to marathon, and possibly hundreds of other course and national records."*** [4]

"When the difference made by technology is larger than the normal difference between athletes, then the integrity of the result is changed." – Ross Tucker

Later in the article, Tucker highlighted the negative effect it may have on the entertainment for spectators: ***"It's much the same for many sports. I don't want a five-set final at the Australian Open thinking "I wonder if this result would be different if Thiem and Djokovic could swap tennis rackets? If only my guy had a different sponsor". Nor do I wish to watch swimming wondering whether the guy in Lane 4 might actually be a better swimmer than the guy in Lane 5, but with a swimsuit that is 3% worse."***

Opinion of Elite Athletes:

In a talk with young, aspiring athletes, Jake Wightman, a British athlete, who is sponsored by New Balance and is known for his performances in 800m and 1500m, was asked about his opinion on the implementation and use of technology during competition. He believed that the shoes are beginning to "overshadow the performance and success of athletes". However, he also mentioned that "all athletes [can] wear the same shoes or spikes" and that if we didn't embrace changes due to improvements in technology, "we would still be wearing leather shoes". Furthermore, his father and coach, Geoff Wightman, stated that at the end of the day athletes are "remembered for medals and titles, not for the time they ran" and used the quote "shoes don't carry on running around the track once you take them off". As well as the improvement in the facilities, the focus on aspects such as diet and lifestyle have increased massively. It is unfair to not praise an athlete for breaking a record because "they were wearing the best shoes around". All of your competitors have put an immense number of hours into getting to the level they are at by eating the right things, recover correctly and train to an elite standard. A common argument is that records would eventually be broken and that the shoes have just been a catalyst which has sped up the rate which standards would improve.

On the contrary, Kara Goucher, a former member of the Nike Oregon Project, and an outspoken critic of its banned head coach Alberto Salazar, explained how she felt she may have lost out in a place in the 2016 Olympic Games after being beaten by Nike-wearing athletes in the US trials. In the 2019 Ironman World Championship, eight of the leading 15 male finishers and the entire women's podium all wore Vaporfly Next%.

Conclusion

To conclude, I believe that there is a huge issue that needs to be handled extremely carefully by World Athletics. It is quite evident that these shoes do "enhance performance"; however, in 5 years' time I doubt that there will be a large issue with the shoes, as all brands will have shoes which have similar qualities. The new restrictions by the Athletics governing body are much clearer and prevent any huger exploitation in shoe technology. Personally, I believe that they have been calculated in their decisions, preventing the high-tech trainers from being worn during competition on track, but it does not prevent the sport from becoming one which revolves around the income of the individual. During elite performance, all athletes have the ability to wear and utilise the best gear on the market. However, athletes that are not sponsored will rely on making enough money to get the "le crème de la crème" in terms of equipment. This is unfair but is required for the companies producing the shoes to make a profit. The cost of carbon fibre is so large that it is almost impossible to sell a shoe with carbon

fibre in it for less than £160. Due to the fact that there are no negative side-effects of using the shoes, I do not believe that the use of them should be classed as a form of doping.

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How Does Music Affect The Brain? The Science Behind Different Music Preferences

Kyra

There are many different factors that influence music preference including: personal experiences, cultural background or random choices, perhaps our personality and our personal as well as collective identity. There are many different types of research into this area but none of them all agreed with each other which I found interesting so I wanted to found out more to find out the true reason as to why everyone likes different music and seeing if my research linked to other research that was conducted in this area. Using my primary research and the analysis to go with it as well as the conclusions made from gathering a range of secondary research in order to finally answer this fascinating question that has left me wondering what the answer truly is and whether it is purely down to one factor or whether there isn't one standalone factor. Throughout this write up, I will explore these different factors that play a part in this conclusion and link this to these previous experiments as well as my own.

Personal Experiences

One factor that influences musical preference includes an individual's personal experiences. This links to nostalgia and memories that certain songs or music styles link to. For example, this could be where a sad song brings back sad memories or a more upbeat song brings back happy memories or you associate the lyrics with a time or event in your life or even where a specific song has memories attached to it and so you like the song as you remember the memories that were with it. Therefore, if you associate memories with that music, you may like that music as you enjoy the memories that go along with it.

Personality

Secondly, personality links to musical preferences. There are stereotypes that people associate with the different music genres such as the stereotype that more aggressive individuals tend to gravitate towards rock and heavy metal and secondary research proves that this isn't always the case. Two different pieces of research cover this theory and the accuracy that these stereotypes convey. For example, there was a study conducted by Cambridge University, involving 4,000 participants in the United Kingdom which led to the discovery that there is a correlation between brain types/ thinking styles/personality and musical preference. The study involved splitting the participants into 3 groups: empathizers (Type E) which include individuals that focus on other people's emotions, systemisers (Type S) which include individuals that focus on rules and regulations and finally balanced (Type B)

which include individuals that focus equally on both aspects. David Greenberg (psychologist and researcher at Cambridge) and his team found that empathizers tended to "like low energy songs with emotional depth, including sad songs, and genres like soft rock and singer-songwriters" (1), sympathisers tended to "prefer more intense and structured music like heavy metal" (2) but Type B tended "to display a broader range of preferences than either of the other types" (3). Greenberg stated that "We are seeking music that reflects who we are, so that includes personality, that includes the way we think, and it may even be the way our brain is wired." This shows that there is in fact a link between music preference and personality and our social identity.

Another similar piece of research was conducted by researchers at Heriot-Watt University where more than 36,000 participants across the globe were involved. "Participants were asked to rate more than 104 different musical styles in addition to offering information about aspects of their personalities" (4). The researcher (Adrian North) said that "that people do define themselves through music and use it as a means to relate to other people" (4) For example, people who listen to pop "tend to be extroverted, honest, and conventional. While pop music lovers are hardworking and have high self-esteem, researchers suggest that they tend to be less creative and more uneasy" (4). However, individuals that listen to rap and rock "Rap fans do tend to have high self-esteem and are usually outgoing". In the research, they disprove the stereotype or misconception that individuals who like this type of music are seen as aggressive or violent but there is no link between these factors. They found that extroverts "seek out songs with heavy bass lines while those who enjoy more complex styles such as jazz and classical music tend to be more creative and have higher IQ-scores" (4). Therefore, using all of this evidence, one can conclude that whilst there is a link to personality, the stereotype that more aggressive individuals like rock isn't true as there is no research to back up this theory.

Mood

Another factor includes mood on a specific day and how this might affect the music that you choose to listen to as a consequence. This links to another study which was conducted in 2015 by researchers from Yale and Hebrew University where they found that our moods affect which music we decide to listen to. They found that people who are depressed would listen to sad music rather than upbeat music that you would expect. They preferred what is known as low energy music which the participants described as having a calming effect. This links to a previous study from 2011 where the Ohio state professor found that for some people, listening to sad music, produced a hormone known as prolactin (released by the pituitary gland). It results in someone feeling calm or relaxed and is the hormone that is released when we feel empathetic. Another hormone that is also released is oxytocin which has a similar effect and links to studies with slow music, resembled in sad music. The conclusion is that some people release these hormones when listening to music and this is because they have a larger hypothalamic region in the brain which is also where these hormones are produced as it is the area of the brain linked to emotional reasoning and feeling. This shows that if these

people have larger hypothalamic areas in the brain, they are more empathetic as they release these hormones more readily and so are part of Type E which is empathisers and hence why they prefer low energy songs with emotional depth. Sympathisers have larger cingulate and dorsal medial prefrontal areas which are the areas responsible for analytical those part of the balanced category, have the normal proportions and so have balanced music preference. This is proof that music preference is down to more than just random choices and actually to the proportions of the brain and how this links to the processing of different music.

Culture

For the next factor of cultural backgrounds, it links to consonant and dissonant which are different intervals: Consonant is where the intervals are seen as stable and harmonious and dissonant is more unstable and harsher sounding. Initially, it was believed that everyone preferred consonant intervals over dissonant intervals and that it was innate or part of the human nature. However, research conducted in 2011 and again in 2015 by Josh McDermott and Ricardo Godoy proves that there is a balanced preference to consonant and dissonant but in America, consonant intervals is much preferred. They travelled to remote areas such as Tsimane where they would have little or no exposure to these different intervals and asked them to listen to different music either consonant or dissonant and say which they preferred and found that the preferences were equal which shows that this preference isn't part of our biology or universal as it is different for different cultures and countries, but in fact learned (nurture) by the amount of exposure to each interval. This links back to the other research where it is the familiarity that creates the preference rather than already having it from birth. Therefore, if someone is exposed to more consonant music such as western music or the Beatles for example which is mostly part of the major scale (upbeat and happy) or if someone is exposed to more dissonant music such as classical music, this is more part of the minor scale (dramatic and gloomy) they are more likely to prefer music with these criteria. This is as part of our music preference has been learned overtime due to exposure which links to where we grow up and our culture as they might have different preferences depending on the cultural backgrounds.

A Wealth of Factors

As well as the more complex factors that affect musical preferences, there are simpler factors that include: age, gender, social class and as mentioned before, cultural backgrounds. For example, different age groups would've grown up with different music and so were exposed to different music to others and this means that they would have different musical preferences. Different genders may be more likely to listen to certain types of music by stereotypes for example. Social class is another factor that plays a role as for example, people of a higher class might be expected to listen to certain types of music such as opera or classical music due to stereotypes for example of growing up with this music due to the stereotypes that could've become what their family listens to. This links to Normative Social Influence

which is where an individual conforms to feel accepted as part of a group and not to be rejected. A real-life example of this is someone in a friendship group listening to a certain style of music just because the rest of the group does, even if they don't truly like it themselves. This could just be compliance, where they would only listen to the music around their friends, identification which would be where they would listen to the music but would still prefer someone else and listen to something else too or internalisation which would be where they would listen the music both publicly and privately because it has become part of their beliefs as their beliefs have changed to them truly liking that music as they have accepted the 'norms' and it has become part of their identity/ personal beliefs.

Conclusion

In conclusion, it has become apparent that there isn't one standalone factor or contributor that influences or determines musical preference as there multiple. These include more complex factors such as personal experiences, personality types, your mood, childhood and your cultural background. There are also simpler factors that include: age, gender and social class. We know that music is part of someone's identity and how they see themselves as well as a way of expressing yourself. This can be part of a collective identity where someone is part of a group or culture where they share an interest in certain music as part of the group or culture. This could also be where someone is influenced by others such as friends or as part of that group where they feel obliged to like a certain type of music when they truly don't. A term used to describe this is Normative Social Influence which is where individuals change their behaviour to be accepted and feel part of a group. The music that we prefer creates a response and brings up memories and feelings which is different for every individual but affects the way the auditory information is processed, with regards to the hippocampus and so regardless of the genre, it is the familiarity which evokes the response where you prefer the music and not the genre itself. Using all of the research that I have discovered and used this to create conclusions to the answers of my questions, I have found out that the multiple factors all contribute to musical preference. It is proven that musical preference isn't down to random choices as it is more complicated than that and in fact links to the brain where it was discovered that individuals with a larger hypothalamic region of the brain tend to be more empathetic and are known as empathisers or Type E and through multiple researchers' research, they are proven to listen to low energy songs with more emotional depth as having a larger hypothalamic region means that more prolactin is released which makes us feel more relaxed and at ease and therefore more empathetic. Our musical preference can change depending on our mood. For example, when we are sad, we listen to more emotional songs as we get that calming affect (proven in 2011) or when we are happy or working out, we listen to more upbeat or happy songs to match your energy. This shows how we listen to music that reflects how we feel mood wise or how we see ourselves in relation to our identity. Personal experiences links to nostalgia as we associate that song and we may not actually like the song itself but the memories that we associate with it brings us joy and so we listen to those songs

to experience that joy again. As mentioned before, personality does play a part in the music that we gravitate towards and whether we are an empathiser, a sympathiser or balanced but the stereotype that people who listen to rock or heavy metal have to be rebellious or aggressive or those who are polite have to listen to classical music isn't true at all so this theory was disproved as there is no research to back this up at all. Our cultural background plays a part in whether we prefer consonant (stable) or dissonant (unstable) intervals as well as discovering that it isn't actually innate to prefer consonant variable as it is nurture or learnt instead and differed from person to person. Also, the songs or type of songs that we listened to when we were growing up or are part of our childhood mean that we normally like these songs as we associate our childhood with these songs of genres or it could be due to the familiarity rather than the genre itself. The simpler factors that are also involved include age which links to our childhood as to what was popular when we were growing up and the familiarity rather than the genre as to why we prefer this type of music or song. Gender could also be involved stereotypically but there is no research to back up this theory. Social class also links to stereotypes but it is not true that class is involved in our music decisions. Finally, using all of this evidence as a collective, it proves that there isn't just one factor that influences our musical preference but multipole that combine to form our music taste and the songs and genres that we decide to listen to.

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Bias within the American Judicial System

Justine

Thesis

Bias is present in the judicial system due to individual and collective issues that arise in court proceedings surrounding different aspects of criminal cases.

Introduction

In a place where the environment is kept professional under the rules of the law, there are many aspects that can result in bias showing through in the court room, both individuals in the law field (the judge and jury) and societal issues (attitudes on race, gender, and age) play a role in this matter. From the individuals who decide the fate of the criminal, to the hierarchy of the courts there are multiple obvious, and other more subtle, circumstances for bias to be affective in a case. Over many years of improvement, and wider knowledge of the topic, the system is becoming more modernised and equal amongst all persons who stand before the judge in the courtroom however, in any situation there is always an opportunity for bias to be influential to the case.

Types of bias that can be consciously or unconsciously present during court cases

Bias can be present in court both consciously and unconsciously because of the human brain's natural tendency to connect new thoughts and experiences to previous personal involvements, and therefore the individual is unable to distort between the two separate situations. This relates to the umbrella term 'cognitive bias' [1] which is a systematic way of perceiving specific situations or circumstances as a third person party. The two types of cognitive bias are 'conformational bias', which relates to an individual's inclination to relate preconceived information to personal experiences and values, therefore making it more likely for a judge to be influenced to change their professional opinion. The other type of cognitive bias is 'contextual bias' where the judgement of experts is majorly affected by unrelated information that is presented to them during the hearing. All of which a judge should aim to avoid during a court case ruling however, both types of bias are affective when judges are evaluating evidence and therefore when coming to a final finding which could result with the opposite expectation to what would be morally and factually correct. It was found in a survey from the United States Sentencing Commission that 'in most cities, the length of a defendant's sentence increasingly depends on which judge in the courthouse is assigned to his or her case' [2] meaning that there would be a difference in interpretation on each case

[1] https://www.judiciary.uk/wp-content/uploads/2018/02/stafford-biases-in-decision-making-winter-2017.pdf

[2] U.S. Sentencing Commission, Intra-City Differences in Federal Sentencing Practices: Federal District Judges in 30 Cities, 2005–2017, at 29 (2019)

from the deciding judge, which is strongly connected to cognitive bias and therefore suggesting that judges are not impartial in some cases.

There are two types of judicial bias that can be created in courtroom proceedings; actual bias, which occurs when the judge is a party to the litigation and has an interest in the outcome of the case and apparent bias, which can arise when a judge's behaviours are not impartial when the final decision is announced however it is not because of a particular interest, affiliation, or allegiance to the case. Both of which can affect the concluded decision of the case and therefore affect the future of the individual drastically, however, if a juror or judge were to take an 'Implicit Association Test' (AIT) it would present any associations between factors in the case, pretrial, which would stop unconscious bias. Implicit Association Tests are a test to establish the amount of time it takes for an individual to link two factors together to present a mentally positive or negative mindset. [3] It has been established from performing the tests on mock jurors that it is an effective way to reduce the amount of bias which can be seen in the courtroom, for example using jurors from Hawaii, the results showed that in the court room the individuals had a strong implicit association with black males and guilty verdicts. Therefore, presenting that everyday environmental and social factors and implicit associations can change the verdict of a court proceeding.

The role of the jury in court

Pretrial, there are a group of individuals[4] , jury consultants, specialised in social sciences, communication, psychological studies, or former law backgrounds who select the jurors for each case, checking their background to avoid any bias that may occur from personal experiences through conducting juror research. The jury, a group of 12 uninvolved people[5], are assigned to sit to one side of the courtroom whilst the hearing is proceeding and use the evidence presented to them to acknowledge the guilty state of the defendant, and to come to a collective decision where the majority answer is the given conclusion. Having a group of 12 uninvolved individuals take in the presented evidence and conclude as a whole, lowers the possibility of any individualistic bias, however judicial bias is caused because the jurors are able to draw inferences from what is said in the courtroom; therefore, it leaves room for differences in thoughts to be accounted for in the final decision.

In America, there is a wide issue of racial discrimination, which was aided by the 'peremptory challenge'; a challenge for cause that a lawyer can exclude members of the jury without a reason, with the belief that it will be in the best interest of their client. [6] An example of this challenge created an issue in the Batson v Kentucky case[7] as the potentially discriminatory

[3] https://blog.scholasticahq.com/post/eliminating-bias-criminal-courtroom/
[4] https://www.opveon.com/blog/the-who-what-why-of-jury-consultants
[5] https://www.citizensinformation.ie/en/justice/courtroom/jury.html
[6] https://www.law.cornell.edu/wex/peremptory_challenge
[7] https://www.supremecourt.gov/opinions/19pdf/17-1618_hfci.pdf

peremptory challenges could influence the composition and fairness of the seated juries. [8] The severity of the accusations were heightened from the concern of the role of jury consultants because of the possibility for them to 'assist trial counsel by actually creating biased jury'. However, in each court case there are a number of challenges which can be used, one being the 'challenge for cause' which is a way for the lawyer of the defendant to eliminate one of the jurors on the base of existing knowledge of the event or person, prior to the court hearing which could affect the overall outcome. [9] A challenge for cause is a more impartial way to remove individual jurors from the situation as to stop wrong agreement in difficult or uncomfortable situations when in a group. [10]

The process of the American judicial system

Each state in America, has their individual federal system which enables defendants in the court to be defended with the case drawing to a settled and mutually agreed conclusion. The federal courts have three main levels: The District Court which deals with general trials, the Circuit court which is the intermediate level of courts to settle more major disputes from district courts, and the Supreme Court which deals with controversies under the law. All of which provide protection of the individuals constitutional rights whilst having their case heard and resolved through a third person party. Commonly, the judicial system can be referred to as a 'chain system' with all the courts houses leading up in hierarchy to the supreme court in order to resolve legal disagreements, discipline those who act wrongfully against the law as well as evaluating the innocence or guilt of each person who stands before the judge. However, within the court room there can be bias present from the judge, causing judicial disqualification, and jury based off of the behaviour and attitudes of the defendant. This is most commonly caused by judicial misconduct, a term used for when the judge lacks impartiality during a case and therefore concerns are raised about the behaviour presented by the judge. Commonly, during a court proceeding, no one present is allowed to acknowledge or be informed of the mistakes made by the judge which further increases the risk of bias being present. During the process of a court hearing, decisions are made behind closed doors about judicial misconduct and as a judge an individual is not held to the same amount of strict accountability like other members of the profession, solicitors for example. However, due to the secrecy of the procedure, other persons of the court are unaware of the accusations which creates a chance of a downfall in the case being trialled, being that there could have been an unfair or unjust ruling in which the lawyer could use to go in the favour of their client.

[8] https://core.ac.uk/download/pdf/216743874.pdf
(476 U.S. 79 (1986), modified by Powers v. Ohio, 499 U.S. 400 (1991)
[9] https://www.law.cornell.edu/wex/challenge_for_cause
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A solution for wrongly convicted criminals

Over the years, bias has been the cause for the wrongful conviction of many criminals however, with the introduction of The Innocence Project, over 360 cases have been won[11], providing a clear and trustworthy solution to those who have been imprisoned unfairly. Two gentlemen, named Peter Neufeld and Barry Scheck, in 1992 founded the organisation so to ''free the staggering number of innocent people who remain incarcerated, and to bring reform to the system responsible for their unjust imprisonment.''[12] The legal organisation uses DNA to reconfirm the clients' guilt, leading to 43% of the clients being proven innocent and 15% being inconclusive. The Innocence Project as an organisation uses multiple types of DNA tests in order to receive an accurate and specific result which will enable the conclusion of the case being solved, each test focuses on specific samples being taken from the criminal, in order to get the most accurate and relatable results. DNA testing is used in 5-10% of criminal cases which can also determine the reasoning why the criminal was wrongly convicted in the first place.

Other options to solving the number of erroneously convicted criminals is through forensics, during recent years forensics have been more reliable in the response to only convicting criminals that are seen to be guilty with multiple reasons leading to their conviction. Forensics were first used in court in 1784, however, since then technology has progressed hugely into more detailed and reliable sources, such as entomology (using insects to highlight key factors in the body such as time and place), fingerprints, ballistics (evaluating evidence from a firearm or weapon that could have been used at the crime scene), and autopsies. These solutions are seen as valid and reliable sources to prove or disprove the guilty state of an individual, more so than any eyewitness testimonies from the event if there is any. In criminal cases it is difficult to prove anything using eyewitness testimonies as discovered in a recent study by Loftus and Palmer [13] where they tested the effects of anxiety, misleading questions, and post-event discussion on eyewitness testimonies, hence why forensics are so heavily relied on to prove or disprove the innocence of an individual.

The effectivity of attorneys and sworn testimony

Sworn testimony is a process which each witness has to undertake before taking the stand in a case, to ensure that the truth is the only thing being told in any evidence explanations and therefore, if any lies are found to be said, the witness can be charged with perjury as they are immune from civil liability. In some cases, the judge has to finalise the ruling based solely on the testimony of the witness meaning that the conviction of the defendant is depending on whether the witness is telling the truth or not, through psychological study of body language it would be able to be worked out if a witness is lying whilst talking; playing with hair or being

[11] https://innocenceproject.org/research-resources/
[12] https://innocenceproject.org/about/
[13] https://www.simplypsychology.org/loftus-palmer.html

vague for example [14] although, without the conformation of another witness explaining an opposing statement or the individual actually confessing that they lied there would be no true way of knowing. An example of the ineffectiveness of sworn testimony is the case of Alex Heineman[15] where an innocent young man got wrongly convicted as a teenager for second degree sexual assault based on his DNA being on the neck of the victim, after she refused to have a vaginal DNA swab. After being moved around because of his mental state, the victim later admitted to the police that it was a lie and all the charges against Heineman were dropped, although he still had a criminal record for not returning on bail from being in an unstable state physically and mentally. The situation led to it being his word against hers, creating self-leniency bias (bias that occurs when someone gives one side of the story more positive attention and favour over the other side with no meaningful and accurate evidence). However, during the court hearing the opposing attorney is allowed to cross examine the witness, asking them leading questions to gain more evidence to help their side of the story. By using leading questions, perceived bias is formed as the attorney would be adjusting the thoughts and opinions on the situation and be creating falsified images which the witness would explain, giving an untrue statement and therefore going against the court law. With cross examination being an important part of witness testimonies, attorneys have to stay aware of what is being questioned as the opposing side can impair the witness credibility through making comments based on 'prior inconsistent statements' which can be expressed from drifting from the topic, or when the witness has said something differing from the original testimony that can be clarified by asking the witness to reiterate what they said to minimise any mistakes , 'case-specific impeachment' when the witness may have a strong interest in the financial benefits that sway the importance of the truth being told, and 'character evidence' which arises from situations where the witness may struggle to recollect information or perceive the situation differently.[16] This process allows the attorney to reinstate their original point after the conflicting side provided a biased counter argument which would have a negative effect on the original case.

Conclusion

The American Judicial System clearly has room for bias aspects to influence the conclusions of a court room proceeding, both in past times and present people have been processed throughout the slightly corrupt system with aspects of bias subtly affecting their case. The main factor of the reasons for bias is evidently the individuals under the law, jurors and the jury consultants, the judge and the lawyers both consciously and unconsciously allowing evidence to be accepted that is not properly backed up or explained in order for the case to have a desired result. However, the process of the American court, having a hierarchy dependent on the severity of the case being trialled, also affects the outlook on the case, being that in a higher court with a more serious case would have a different expectation to

[14] https://www.verywellmind.com/how-to-tell-if-someone-is-lying-2795917
[15] https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=5861
[16] https://www.plaintiffmagazine.com/recent-issues/item/cross-examination-to-impair-witness-credibility

just a district court with a minor case. On the other hand, social expectations of criminal cases and their treatment in court changes as years progress so in years to come it could be expected that there may be more bias being that the American traditional outlook on criminals is being modernised so persons in the law field would have a higher inclination to be less harsh on individuals as society expects everyone to have a second chance.

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The Impact Of Gene Editing On Humanity

Ollie

Introduction

In 2012 a new gene editing technology called CRISPR-Cas9 (Clustered Regularly Interspaced Palindromic Repeats) was discovered, introducing radical change to the future of medicine and humanity itself. Gene editing harnesses many applications in medicine and could treat individuals of genetic conditions and eliminate harmful mutations. There is fear that this technology could lead to exploitation and misuse, negatively impacting society and introducing further levels of inequality. However, the research suggests that although there are dangers associated with using this technology, effective global standardization and extensive legislation will guarantee the safety of humans. Although people will abuse the technology, it is important that we continue to progress in implementing CRISRP-Cas9 as it will ultimately benefit humanity.

The Technology of CRISPR-Cas9

Our genome is a set of instructions that provides the foundations for an organism to grow and develop (Your Genome, n.d.). Scientists have developed a method where the human genome can be edited using technology that takes inspiration form a bacterial immune system. CRISPR was first discovered in 1987 when studying bacteria, where scientists at Osaka University observed a gene containing repeating segments of DNA with embedded non-repeating DNA sequences (Marks, 2016). The spaces that separate the regular DNA repeats are DNA segments copied from viruses that have attacked the bacteria before (Vidyasagar, 2018); this process creates memory bank that the bacteria can use to identify threats. From these CRISPR arrays, RNA segments will be made to target the DNA of the virus. To complete the immune response, a Cas9 molecule will cut the DNA, which will inactivate the virus (MedlinePlus, n.d.).

This bacterial mechanism has been developed into a powerful tool used to edit the human genome. Jennifer Doudna, a geneticist at the University of California, co-discovered a method of transferring the bacterial behaviour into a technology allowing cells to edit the DNA at a specific location. Scientists can provide a piece of guide RNA (the gene/part of DNA they wish to target) to the Cas9 protein, the molecule will move along the DNA strands until it locates and binds to the 20-letter long sequence that matches the guide RNA sequence (Page, n.d.), the guide RNA will unwind the DNA. “Then the RNA plus the protein [Cas9] will cut – like a pair of scissors – the DNA at that site, and ideally nowhere else” said by George Church of Harvard Medical School (Vidyasagar, 2018). The Cas9 enzyme will act as biological scissors to cut the DNA at a specific place -inactivating the gene. Following the cut, the cell will attempt to repair the break by joining the ends at the site of the cut. This is known as nonhomologous end joining, this process can lead to errors and the addition of bases incorrectly; inactivating

the gene (How CRISPR lets you edit DNA - Andrea M. Henle, 2019). Homology directed repair is an alternative repair process in which scientists add a template DNA to the repair site, where cellular proteins can repair a defected gene or insert a new gene.

Benefits

Somatic Gene therapy is a method where specific types of cells are targeted, the edited gene will only appear in the targeted cell type, meaning that if any mistakes made in the process, these errors will only apply to the individual and not pass to future generations (Bergman, 2019). Genetic disorders arise when there is a change in a DNA sequence, caused by a mutation in one gene (monogenic disorder) or multiple genes (multifunctional inheritance disorder). Some mutations are inherited from parents and are present at birth, however some mutations can be acquired through a person's life due to environmental factors (National Human Genome Research Institute, 2018). For example, sickle cell disease is caused by a mutation in the DNA sequence, the letter A is replaced by the letter T at the specific locus. Tshaka Cunningham, Minority Coalition for Precision Medicine, explains that the protein is prevented from folding correctly by the mutations, disrupting the structure and function, hence causing the red blood cell (RBC) to collapse. The RBC's struggle to transport oxygen to different parts of the body, reducing the function of different tissues (BBC Storyville (2020) The Gene Revolution, 2020).

A new gene therapy called CTX001, developed by Vertex alongside CRISPR Technologies, is a treatment plan where the patients original blood cells are removed and are replaced with foetal haemoglobin. CRISPR-Cas9 will edit the b-globin gene to produce high levels of foetal haemoglobin, this type of protein is usually present throughout the first four months of age and has a high affinity for oxygen. In July 2020 Victoria Gray, the first patient to undergo this treatment, revealed that her symptoms had been reduced significantly and her pain had disappeared. The trial demonstrated that CRISPR-Cas9 increased levels of foetal haemoglobin, enough for the patient to no longer needing blood transfusions.

Other therapies utilising the CRISPR-Cas9 technology are being developed: Dr. Matthew Porteus of Stanford school of medicine and Dr. Donald Kohn of UCLA suggested that CRISPR could be used to repair mutations that are responsible for sickle cell (Prabhune, 2021). This shows that not only can gene editing be used to edit a mutation that is directly causing diseases, but it can be manipulated to target other certain cells or processes that can reduce the effect of that mutation.

Like with every new technology there is an opportunity for someone to misuse and weaponize, CRISPR-Cas9 technology could be used as a weapon but that doesn't mean that we should not proceed. Alta Charo, Bioethicist at the University of Wisconsin-Madison, stated their opinion:

> *"But I don't think the technologies are inherently good or evil, the technologies are tools, they are power. What you do with the power determines if the result is something that we applaud or something we deplore. But it is not the tool that determines the end point, it's the user." (BBC Storyville (2020) The Gene Revolution, 2020).*

Governments across the world will need to produce legislation to determine the uses of gene editing technology, this should provide a level of global standardization to reduce the risk of misuse.

The Nuffield Council on Bioethics has outlined guidance on germline editing, "We recommend that before any move is made to amend UK legislation to permit heritable genome editing: there should be sufficient opportunity for broad and inclusive societal debate." (Nuffield Council on Bioethics, 2018). The enrolment of the technology will be based on evidence and trials that provide enough reason to safely provide CRIPR-Cas9 to the general public. Naomi Freud, Director of Studies for Human Sciences at the University of Oxford, clarified "Its applications are carefully monitored, as they should be, and there are committees who determine the ethics behind research and applications" (Burley, 2021). So although there are risks that are inevitably going to arise, it is important to be aware that this technology will need to be carefully implemented; and will be applied in a safe and considered approach.

Issues/Ethical Concerns

As well as therapeutic uses, gene editing also can modify the genome to bare specific genetic traits, improving healthy individuals rather than people in need of medical treatment. It is possible that certain social, economic and political powers would pressure those perceived as "unfit" to alter their genetics to conform to external expectations (Baylis, 2018). At the World Festival Of Youth in 2017, Vladimir Putin spoke out about his reaction to Gene editing:

> *"...to create a person with desired features. This may be a mathematical genius, this may be an outstanding musician, but this can also be a soldier. An individual who can fight without fear or pain, and what I have just said may be more terrifying than a nuclear bomb" (BBC Storyville (2020) The Gene Revolution, 2020)*

Initially it could be interpreted that Putin was expressing his bad intensions. However, Putin was merely highlighting the dangers and comparing the global impact akin to a nuclear bomb. If at some stage strength as a trait can be altered genetically, there is the possibility that military groups could abuse CRISPR-Cas9 for selfish reasons, creating armies of people that are genetically 'superior' to the general public. Naomi Freud explains that "Just because you CAN do something, does not mean you should" (Burley, 2021) suggesting that correct usage of this technology might be down to moral judgement. There are many ethical and medical concerns with CRISPR however The National Academies of Sciences, engineering and

medicine warn that “caution does not mean prohibition” (Vidyasagar, 2018); it is important that we pursue this technology at a slower pace with greater regulation as opposed to halting the implementation of CRISPR-Cas9 entirely.

Genes are complex and are responsible for many different functions, by altering one gene you risk affecting other functions; germline editing will permanently introduce the edited gene into the gene pool, making it difficult to reverse. On December 30 2019, He Jiankui was sentenced to three years in prison by the Shenzhen Nanshan District Peoples Court, his sentence was agreed as he genetically edited the genomes of embryos. In 2018 Jiankui and his team, at Southern University of Science and Technology in Shenzhen, edited human embryos to make them less susceptible to HIV using CRISPR technology. CCR5 is the gene that is responsible for allowing HIV into the cells to infect, by using gene editing technology Jiankui could alter the CCR5 giving the embryos resistance to HIV. However, A study at the University of California looking at 410,000 people in the UK, found that you were 20% more likely to die before turning 78 if you had a mutated version of the CCR5 gene. Although making people more vulnerable to HIV, it also is involved in fighting off other infections; as well as active in the brain (Gallagher, 2019). This is an example of germline gene editing, where all cells of the organism (including sperm and egg) are affected, passing all modifications to future generations. Mark Mercola, a professor at the Stanford Cardiovascular Institute, said “The idea of editing human embryos makes a lot of people queasy and it should” “CRISPR isn’t perfect, and when you alter embryonic DNA, the results are passed from one generation to the next” (Shwartz, n.d.). Naomi Freud expressed “Any manipulation of DNA has risks associated with it. Sections of DNA may be associated with one condition or trait but also influence other genes required for other processes” (Burley, 2021). It may be the case that it is beneficial to carry a certain mutation. Having one sickle gene and one non sickle gene will alter red blood cells slightly but not enough to cause major issues. The organism that causes malaria dislikes the altered blood cell shape; having a single sickle gene will act in your favour against severe malaria. In areas like the Mediterranean and Africa, where the environment is known for a high prevalence of malaria, it is preferential to carry a single sickle cell trait than not (BBC Storyville (2020) The Gene Revolution, 2020). Matt Porteus, a sickle cell researcher, highlights “The relationship between our genes and our environment is incredibly complex, and we don’t understand that.”, when editing what we think is an isolated gene providing one function, may have other evolutionary benefits. By ‘correcting’ a mutation that we believe to be a threat may be exposing us to other dangers, threatening not only the individual but creating a vulnerable population. However, Germline editing offer hope for many parents who are aware that they carry a genetic disease, CRISPR-Cas9 could offer a means of eliminating that risk from their offspring. Jeff Carrol (a researcher at Western Washington University in Bellingham) and his wife decided not to have children when he discovered that he had the mutation that causes Huntington’s disease (Ledford, 2019). Although germline editing is not widely accepted yet, for many people the prospect of being able to prevent

genetic disease in their children is ground-breaking and could offer hope for those who fear passing mutations on to their offspring.

Inequality is becoming ever more present in today's society – accessibility to gene editing therapies are currently based on economic stability. Spinal muscular Atrophy is a genetic disease that results in weakness of the muscles as a child grows. In 2019 Novartis (a large pharmaceutical company) initiated Zolgensma, a gene therapy where the damaged SMN1 gene is replaced with a functioning copy using a virally delivered system (Irvine, 2019). After the U.S. Food and Drug Administration approved this therapy, Novartis announced that the treatment would cost $2.125 million (Roland, 2019). At this time only a small group of people would have access to this amount of money and be able to proceed with this therapy. But currently the medical expenses for this therapy are high as research, development and clinical trials are expensive for pharmaceutical companies, moreover there is lack of competition from other companies allowing Novartis to price the treatment that guarantees high profits. It is evident that developing countries do not have the access to this technology and the economic stability required could introduce a situation where richer groups of people will be able to benefit from this therapy where poorer communities won't have access. However like with any new drug, prices are very high due to their premature nature. Without competition from other pharmaceuticals, Novartis can price according to exclusivity, but as other pharmaceuticals start offer the treatment prices will drop and become more affordable.

Conclusion

After researching the impacts that gene editing will have on humanity. It is evident that CRISPR-Cas9 is crucial to the progression of modern medicine and offers new approaches when dealing with many genetic disorders. There is fear of a dystopian future where gene editing will give the opportunity to edit other human beings to have certain traits. However, as mentioned, genes are complex and it will very difficult for this to happen. For example, Scientists still have little understanding of what intelligence is. A study (published in *Nature Genetics*) analysing the genomes of 78,000 people, found that intelligence is coded for by at least 22 genes (Battista, n.d.). It's clear that intelligence is coded for by a myriad of genes, as well as the other factors like lifestyle. Intelligence is one of many desirable traits that is currently impossible to alter effectively. CRISPR-Cas9 technology has already been used in the fight against covid-19. In March 2020, Stanford Bioengineering developed a safe method where CRISPR-Cas9 would precisely target and destroy the COVID-19 virus. It showed that coronavirus loads were reduced by 90% in human cells (Anon., 2020). Already CRISPR is being used to ultimately benefit humanity by aiding the fight against global pandemics. Gene editing offers new hope for many patients suffering from diseases, also with the potential to prevent further generations from suffering by using germline editing. Global standardization will be difficult, but possible to achieve. Many advisory groups will ensure that CRIPSR-Cas9 is not exploited and will work with governments across the world to ensure a safe implementation.

Gene editing is the future and will provide great levels of safety for humanity, revolutionising the world of medicine.

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What Fuel Holds The Future Of F1 And Motorsport?

Ryan

Section 1: Fossil fuels and their background

What are fossil fuels?

Fossil fuels are compound mixtures of fossilised plant and animal remains from many millions of years ago, predominantly in the oceans. The type of fossil fuel created will vary depending on the heat and pressure environment in which they are found, these types being: coal, oil and natural gas.

In further detail, the energy in these fossil fuels originally comes from the sun, as plants and microorganisms grow through the use of photosynthesis to utilise this energy into other forms such as chemical energy stored in the individual bonds between elemental molecules. Both plants and animal's basic building blocks are the elements of carbon and hydrogen. It is these two elements which combine together to create hydrocarbons in which the energy is stored over the millions of years after the death of the original organisms. As these fossilised remains of organisms get buried deeper underground, they get exposed to greater heat and pressure. This increase in both variables causes the breakdown of the fossil material and creates new compounds such as kerogen from plankton and peat from plants, these compounds do store energy, however not as much as fully formed coal, natural gas or oil. The final step in the formation of fossil fuels is the addition of time. The initial compounds decompose organically and form the compounds and energy sources that we are most familiar with. Plants become coal and plankton forming natural gas and oil. (Smithsonian)

The limitations of fossil fuels

Fossil fuels are a finite resource, as previously stated they take millions of years to form, meaning they will not replenish themselves in a time period that is short enough for humans to take advantage of. The human race is consuming fossil fuels at a completely unsustainable rate, one in which we will see global oil supplies run out within 50 years.

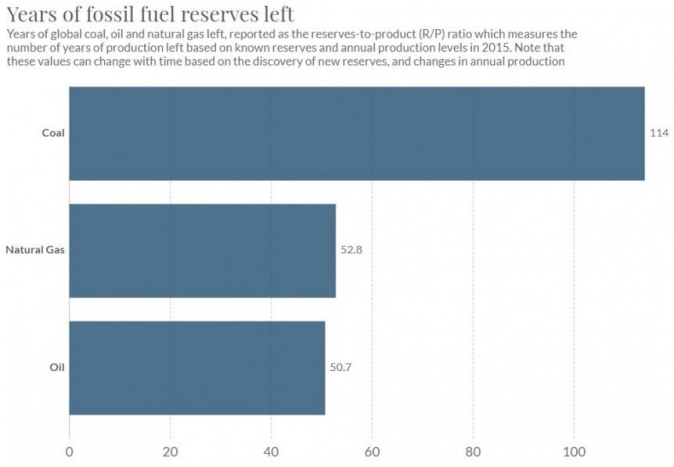

Figure 1 right: Years of fossil fuel reserves left (Our World in Data)

What are the uses of fossil fuels?

The use of coal as an energy source predates recorded history, however it wasn't until the

industrial revolution starting in the 1760s across Europe and the US that fossil fuels became mainstream and fuelled the industrial sectors and countries; These countries then using this discovery and utilisation of fossil fuels to expand and annex a large portion of the globe in their empires. This expansion of empires also allowed for many other areas of the world to begin using fossil fuels for production and manufacturing.

Fossil fuels and their relationships to motor vehicles

The creation of the motor-vehicle is credited to Karl Benz in late 1885, however this was a three wheeled vehicle, creating the first motor company 2 years later in 1888 with the model 3 Benz. The first four wheeled motor car was created in 1886 by Gottlieb Daimler and his partner Wilhelm Maybach, Daimler went on to create the Daimler Motoren Gesellschaft in 1890. These two main players in the automotive market went on to merge on the 1st of July 1926 to form Daimler-Benz AG who created the Mercedes-Benz range of cars, a business still active today.

As shown in the graph adjacent, car production has increased exponentially over from the early 20th century to 2016, with the only significant dips in production being WWII and the global financial crash of 2008. In tandem to this increase in production, even considering the steps taken to increase fuel efficiency, the global consumption of fuels such as diesel and petroleum have also increased exponentially.

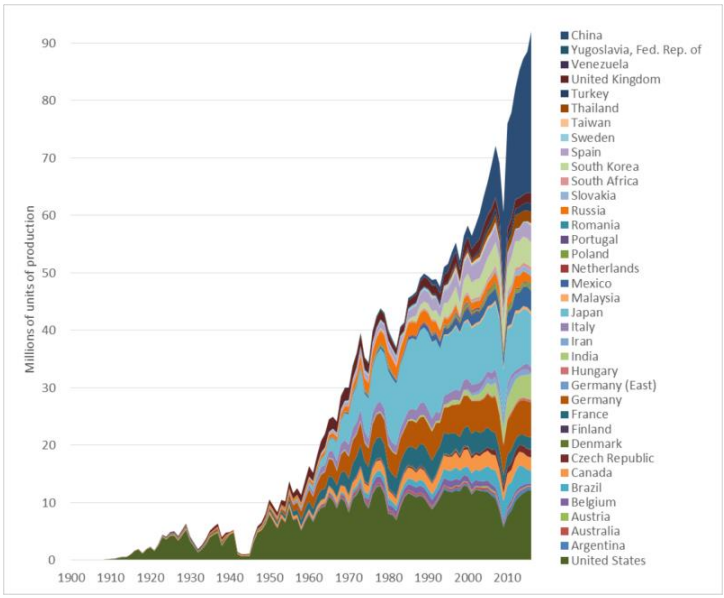

Figure 2 right: Global car production in millions (Qualman)

The demand for fossil fuels over time can also be tracked through the use of global price per barrel. The higher the price, the greater the demand for the product. Specifically in this case, unrefined crude oil. In this graph, it is observed as a positive growth trend over time. However there are certain spikes or dips in price due to uncontrollable economic situations such as recessions (grey areas) and the Coronavirus pandemic in early to mid-2020.

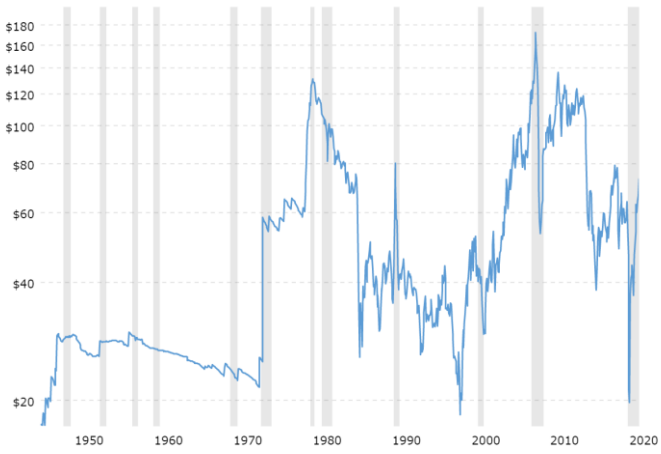

Figure 3 right: Global crude oil price per barrel (inflation adjusted) (Macro Trends)

A short background on fossil fuels in motorsport

Fossil fuels have been the backbone of motorsport for over a century, with the first ever organised race in 1894 by a French newspaper on a route from Paris to Rouen (Gifford, 2006). And then the first recorded motorsport series was established in 1900 as the Gordon Bennett Cup. From their establishment, racing has been centred on the use of refined fossil fuels such as petroleum to power the vehicles that compete. Motorsports saw a sharp, exponential growth in popularity throughout the 20th century as motorised vehicles became more widespread and accessible; with this growth, the consumption of fossil fuels has also increased greatly, leading to a harsh realisation that the motorsport world will have to confront and overcome. What happens when fossil fuels are gone?

Fuel as per the Formula 1 franchise

A modern formula 1 car is now allowed to use up to 110kg of fuel per race, multiplied by the number of cars as well as up to 23 races in a calendar year, the amount of fuel consumed is substantial. Roughly 50,600kg of fuel over the season; this not including the massive amounts of fuel used for the global franchise to reach their exotic destinations. As a percentage the actual race cars only represent 0.7% of the franchise's carbon emissions. (Dixon and Sports Pro Media) Each team will have around 10 trucks, which transport the mobile operations for each team. In a study by the SLoCaT partnership (over 90 individual entities ranging from governments and the UN to private sector businesses) in 2018, it was discovered that heavy and long haul transport accounted for more than half of the total global transport CO2 emissions per year, around 56%.

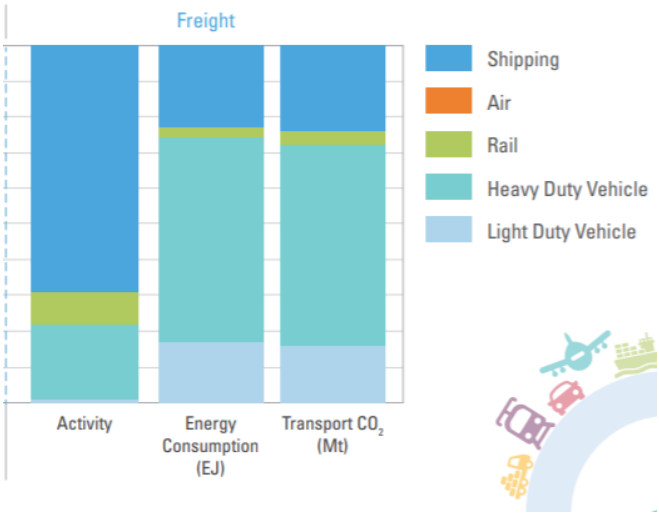

Figure 3 right: Freight Modal Shares: Activity, Energy Consumption and CO2 Emissions (2015) (SLoCaT partnership)

Formula 1 has possessed a global logistics deal with DHL since 2004, which has seen the company transport everything that the franchise needs to be able to compete and televise the competition to over 85 countries directly, as well as the rest of the globe through partnerships with broadcasters. DHL uses a combination of long haul trucking, around 300 full laden trucks for instances such as the European periods of the competition, as well as up to 6 or 7 full freight Boeing 747 aircraft. Unmistakably, this leads to the heavy consumption of fossil fuels for the franchise as a whole, not just the physical races.

The capitalist background of fuel in motorsport

Formula 1 is used as a showground for oil companies to display their products to the global market. Each of the 10 teams is free to source car fuel from any producer that may approach the team as a sponsor, for example Mercedes AMG Petronas F1 team clearly has a fuel deal with the global oil company Petronas, McLaren having a partnership deal with Gulf Oil.

However each of these companies has to supply a minimum octane fuel of 87, the reason behind this being that this is the octane of fuel available at pump stations for the average consumer. This similarity between the fuel used in F1 cars and the fuel available to the global market is used as a marketing strategy by the oil companies partaking in the sport, if the car that uses the fuel is doing well, the more coverage they receive and thus more awareness for their product which is now perceived as high performance. This marketing technique makes both F1 and the individual corporations a significant amount of revenue, a sign pointing towards a future in which F1 will not move away from fossil fuels for a long time.

Current steps to a more sustainable future in F1

For the 2020 season, Formula 1 had regulations in place forcing fuel manufacturers to use at least 5.75% of biofuels with the aim of increasing this fuel mix to 10% in 2021 and onwards. This shows the steps that are being taken by F1 to try and highlight the importance of using carbon neutral alternative fuels. As of mid-December 2020, F1 announced they have created a 100% sustainable biofuel that has been submitted for testing with the four engine manufacturers (Honda, Renault, Ferrari and Mercedes) for testing. This fuel is described as a second generation biofuel variety, being refined from bio-waste not suitable or meant for human or animal consumption. (Elson and Motorsport Magazine)

Formula 1's proposed plans for the future

The governing body above Formula 1, the FIA (Federation Internationale de l'Automobile) have set out plans to be carbon neutral in 2021 and net zero in 2030. This being based on the reduction target plan as laid out in the Paris Agreement. (Formula 1) Initial plans are in place to make the new series of engines compatible with this new 100% sustainable biofuel which will be due in around 6 to 7 years. The usage of these biofuels in the most visible part of the franchise will be an important step in the direction of a more sustainable future as it shows off the benefits and performance of biofuels to the global community. However it will take many more steps for F1 to completely deploy biofuels across the franchise due to the amount of fuel used in transport as previously stated in this paper.

Section 2: Electric energy in motorsport

Formula E

As of 2021, there are many championships competing under sanction by the FIA that currently use electric energy as their source of energy. For example the most comparable to Formula 1 would be Formula E. Like F1, FE is a single seater motorsport championship series that uses electric motor propulsion as an alternative to fossil fuels. It was conceived in 2011 by Jean Todt at the FIA. The first grand prix was held in 2014 in Beijing. The first generation of Formula E cars from 2014-18 highlighted the difficulties that would have to be faced when using a relatively new innovation in electric battery technology; This early stage in the series included mid-race car swaps as the battery technology used was not advanced enough to store the

energy needed for a whole grand prix (a minimum power of 190 kW). Although this did provide for an additional source of excitement for the spectators, many still saw the sport as greatly inferior to its fossil fuel burning counterparts. From the 2018-19 season, the second generation of FE cars were introduced which contained new and significantly greater battery technology with batteries capable of an output of 250 kW, a 60 kW increase on the previous generation, eliminating the necessity of swapping cars mid-race. This was a step in the right direction for electric motorsport as it caused for a more positive public perception of electrified transport. The series as a whole is being used as a platform to demonstrate new and improved innovations on the alternative propulsion method.

Potential franchise conflict

Due to the similarities that can be drawn between both Formula 1 and Formula E, such as racing on the same tracks, similar names, as well as multiple constructors and manufacturers competing in both series, there may be a situation where F1 is unable to utilise the advances made in battery power due to FE possessing an established and mainstream championship doing the same thing. As F1 is the more watched and well-known of the two series, if F1 were to adopt electric power as its method for propulsion in the future, it is likely that FE would lose viewers as well as constructors as F1 is still the more profitable and a greater platform to attract sponsorship to fund their title charges. This conflict of interests between the series may mean that F1 are unable to branch out into complete electrification of racing, causing them to have to seek out alternative sources of power.

Section 3: Hydrogen fuel

What is hydrogen fuel and how is it produced?

Hydrogen fuel in cars refers to converting the chemical energy of hydrogen into mechanical energy by reacting hydrogen with oxygen in a fuel cell to convert chemical energy into mechanical energy through an electric motor. Hydrogen fuel is most commonly produced through a process called steam reforming. This process involves the use of steam in a high temperature process where it reacts to a hydrocarbon fuel to produce pure hydrogen. This process can be completed with many forms of hydrocarbon fuels such as diesel and renewable liquid fuels, however the most common is natural gas which creates a total of 95% of hydrogen fuel. (Office of Energy Efficiency & Renewable Energy) For example, the process when steam reacts with methane produces hydrogen as well as carbon dioxide. Hydrogen production can be split into 4 main categories however only two can be produced using steam reforming, this being grey and blue hydrogen, where the carbon dioxide is released into the atmosphere and when it is mostly captured and stored geologically, respectively.

Hydrogen can also be produced through processes such as electrolysis. This is a process in which water is separated into hydrogen and oxygen. This process does require electricity to be input in order for the water molecules to be split apart into their elements. This method

can be seen as much more promising environmentally as it has the potential to have net zero greenhouse gas emissions when a renewable source of electricity is used such as solar or wind. However this process is much more expensive compared to steam reforming of methane, meaning that hydrogen producers currently have no incentive to produce hydrogen in this more environmentally friendly way.

How is hydrogen fuel turned into mechanical propulsion?

In the case of F1, hydrogen would have to be stored in tanks on board the cars, either compressed to 300x their uncompressed volume or in liquid form which requires temperatures of less than -250℃ which uses significant amounts of energy and resources to complete. This hydrogen fuel will then pass through a platinum catalyst which causes the individual molecules to separate into an electron and a positively charged hydrogen molecule. These electrons can now be sent through an electric circuit in the car, eventually reaching the power control unit which will decide to either send this power to the motor which drives the wheels of the car or to an on board battery to be redeployed at a later instance. After the electrons have travelled through the motor, releasing their energy, they circle back through the circuit and combine with a positive hydrogen ion. Finally, these hydrogen atoms react with the oxygen in the air to create water, the only bi-product of the whole process.

What are the benefits and drawbacks of hydrogen fuel in racing?

Hydrogen fuel when used in a fuel cell is significantly more environmentally friendly when it comes in the form of blue hydrogen or from electrolysis. Using hydrogen in F1 would reduce the amount of carbon emissions from the races themselves to 0, not only does this directly benefit the environment directly but also helps to improve public awareness and perception of hydrogen powered cars.

Not only is hydrogen a cleaner alternative, but it actually has a higher energy density per kg than petrol and diesel. Hydrogen has an approximate energy density of 120 mega joules/kg in comparison to 45.8 MJ/Kg for petrol. Although hydrogen is more energy dense than petrol, in an unpressurised circumstance, 1kg of hydrogen will take up around 11m3 which is about 2.2m x 2.2m x 2.2m, evidently too large for use in a Formula 1 car. The factor perhaps more important for racing is the volumetric density of the fuel source, it is key that race cars are kept to an appropriate size so that they can fit well on track and provide close racing for spectators.

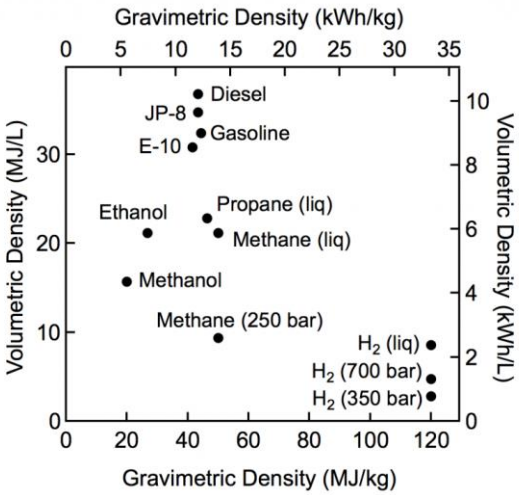

Figure 4 right: Energy density of various fuels for Volume and weight

Hydrogen, as shown in this graph, has a comparatively low volumetric energy density as opposed to liquid fuel such as petrol and diesel. (Office of Energy Efficiency & Renewable Energy) A potential workaround of this storage issue that hydrogen imposes on the sport would be through the addition of mid-race refuelling, unlike electric batteries, hydrogen can be injected into the cars at a rapid rate, similar to the speed of petrol. Overall, a promising sign alternative for F1 but unable to deliver on the core mantra of the sport in sound and excitement.

Section 4: Biofuels

Formula 1's stance

As previously discussed in section 1, Formula 1 currently has plans to utilise advances in biofuel technology to power cars for the next generations of the sport, this shows the professional opinion that Formula 1 have in biofuels and that they believe it will be a sustainable switch they can make work in the long term. Also previously mentioned was the innovation made by F1 as they manufactured a 100% sustainable biofuel which has been submitted for testing by the engine manufacturers.

Biofuel production

Biofuels are liquid fuels which are produced from 100% renewable sources such as vegetable and crop oils and animal fats. It is produced by combining alcohol with fats and oils, regardless of whether they have been used previously. (Office of Energy Efficiency & Renewable Energy) In the case of F1, the fuel that has been developed is produced from plant oils that were not suitable for human or animal consumption, meaning that they are not taking crop away that could have been used to feed the population of humans or livestock, a potential issue that may arise if biofuels become more widespread.

Benefits and drawbacks

Biofuel helps to deliver on F1's most core principles that have been reinforced over the 71 years of racing motorcars. Biofuels can be used in traditional internal combustion engines with very little adaptations being needed, not only would this maintain the sound that fans across the globe love and link with F1 but also it would mean a much less abrupt transition for teams and the franchise as a whole, helping them to keep moving forwards and racing smoothly.

The cost of a gallon of biofuel is also roughly the same price as a gallon of petrol at $6. However, this does not include some of the cost that farmers and manufacturers can make back from selling the by-products of biofuels such as the seed meal which can earn a farmer around $3 per gallon. Thus offsetting the price of manufacture of the biofuel to roughly only $3 a gallon. The main cost of producing biofuels in these early stages is the investment in

infrastructure needed to produce the fuel at an efficient and consistent rate to be able to meet the demand of F1 and potentially other racing series in the future.

Section 5: Conclusion

In reflection of the question I asked at the beginning of this paper, after research carried out using multiple sources and my own opinion after consideration of benefits and drawbacks, I believe that biofuels are the way forward for the Formula 1 franchise, and will be a key stepping stone to help the world better perceive alternative fuels, acting as the catalyst for much needed changes in habit and beliefs worldwide. The evidence gathered points towards biofuels being the best alternative for an iconic and historic sport that needs to remain consolidated with its core values that were created decades ago and need to be upheld for future generations to relish.

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How Has The Coronavirus Affected Human Interaction Over The Last Year?

Essa

Introduction and Thesis

The Coronavirus is the main reason as to why humans interact differently with one another today. However, it can be argued that there are many other factors affecting human interaction such as technology (social media) which has drastically changed the way we communicate for a long period of time.

What is the Coronavirus?

The Coronavirus was a virus that broke out on 31st of December 2019 in Wuhan (China) which started to spread all over the world and by March 2020 the whole world was experiencing some cases of covid-19 within their country. The Coronavirus is still an ongoing pandemic, and it has affected us an individual as to how we can live our daily lives such as going out when necessary or seeing our loved ones. Covid-19 has caused numerous deaths since it has started and has dominated the world as a leading virus.

How has the Coronavirus affected human action/interaction with each other?

The Coronavirus has affected the way human actions in many ways. For example, having to wear a face mask when going out, staying a specific distance away from one another and not making any physical contact. This is a major move from normal life because we must take extra precautions when we go out and we cannot enjoy the things we used to do before. When it comes to interaction, we must also be very aware as to how we speak for example not giving handshakes or holding hands and in offices and schools sanitizing before you touch something. This is a big move as well because we must respect the distance, we stay away from one another and try to communicate a different way in order to keep everyone safe. After all social communication is key to us as humans.

David Crystal and the origins of English Language

David Crystal is a writer, editor, lecturer, and broadcaster. Born in Lisburn, Northern Ireland in 1941. In 2002, he published a book called ‘the English language. A guided tour of the language which is a book about the development of English Language throughout centuries. This all started when Britain was invaded in 449 AD from tribes such as the Saxons, Angles and Jutes. Old English did not have a formal name until the 18th century where it was properly known as ‘Old English’ and since then has been the preferred for the name of this language. The name reflects a view which emphasizes the continuing development of the language from Anglo-Saxon times through ‘Middle English’ to the present day. When we take a deeper look into ‘Old English’ we tend to see it as a language that looks alien because of its distinctive

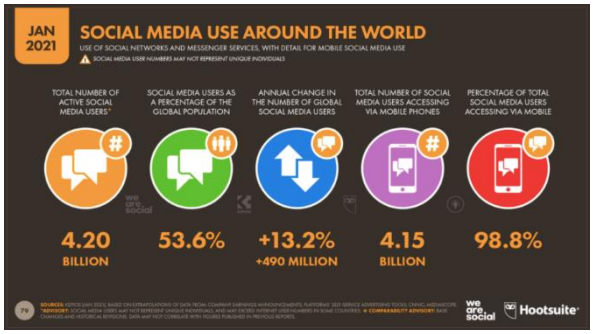
spellings and the great deal of unfamiliar vocabulary and many grammatical differences. Old English was first written using the Runic alphabet. This alphabet was used in Scandinavia (which is now present-day Germany) and it had been preserved in about 4,000 inscriptions and a few manuscripts. The common runic alphabet used throughout the area consisted of 24 letters. It is written from both left to right and from right to left.

Middle and Early Modern English

Middle English emerged from the year of 1066 which marks the beginnings of a new social and linguistic era in Britain, but it does not actually identify the boundary between Old and Middle English. But however, in 1154, the style of writing was quite different. There are points of similarity with the previous work, but the overall impression is that writers were starting again using vocabulary and grammatical patterns which reflected the language of their time and locality into coping with the new spelling sounds. This period of English runs through from the beginning of the 12th century until the middle of the 15th century with manuscripts at either end of this period showing the language in a state of change. For example, in terms of vocabulary, there were enormous numbers of French words which came to the language around 10,000 according to an estimate. This was due to the mechanisms of law and administration but also included words from medicine, art and fashion. Furthermore, there were changes in grammar too with majority of the old English noun endings died away during this period. However, there were some verbs that were carried on from Old English. For example, using the northern use of -es instead of -eth. Early Modern English has developed since 1476 when William Caxton developed the technology of printing in England. Its role was to develop a standard form of English which produced over 20,000 English books the following 150 years. The Renaissance period was the main factor promoting the flood of new publications and it renewed interest in the classical languages and literatures and in the rapidly increased during the following years. This time period sparked around 1650 as the discovery of America had been found and the efforts there were to add these fresh perspectives of English Language were immediate, controversial and far-reaching. William Shakespeare was immensely popular in this time period as majority of his works contained about 20,000 different words. It is also stated that Shakespeare is the first to use this type of language in his famous plays that he has done, and he does it in a clever way because he puts his use of words in a circulation which any way has not been used before.

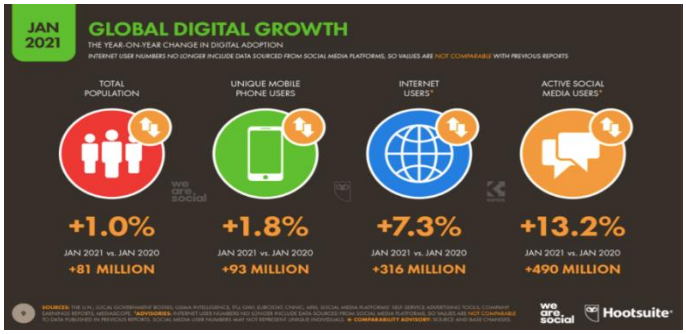
Technology

Technology is a noticeably big part in today's world. It is used by a lot of people across the world. However, it has been changing the world since it was introduced in the 1980s and since then it has developed a lot and used by many offices and schools worldwide. It can be seen as a benefit to have all the latest technology and we can communicate with our friends via social media. Although this can be seen as a benefit it can also be seen as a weakness at spending too much time on social media can draw us away from the natural way of communication.



Benefits of Technology

- Communication Made Easy
- Life saver
- Global Knowledge Access
- Time Saving
- Cost-efficient

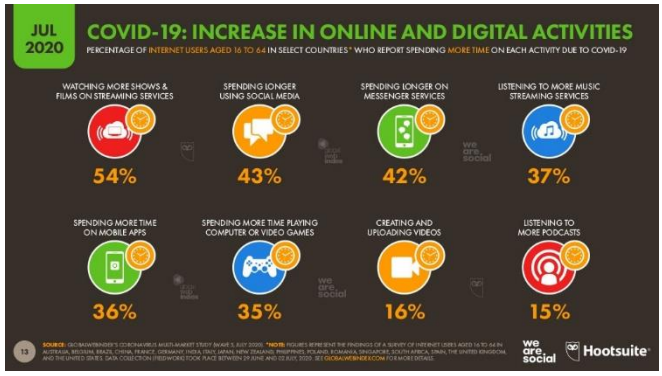


Weaknesses of Technology

- Social Isolation
- Addiction
- Negative Impact on Students
- Degradation of Memory
- Dependency on Technology

Social Media Before the Pandemic

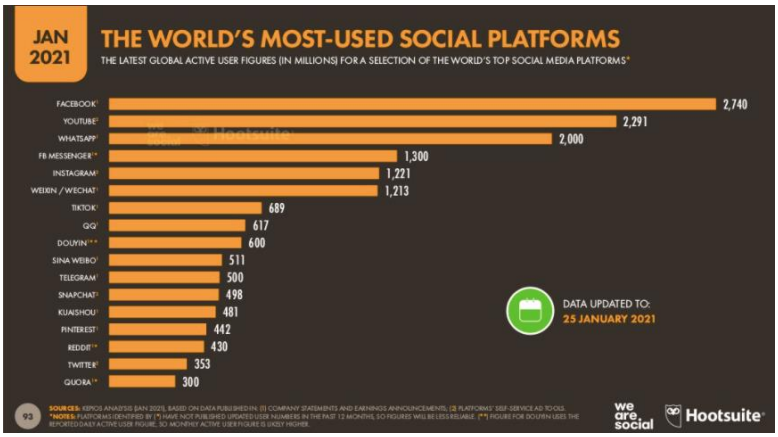
With the uncertainty that the initial shutdown brought to many people and businesses around the world and let us face it, complete boredom social media became the first stop for news, entertainment, information, and human interaction. With bars closed, concerts postponed, and businesses shut down, social users quickly turned to social media networks to make up for that lost human touch. But however, before the Pandemic had started apps started to lose user engagement especially Facebook and Instagram. Facebook had declined from 0.16% to 0.09% from 2018 to 2019. Similarly, Instagram rates had dropped from 1.73% to 1.60 % between the years 2018-2019. This shows that many people were not as active on social media before the pandemic had started but

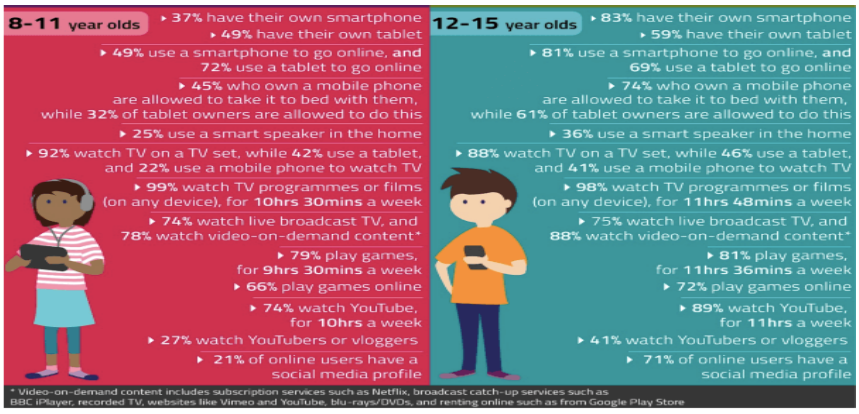


these figures are high portraying the amount of people that were using social media during daily life.

Social Media During the Pandemic

When the Pandemic had started social media spiked up instantly as everyone wanted to check what was going on in the world with the new pandemic that had just started. But when we entered our first lockdown back in March the figures of the number of users on social media had risen to more than 43% of people using their phones for this and an increase on the time, we spend on our phone had risen to 36% which demonstrates that the pandemic did influence people's way of social communication. And this continued to grow as the pandemic got worse and the longer, we stayed in Lockdown in which by January 2021 Facebook and Instagram were in the top 5 for most used apps for millions across the globe. Not only did this influence adults and teenagers, but younger children also age 8-15 were spending more and more time on their gadgets as some were allowed to take their iPad or mobile phone to bed. These findings demonstrate that majority of the population were not going out even when we could go and exercise but chose to spend their time on a screen which did have a negative impact on the way they performed during online lessons.





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How Can Wind Tunnels Assist Development Of Vehicles?

Louis

What is a wind tunnel?

(Apex, 2016)

A wind tunnel is a method of testing aerodynamics of any object placed within the test section, this can range from a simple aerofoil to vehicles such as cars, planes or even rockets. The purpose is to simulate the situations the object being tested would experience in the real world, while taking measurements and recording data regarding airflow.

Streamline Airflow

It is very important to achieve streamline air flow through the wind tunnel, this will allow the most accurate readings when compared to real life scenarios. On a large scale large, enclosed wind tunnels are used which maintain laminar airflow with geometric grids to direct the air in organised and predictable streamlined airflow. On a smaller scale it is much more challenging to create a closed return wind tunnel where their air circulates around the tunnel as it would be far too large. On this small scale in order to create streamlined airflow in an open-ended wind tunnel, straws are perfect for getting rid of turbulent air flow as the fan sucks the air though the system from the end. The reason the fan is at the end of the wind tunnel is to minimise the effect of the spinning blades on their fluid within the tunnel. Instead of blowing air into the tunnel, sucking air through is far more effective and leads to the most laminar airflow.

What can you measure USING WIND tunnel?

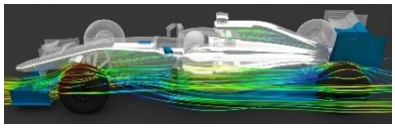
Using a wind tunnel will allow you to visualise the airflow around the object in the test section, using a smoke rake you will be able to track the streamlines. However, the device which introduces the smoke needs to have a minimal effect on the airflow as not to interfere with the streamlines. Despite this being many people's initial thoughts when thinking of wind tunnels, smoke is not used very often at all for actual research purposes, rather just for the media as it is visually pleasing and easy to understand.

Most commonly, load cells are used to measure downforce and drag. Load cells are force transducers which convert a force into an electrical signal which can be read by a computer. On full sized wind tunnels, multiple load cells are used to measure the downforce at separate sections of the car for example; the front end and rear end. In my project I aim to use one load cell to measure the downforce and one to measure the drag of the model in the wind tunnel.

Computational Fluid Dynamics

Computational fluid dynamics or CFD, is the process of mathematically modelling a physical phenomenon involving fluid flow and solving it numerically using the computational prowess. (Anon., 2021) Using modern technology virtual simulations of real-life situations can be produced, similar to a wind tunnel however, an easier and cheaper method. However, this

doesn't mean that wind tunnels no longer have a use, in fact in racing teams for example, where their car needs updates to improve performance both CFD and wind tunnels play a huge part in developing these upgrades. Initially, the potential upgrade is tested using a CFD software as it less costly and not as challenging as doing wind tunnel tests. Following on from these tests, if the upgrade is seen to have a positive impact on the vehicle it will then be tested in a wind tunnel to get more accurate data as very advanced wind tunnels almost replicate the same conditions as driving outside. The tighter the correlation between CFD, wind tunnels and the real world the quicker upgrades can be developed for a racing team.



Reynold's Number

The Reynolds number (Re) helps predict flow patterns in different fluid flow situations. At low Reynolds numbers, flows tend to be dominated by laminar (sheet-like) flow, while at high Reynolds numbers flows tend to be turbulent.

The Reynolds number is defined as:

Where:

$$\mathrm{Re} = \frac{\rho v l}{\mu} = \frac{v l}{\nu}$$

- ρ is the density of the fluid (SI units: kg/m3)
- u is the flow speed (m/s)
- L is a characteristic linear dimension (m)
- μ is the dynamic viscosity of the fluid (Pa·s or N·s/m2 or kg/(m·s))
- ν is the kinematic viscosity of the fluid (m2/s).

(Wikipedia, 2021)

Reynolds number is related to this project due to involvement of all variables above. For example, if a full-scale wind tunnel was testing a car at 60mph wind speed, to get the same results on a half scale, the wind speed will have to be doubled to 120mph due to the wind speed inversely proportional to the size of the tunnel.

Measuring Airflow

Measuring the wind speed is necessary to make comparisons between real life situations and the wind tunnel, using the drag and downforce readings from the load cells.

Anemometer:

An anemometer is one potential way in which we could measure the wind speed of the air flowing through the wind tunnel. We are restricted by cost so an anemometer is a cheap device to estimate the wind speed, which can be made using everyday materials commonly found in the home. It consists of 3-4 cups connected to a central pivot point allowing the cups to rotate around the centre on their arms when the wind is blowing. However, this only provides a very rough estimate of the wind speed and is mostly a visual indication, it also depends on the frictionless build of the anemometer and the radius of the cups.

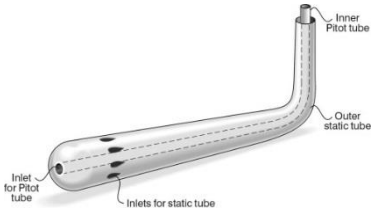
(Society, 2021)

Pitot Tube:

The alternative method to an anemometer is a pitot tube, also, relatively cheap and yet a lot more accurate and precise, due to the nature of measurements and lack of human interpretational in comparison to the anemometer.

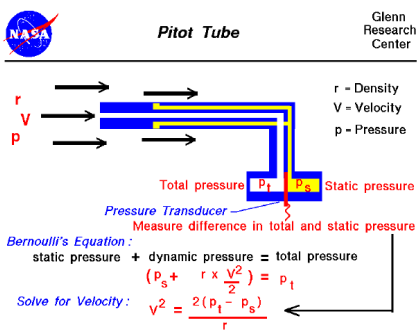
The Pitot tube works as shown in the two figures. It measures both static pressure and dynamic pressure therefore allowing a comparison to be made between the two values. From this we use Bernoulli's equation, which is rearranged to find velocity to give us the value of the wind velocity. This method is more complex than an anemometer, yet it will provide accurate readings which will be vital in the collection of further data and analysis.

Project Planning



(Richard Gentle, Bill Bolton, 2001)

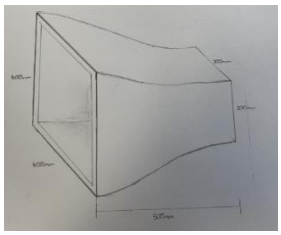
In order to demonstrate how wind tunnels can assist the development of vehicles, I decided to design and build my own small scale wind tunnel, complete with measurement devices to take readings. The wind tunnel will be around 1.5 metres long, made up of three components; the contraction cone, the test section and the diffuser, each with a different purpose.



(Benson, 2021)

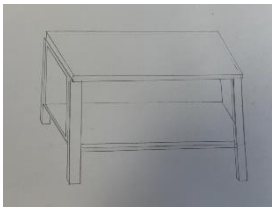
The contraction cone:

Arguably the most important piece of the wind tunnel, the contraction cone's primary purpose is to maximise the airflow through the tests section. The contraction cones shape allows for air to be sucked in across a large surface area then contracted into a smaller tube, the test section. However, before the air can reach the test section, the airflow must be laminar otherwise inaccurate readings will be taken. Often large geometric grids are used to organise the airflow, but on a smaller scale that would be much harder, which is why I will use straws, Paper straws will be perfect to create the streamlined airflow. I will glue them in a cuboid shape, layer by layer to ensure minimal turbulent airflow, the block of straws will be placed in between the contraction cone and test section.

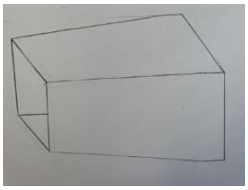


The test section:

The test section is where the models will be tested, drag and downforce will be measure using sensitive load cells, connected to an Arduino and a code programme we will be able to translate the electric signals into something we can understand. There will be a Perspex window at the front to see inside the test section, with lights on the top panel to light it up. The base and back will be spray painted matte black to contrast from the smoke.



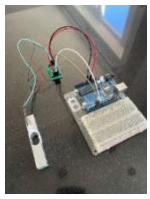
The diffuser:



The diffusers job is to minimise the effect of the fan blades spinning interfering with the test section. The fan will be facing outward blowing air out of the tunnel sucking air through it, so it is vital that the co0nnections between the fan, diffuser and the test section are a tight as possible to maximise the air speed through the test section.

The Build

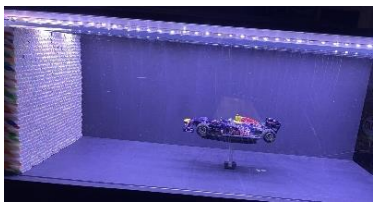
After some research and design sketches we were ready to start construction of the small-scale wind tunnel. The first part to be made was the test section, the primary centrepiece of the wind tunnel where the objects are tested and data is collected. It is much more complex than either the contraction cone or diffuser is due to the moving parts and technical aspects. Essentially the test section is made up of the cuboid tunnel, with a Perspex window to observe the model, a block of straws in parallel to ensure laminar airflow through the tunnel and the load cells where the model is secured and data is collected.



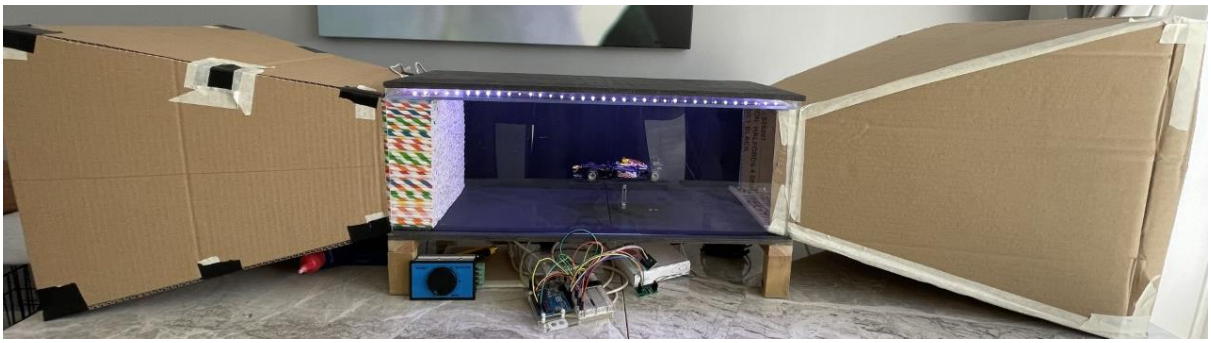
The 1kg and 100g load cells were easy to wire and connect to an Arduino, the computer code to transcode the electrical signals to data which we can record and read. In order to complete this I followed a tutorial from Indrek on YouTube (Indrek, 2020) , in the description of the video he left a link to the Arduino code used to translate the signals (Kallhovd, 2021). The 1kg load cell is secured in parallel to the base of the test section underneath, with pins going through to floor for the 100g load cell to connect to. The perpendicular 100g load cell will be the stand for the models to be tested on allowing drag readings to be taken, downforce is measure by the parallel 1kg load cell. These will be connected to an Arduino which will be attached to the base of the test section.

The test section is comprised of two wooden panels, one being the base and the other the back wall, it has a Perspex front window in order to be able to see inside along with a Perspex roof panel which separates the lights and the rest of the wind tunnel which avoids interference with airflow.

Ideally the model would be positioned on the base of the test section to have minimum flow interference and create minimal vortices however due to the set up the sensors this is the next best option. However, in laminar airflow the velocity of air in the centre is often the fastest which is where the models are now positioned so it benefits the data. Due to the complications of the sensor set up we had to find a way around the issues of suspending the model upon the load cells and still collect precise data. The solution was to design and 3D print a base stand for the model which will be able to connect to the load cell and have a minimal effect of the airflow whilst allowing the models to behave as they would in normal conditions.



In order to keep the cost and weight of the project as low as possible, both the contraction cone and diffuser were made from recycled cardboard. The contraction cone was very simply to construct, as it only consists of 4 sides and no other components. It is designed to slot around the block of straws so it can direct as much of the air as possible through and into the test section. Along with the connection to the test section the other end of the contraction cone will rest on the surface to remain stable and faction well. It was simply constructed from four trapezium shapes cut out and stuck together to create the pyramid shape. The diffuser was also constructed in a very similar way, this time the cone had parallel sides at either end to be able to slot into the test section and have an area to accommodate the fan. The fan is from a Mazda MX-5 so will be powerful enough to create the kind of wind speeds we'd be looking for inside the test section.



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Fullbrook6

Big enough to challenge, small enough to care