CUSJ COLUMBIA SCIENTIST

Featured Article:
THE SCIENCE OF LASIK

EDITION 1: SPRING 2022

About the Journal

Aims and Scope

The Columbia Undergraduate Science Journal (CUSJ) was founded in 2006 by students who were passionate about showcasing undergraduate excellence in scientific research. Since then, CUSJ has remained Columbia's premier publication for original scientific research and scholarly reviews, and is managed by an editorial board of undergraduates with a vast scope of interests across all disciplines. The editorial board also manages the Columbia Junior Science Journal (CJSJ), a publication designed to introduce high school students to research and Columbia Scientist, a publication aimed at increasing scientific engagement and thought at all academic levels. In addition to our publications, the CUSJ team is dedicated to fostering the scientific community, both within Columbia and in the surrounding Morningside Heights and Harlem communities. To this end, the board frequently plans outreach and networking events relevant to young and early career scientists, including an annual Research Symposium poster session each spring.

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Letter from the Editor-in-Chief

Dear Readers,

It is with great pleasure that the editorial board of the Columbia Undergraduate Science Journal (CUSJ) presents the inaugural edition of our newest publication, Columbia Scientist. Since 2006, CUSJ has sought to celebrate and recognize undergraduate scientists, and to encourage the sustained academic growth of students across all universities. This design was extended to high school students in 2015 when CUSJ initiated the Columbia Junior Science Journal (CJSJ). Over the past years we have seen an alarming increase in mis-information and illiteracy in science communication. The CUSJ board determined to combat this trend by releasing a new publication, Columbia Scientist.

Like the CUSJ publication, Columbia Scientist will celebrate and foster young scientists across the globe; however, publications will come in the form of editorials, opinion pieces, letters, art and multimedia responses.

The inaugural edition of Columbia Scientist highlights students' interactions and thoughts in an impressive array of disciplines. It was a pleasure and honor to read through the many submissions we received. I am hopeful and confident that you will find the selected pieces as insightful and inspiring as we have.

I would like to express my gratitude to the many wonderful individuals who have worked to make this publication a reality. From our CUSJ editorial board and editorial committee, to our advisors at Columbia Libraries, Faculty Advisory Board and peer reviewers. I am grateful to all the students who ventured their work, and especially to our published authors who worked to revise their papers to bring the quality pieces you will find in this publication. I would like to express a special thanks to Professor David Vallencourt and the Art of Engineering course and Professor Ivanna Hughes and the Frontiers of Science course with whom we partnered this year to bring you many of the great submissions herein. Finally, I wanted to express gratitude to Shloka Janapaty, CUSJ Director of Outreach, who played an integral role guiding Columbia Scientist's inception.

We encourage you to submit a response to papers in this edition, or a different topic for which you are passionate to our next edition this fall. More information will be available at cusj.columbia.edu.

It has been a great pleasure and privilege to serve as the 2020-2021 Editor-in-Chief of CUSJ Columbia Scientist. I am excited to see how CUSJ and Columbia Scientist continue to evolve and improve.

Aaron Jackson
Editor-in-Chief, Columbia Scientist
Columbia Undergraduate Science Journal

Letter from the President

Dear Readers,

I am proud to announce the publication of the inaugural edition of Columbia Scientist! Columbia Scientist is our editorial-based journal consisting of opinion editorials, ethics reviews, science-themed art, and other editorial-based works at the intersection of multiple scientific and social disciplines.

The role of science is to help us understand the true nature of our world. In this understanding lie solutions to society's most pressing questions, the structural beauty of nature, and most importantly, additional questions that demand scientific answers. Curiosity is at the heart of scientific and technological advancement.

The role of Columbia Scientist is to pique our readers' curiosity of current topics in science. Publishing editorial-based works makes active discussions in scientific research and technological development more accessible to a larger audience. Through greater access to scientific knowledge, we may create a more curious society.

I am proud of our editorial team for leading the Columbia Undergraduate Science Journal in this cause, and am honored to include the works of every author published in this inaugural edition. I am especially grateful to Aaron Jackson, Editor-in-Chief of Columbia Scientist, whose leadership made this publication a success. I also want to thank the Frontiers of Science and Art of Engineering faculty for encouraging student submissions to this edition.

Congratulations to our authors, and thank you to our readers!

Arjun Kudinoor
President, Chief Editorial Officer
Columbia Undergraduate Science Journal

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Masthead

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The Science of Lasik

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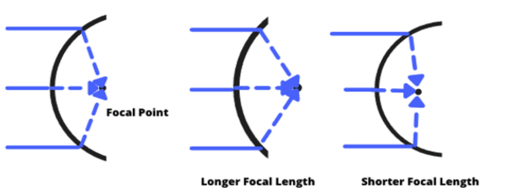
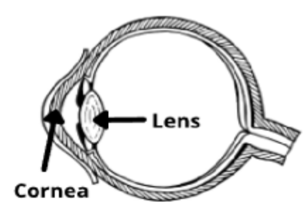
Everyone has heard of LASIK, a 15-minute procedure that promises to eliminate your need for glasses and contacts. Over ten million Americans have gotten LASIK since its FDA approval in 1999, and the numbers have shown it to be widely successful. With such promise, many people are interested in understanding how it works.

At its core, the eye is a two-lens system that works to focus light on the retina. As such, in order to understand how we fix vision, one must understand how optics work in the first place. The guiding principle behind all lenses is refraction, where light bends after entering a new medium. To measure the degree of "bendiness", or optical power, that a lens imparts on a ray of light, physicists measure the focal length of the lens. A positive focal length converges light, bending it inward, whereas a negative focal length diverges light, bending it outward. A short focal length sharply bends light, whereas a longer focal length does not.

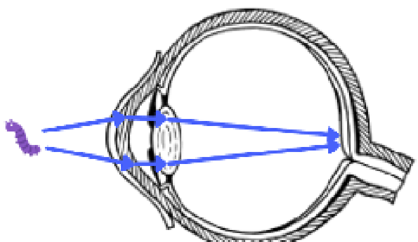


Op[illegible] di-opter, which is 1/focal length. This unit has a much more intuitive nature; a 3 diopter lens will focus parallel rays of light at ⅓ of a meter away. Therefore, when talking about the eye's refractive powers, one speaks in terms of diopters.

Moving from physics to physiology, let's imagine a child staring at a bug on the sidewalk. The light reflecting off the bug must first pass through the clear front part of their eye, called the cornea. The cornea is actually composed of three layers: the epithelium (front), the stroma (middle), and the endothelium (back). Seventy percent of the eye's focusing power, about 43 diopters, actually comes from the cornea, making it an incredibly vital first step in concentrating light. After the light passes through the cornea, it moves through the pupil, and then through the lens. The lens of the eye provides the remaining thirty percent of the focusing power. In a young, healthy eye, the lens undergoes accommodation, in which it changes shape to adjust its refractive power.

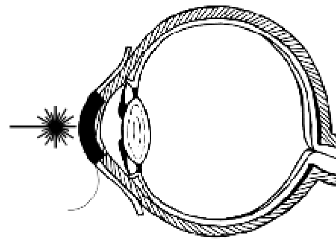


Far-away [illegible] much bending, as their light enters the eye nearly parallel. However, the bug on the sidewalk is quite close, and so the light rays reflecting off of it are much more divergent. To counter this, the child's ciliary muscles contract, thickening their lens. Once the light is focused, it hits the back of the eye, called the retina, where light-sensitive nerve cells transduce it into electrical impulses. For the purposes of vision correction, the cornea and the lens are the most important structures to note.



While this hypothetical child may have fine vision, a growing issue in the US and around the world are refractive conditions, in which the eye has trouble focusing incoming light. In some people, the eye is either too long or the cornea is too curved. A very steepened cornea would have a low focal length (high optical power), causing light to converge too soon. In either case, light from faraway focuses in front of the retina, causing blurry vision. This condition is called myopia, or nearsightedness. To correct it, a diverging lens is used, which will have a negative diopter measure. For this reason, the severity of myopia is measured in negative diopters. The opposite condition, hyperopia, is categorized by an eye that is too short or a cornea that lacks enough optical power. To correct this, a positive diopter lens is used, and so the severity of hyperopia is measured in positive diopters. A related condition is astigmatism, in which the cornea isn't perfectly spherical, leading to asymmetry in the optical power. If a regular eye is shaped like a soccer ball, then an astigmatic eye is shaped like an American football. This can cause blurriness or double vision, as images are smeared across different focus points.

These issues are usually corrected through glasses or contacts, but many people opt to permanently change their vision through refractive surgery. Operations like LASIK and PRK, work to modify the shape of the cornea itself. The main difference between them is how they access the strong inner portion of the cornea, called the stroma tissue. The first one to come out was Photorefractive keratectomy, PRK, approved in 1995.



Accessi[illegible]emoving the epithelium layer using an alcohol solution or a specialized brush. In LASIK, or Laser-Assisted In-Situ Keratomileusis, a flap is cut in the epithelium which is flipped up during surgery, and then flipped back down. Besides the way they access the stroma tissue, the two procedures work in much the same way. They remove sections of the stromal tissue to modify the cornea's optical power. In myopes, the center of the cornea is flattened, effectively enlarging the focal length, and reducing its optical power. In hyperopes, the periphery of the cornea is removed, shortening the focal length, and enhancing the optical power. Astigmatism involves ablating the asymmetry, rounding out the cornea. This process can be done in conjunction with myopia or hyperopia treatment. These two procedures work remarkably well and can give a patient 20/20 vision within hours after getting off the table.

Ophthalmology is, at its core, applied optics, and so understanding the science behind the eye is essential for both practitioners and patients. Fundamentally, LASIK is simply the reshaping of the cornea, changing or concentrating the focal point in order to improve the image on the retina. Where and how much stroma tissue to remove is based on the pathology of the eye: those who bend the light too much have their focal length increased, and those who don't bend the light enough have their focal length decreased. The simplicity and effectiveness have rocketed LASIK to the number one refractive procedure in the US.

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Strengthening Concussion Safeguard Through Community Education

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A young athlete is knocked to the ground. The spectators let out an audible gasp. The referee jogs over to the scene while the coach holds their breath. But then, the athlete pauses and slowly staggers to their feet -- the crowd goes wild!

This is a shared memory for many high school athletes, regardless of whether they are caught in a powerful tackle during the homecoming football game or struck in the head by a ball during the championship soccer match. Those few seconds may not last in the spectators' memory, but they can be life-changing for the athletes, especially if they have suffered a concussion. As we approach major sporting events such as the National Football League's Super Bowl LVI in early February of 2022, I think back to head injury protocols in my home state of California. While the California state government has established policies for identifying and treating sports-related concussions, the reality is that the diagnosis and recovery journey is still convoluted for many young athletes. However, implementing community education programs at the individual school level is a crucial component of navigating the concussion epidemic.

Specifically, a concussion is a form of traumatic brain injury that occurs when a person experiences a bump, blow, or jolt to the head. Youth often experience concussions during high-impact sports due to falling, colliding with other players, or crashing with obstacles. The Centers for Disease Control (CDC) estimates that approximately five to ten percent of youth athletes experience a concussion each season; football, hockey, soccer, basketball, and cheerleading athletes are especially at risk. Symptoms of concussion include nausea, balance issues, dizziness, headaches, visual disturbances, and fatigue. During the intense adrenaline rush of a game, however, athletes may not realize they have experienced a concussion and continue to play on. In other cases, athletes may avoid reporting symptoms for fear of letting their team or coach down, losing out on playing time, or believing the injury is not serious enough for medical attention. According to a study published in the Journal of Athletic Training, this has led to high school athletes underreporting concussions in up to 55 percent of incidences.

Many individuals carry the mainstream "shake-it-off" attitude when it comes to concussions, but this is harmful to young athletes' perception of the condition. In addition to causing short-term memory, sleep, mood, and concentration issues, delayed concussion diagnosis can pose risks for developing serious conditions such as depression and dementia. Considering the teenage years are a critical period for brain development, it is important to strengthen concussion safeguards in the present to ensure athletes' brain health in the long run.

On a broader level, California has the second-highest number of high school athletes (800,000 individuals) in the United States, yet regional disparities play a large role. Access to trained sports medicine professionals is an equity issue, considering schools in more rural, lower-income communities are less likely to have the funding bandwidth for hiring additional staff. In a 2019 study, approximately 55 percent of 1,270 sampled California high schools reported having no athletic trainers present at practices or games.

While this gap is alarming, community education programs can open up ways for coaches, peers, and other school members to support athletes at risk of concussion. Partnerships with local hospital networks can catalyze building more accessible online training, allowing individuals to understand the signs of concussion. This is especially important in cases where the athlete is unable to self-report a potential concussion due to personal or social pressures. The launch of the Dignity Health Concussion Network in 2016 is a prime example of a community-centered movement within California that is bolstering concussion support for youth at five Bay Area high schools, impacting thousands of athletes.

Building a school-wide concussion management plan is another essential component that involves bringing administrators, teachers, and parents into the conversation. For instance, Saratoga High School and Menlo School implemented protocols that outline clear next steps for community members, ensuring no one is caught off guard. Additionally, easily understandable infographics such as those released by the Brain Injury Association of America can quickly be referenced during athletic activities on the spot. During this process, one hurdle community members face is the fear of missing important signs or inaccurately reporting suspicions, which could negatively affect athletes' performance. It can certainly be intimidating to make a confident judgment, especially if an individual is not a trained healthcare professional. However, taking the initial steps in the concussion management plan outweighs the costs by ensuring that young athletes can receive adequate, time-sensitive support. In turn, having a strong community support network can encourage young athletes to feel more confident in voicing concerns about symptoms.

The time for concussion awareness is now -- as a community, we are the key in bridging the gap between state-wide policies and school concussion protocols at the ground level. Recognizing concussions among high school athletes allows us to promote brain health now and into the future.

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Enhancing The Current Classification Of Diabetes

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Diabetes is a chronic metabolic disease that has been around for centuries, even before the mechanisms were largely understood. In today's day and age, there exists an enormous population of diabetic patients, close to five hundred million that are impacted across the globe. Unfortunately, this number is expected to rise dramatically in the forthcoming years resulting in billions of dollars of global expenditures for diabetes-related healthcare costs and excessive strain on the healthcare system. Therefore, with the advent of novel and emerging technologies that unite the intersection between the fields of technology and science that were once unimaginable, it goes without saying that we must push for a cure or improve treatment of this disease for the sake of our patient population.

This exceptionally large feat is of course not easy and will take both time and money. However, what it requires first is a better understanding of the disease on a biological level to one day advance the development of more effective therapeutics.

This recent article published in the journal, *Diabetologia*, explores interesting facets of Diabetes, that were once not explored that may help in developing a better course of treatment. We currently know of Diabetes largely centering around two main etiopathogenetic categories, I and II. Type I diabetes, which is called insulin-dependent diabetes mellitus (IDDM), is primarily due to a deficiency in insulin due to the autoimmune-mediated destruction of pancreatic β cells. Type II Diabetes Mellitus (T2DM), the most common form of diabetes, is a prevalent metabolic disorder and its pathogenesis is caused by a combination of peripheral insulin resistance and dysfunctional compensatory insulin secretory response from pancreatic β cells.

What we are now seeing is the demarcation of five subgroups (subtypes), namely severe autoimmune diabetes (SAID), severe insulin-deficient diabetes (SIDD), severe insulin-resistant diabetes (SIRD), mild obesity-related diabetes (MOD), and mild age-related diabetes (MARD). The SAID subgroup consists of individuals who are typically classified as type 1 diabetic, whereas SIDD, SIRD, MOD, and MARD individuals compromise novel entities of type 2 diabetes. This is such an important next step in our overall understanding of the disease pathogenesis as now having more specific subgroups we can understand the difference amongst patients having differing clinical outcomes and disease progression. That being said, it has the potential to allow for healthcare providers to develop a more unique and stratified set of treatment for each patient. Furthermore, with these specific classifications, we are also able to cluster people by their various trajectories in the onset of diabetes-related complications such as CKD, retinopathy, CVD, NAFLD, and neuropathies. With all this in mind, the differing pathophysiological phenotypes allow for individualized lifestyle-related and pharmacological treatment options.

For patients who classify under the SAID category, they could potentially require the early introduction of insulin supplementation, whereas SIDD patients may benefit from a dipeptidyl peptidase 4 inhibitor (DPP4i). To add on, both SIRD and MOD patients would benefit from medication that induces weight loss (SGLT2i, GLP-1RA, dual agonist) or also addresses the risk of CVD or nephropathy (SGLT2i, GLP-1RA). Lastly, patients with MARD should receive treatments avoiding weight loss and sarcopenia (e.g. protein-balanced diets and moderate resistance training).

The overall picture of diabetes should not be looked at as something black and white, but rather as a colorful spectrum with the different subgroups leading to different prognostics. This will allow us to develop innovative strategies that are more effective and provide precise personalized treatment options for patients.

Diabetes is a multifactorial disease that impacts the body and almost every organ system and due to the complex nature of the illness, there lie many gaps in the current body of knowledge surrounding the condition. With the combination of our understanding of the disease and the plethora of new methodological ways of studies, we can harness data from longitudinal and topological studies that will further highlight the pathophysiological hallmarks of type 2 diabetes and advance treatment from a clinical perspective.

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Cybersecurity Practices for Healthcare Providers: A Consortium

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The digital advancement in the healthcare sector has seen a steep increment both due to its ease of maintenance and accessibility. The creation of online records, cloud storage and encrypted software has resulted in availability of every patient record at any branch of a healthcare system (Deibert, 2018). Making the patient records decentralized has, however, also resulted in the increased risk of security, hacking and protective concerns (Kim, 2017). The lack of adherence to the Health Insurance Portability and Accountability Act (HIPAA) rules and regulatory compliance could result in a cyber-security breaching and attack (Miller & Pollak, 2003). With the high risk of cyber attacks and hacking, the presences of good cyber security practices are as essential as having proper medical equipment and oxygen supply. Some of the best practices, tests and rules have for prevention of cyberattacks involve: Complying with the HIPAA rules of privacy and security – HIPAA is an established federal law governing the national standards of cybersecurity. The rules need to be followed in order to promote healthy digital practices (Miller & Pollak, 2003). The privacy and security rule of HIPAA ensure that no data about any patient will be disclosed without consent from the individual. Any breach of such actions will be taken charge through legal means. Regulatory Compliance with Encryption – The end-to-end encryption of data and creation of backups at a code location is the key to nullify any cyber-attacks. The encryption needs to be maintained all throughout the cloud storage (Stevens, 2018). This will decrease any chances of data stealing and cyber hacking from any external sources. SOC 2 Audit – The Service Organization Control 2, or Sock Two, determines the Trust and Safety Services Criterion of the data security system of healthcare (Sabillon, 2022). It focuses on the aspect of security and availability of protected data without any risks of cyber attacks. Under the AICPA's criterion, SOC 2 Audit is an essential practice which performs a check on the security firewall and determines the authenticity and safety of the software (Sabillon, 2022). Penetration Testing – This is another effective method of lowering risks related to hacking and data stealing practices. The penetration testing, or the pen test, is a hacking procedure classified under good and ethical hacking practices (Wooderson & Ward, 2017). This method is used to deliberately hack the firewall of the healthcare system to check its redundancy and protective ability (Deibert, 2018). Using such methods leads to the identification of loopholes and fixes the code. The presence of a protected and secure healthcare firewall is a step towards patient privacy. This becomes even more important when the consequences of leakage of the data are analyzed (Stevens, 2018). The patient privacy guarantee is a responsibility of the healthcare system as well as the right of the patient. These mentioned methods, tests and compliance protocols are essential to ensure good cybersecurity practices across the healthcare system. An informed staff with awareness of these practices can ensure the best possible security backed by regional and HIPAA guidelines.

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The Monster We Help Create: The Algal Neurotoxin Getting a Helping Hand From Pollution

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In 1998, 81 sea lions would find themselves stranded along the California coastline, exhibiting neurological symptoms. (Gulland et al., 2002; Ramsdell & Zabka, 2008). Confused and unable to continue their journey, they would receive treatment, but 55 of those sea lions would ultimately not survive. Over on land, just over a decade earlier, more than 100 people had fallen ill after ingesting contaminated mussels, and three of those individuals subsequently died of acute poisoning. (Mos, 2000). The microscopic thread tying these events together can be found riding the ocean's currents, just under the water's surface. The phytoplankton Pseudo-nitzschia, a unicellular form of algae, is capable of producing the neurotoxin domoic acid, an amino acid with the potential to generate an array of gastrological and neurological symptoms, ranging from vomiting and confusion, to seizures and memory loss, and in extreme cases, even permanent brain damage and death. (McKibben et al., 2016; Mos, 2000).

In this ecological chain reaction, a mere by-product of a microscopic phytoplankton spells trouble for marine mammals many orders of magnitude larger than itself. This by-product, domoic acid, even makes the jump out of water to affect humans. (Mos, 2000). Domoic acid finds itself incorporated into the food chain, when, along with its algal-progenitor, it is swept up by the shellfish who consume these plankton. (Mos, 2000). While many of these shellfish possess bacteria capable of metabolizing domoic acid, the marine mammals who feast upon shellfish do not, making them susceptible to the accumulation of domoic acid residing in the tissues of shellfish. (Mos, 2000). Both the 1987 outbreak in seafood consumers from Prince Edward Island and the 1998 mass mortality event in sea lions – as described above – are the result of acute domoic acid poisoning, which resulted from the consumption of shellfish by those higher on the food chain. (Gulland et al., 2002; Mos, 2000).

This neuroexcitatory toxin, once ingested by a susceptible host, travels to the brain, where it binds to the NMDA channel receptor protein, releasing the neurotransmitter glutamate. (Ramsdell & Zabka, 2008). The toxin passes with ease through the placental wall and accumulates in the amniotic fluid, where it is readily able to reach both the fetus' and mother's brains, positioning itself as a distinct threat to both. (Ramsdell & Zabka, 2008). While domoic acid traditionally doesn't pose a significant threat to adult sea lions and other marine mammals, studies have indicated that prenatal and juvenile exposure can lead to hippocampal abnormalities and increased susceptibility to seizure activity, also leading those mammals exposed early in life to find themselves in heightened danger from the toxin at all stages of life. (Ramsdell & Zabka, 2008; Mos, 2000).

Over the last few years, domoic acid poisoning has become a more common threat to the marine mammals who ingest these shellfish, with large scale events like clusters of stranded marine mammals as a result of neurological symptoms, as well as mass mortalities both becoming more common. This increased prevalence and severity thus suggests external factors increasing prevalence. (Ramsdell & Zabka, 2008; Mos, 2000; Gulland et al., 2002). As it turns out, the increased prevalence of domoic acid poisoning may very well be another lasting legacy of human actions leaving scars on the earth and our ecosystem.

Our warming earth means warming waters, and the lasting impact of our carbon emissions appear to be at least partially responsible for the proliferation of harmful algal blooms, which have the ability to produce neurotoxins like domoic acid. (McKibben et al., 2016). Researchers have shown that with warmer temperatures, blooms of Pseudo-nitzschia have not only thrived, but seemingly demonstrated more toxic effects, meaning that these algal blooms in the ocean are an outgrowth of human activity back on land. (McKibben et al., 2016).

Yet, another cruel remnant of human activity would also find its way into the ocean to exacerbate the situation. The chemical catastrophe of organochlorines, more popularly known as “persistent organic pollutants” (Jones & de Voogt, 1999) or colloquially as “forever chemicals,” represent a hallmark of material comfort – except that now marine life are paying the price for our capitalist creature comforts.

I grew up during the Scotchgard craze, a time where you could go into just about any affluent suburban home and marvel at the carpets and fabrics that stayed clean almost by magic. Staring in wonderment at how liquids would simply bead atop the chemically-protected surfaces, not daring to bore through the mystical barrier was almost a rite of passage, but we did not realize then that this magic trick was the result of a chemical compound almost impossible to break down. (Jones & de Voogt, 1999). Nowadays, the specter of Scotchgard, just like the Teflon that coats our non-stick pans, or the pesticides we spray into the air, lurk through our oceans. The harmful effects of these organochlorines seem to be playing a significant role in the increased prevalence of domoic acid poisoning. (Tiedeken & Ramsdell, 2009; Ramsdell & Zabka, 2008; Ramsdell, 2010; Tanabe, 2002).

In recent years, the discovery of a chronic domoic acid poisoning syndrome, particularly in young California sea lions, has provoked curiosity into the concurrent factors creating enhanced susceptibility in these mammals. (Tiedeken & Ramsdell, 2009). Characterized by enhanced seizure susceptibility and behavioral abnormalities, researchers noted that in addition to this perplexing syndrome, California sea lions were carrying with them an exceptional burden of organochlorines. (Tiedeken & Ramsdell, 2009; Ramsdell & Zabka, 2008; Tanabe, 2002). This discovery led to experiments in zebrafish, which found that embryonic exposure to the pesticidal organochlorines DDT and DDE resulted in increased susceptibility to seizure-inducing toxins, like domoic acid, later in life. (Tiedeken & Ramsdell, 2009). The exact mechanism by which organochlorine-exposed animals find themselves at heightened risk from domoic acid is not completely certain, however there are some strong theories on the matter. This increased risk may be a result of environmental factors like chemical pollution and climate change being stressors that disrupt homeostasis, or due to the fact that organochlorines are known to be endocrine-blockers – and in some cases even present neurological disturbances of their own. (Tiedeken & Ramsdell, 2009; Tanabe, 2002; Jenssen, 2006; Jones & de Voogt, 1999). While these organochlorines, earning themselves the nickname “forever chemicals” for good reason, may be declining in production and usage recently, the damage they cause is far from being mitigated due to their chemical structure, which is characterized by uniquely strong chemical bonds paired with a stable molecule, which makes them nearly impossible to break down, and a ubiquitous threat across the planet. (Jones & de Voogt, 1999).

Much like the legal framework that largely protects these "forever chemicals" from facing restrictive legislation in the US, there is reason to believe that the fishing of domoic acid-contaminated shellfish might not be sufficiently regulated. A study found that chronic low-level exposure to domoic acid, significantly below the legal limits which had been based solely off of acute poisoning, caused cognitive deficits in rats. (Lefebvre et al., 2017). Legal frameworks in the US more often than not place an expectation that a substance be proven unequivocally hazardous before facing restrictive legislation, allowing "persistent organic pollutants" to fester freely in our ecosystem. The increased severity and prevalence of domoic acid poisoning, along with the chemical pollutants and climate change effects thought to drive it, are the ghosts of human negligence and consumption – but marine life, just like us, are forced to face the haunting.

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To Preserve Urban Wildlife, Ban Gas-Powered Leaf Blowers

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In October 2021, New York State Senator Peter Harckman introduced a bill that would ban the sale of gas-powered lawn equipment, such as lawn mowers and leaf blowers, by 2027 across the state [1]. This type of equipment is a major source of harmful air pollutants, like carbon monoxide, hydrocarbons and nitrous oxide [2]. Less discussed, however, are the harmful effects of pollution caused by gas-powered lawn equipment. The Environmental Protection Agency categorizes noises above 85 decibels as harmful, and the World Health Organization has determined that a typical gas-powered leaf blower emits between 102 and 115 decibels of noise pollution [3]. Exposure to extreme noise is not only damaging to human ears, but it can also be detrimental to wildlife [4] [5]. Banning these devices would reduce noise pollution and would therefore be highly beneficial to the health of humans and the ecosystems we occupy.

Noise that comes from human-made sources (such as cars, planes and leaf blowers) is harmful to wildlife because it disrupts communication between animals, particularly birds, insects and amphibians [5]. For example, the rush of a highway or the roar of a lawn mower can overpower a bird's call, making it more difficult for it to communicate with nearby birds and threatening its survival [5]. Furthermore, most noise pollution from human-made sources, such as highways and lawn equipment, is very loud and low in pitch [5]. These types of sounds are different from sounds that typically occur in nature, such as rain or the flow of a stream, which tend to be quieter and higher in pitch [5]. Because of this difference, animals often interpret human-caused noise as an environmental stressor [5]. Banning loud, gas-powered lawn equipment would for these reasons be beneficial to urban wildlife populations.

Protecting city-dwelling wildlife by mitigating noise pollution is not only important from a conservation standpoint. The animals in question serve critical ecological functions, known as "ecosystem services," which both support ecosystems and tangibly benefit humans. Birds, for example, provide ecosystem services in the form of pest control and can function as pollinators in urban gardens [6]. They can also boost the economic and cultural value of urban parks by attracting tourists and local residents alike [6]. For example, the Ramble, a patch of woods in the middle of New York City's Central Park, is home to over 200 bird species every year and is for this reason a popular destination for birdwatchers [7]. By banning gas-powered lawn equipment, cities and states can protect urban wildlife and enhance the ecosystem services these animals provide.

The bill introduced in the New York State Senate banning lawn equipment that emits harmful gasses comes on the heels of similar legislation from other jurisdictions. In October of 2021, California passed a law banning gas-powered leaf blowers that will go into effect in 2024 [8]. Washington D.C.'s ban took effect this year on January 1st of this year, after it was unanimously approved by the city council in 2018 [9]. Washington D.C.'s ban was passed three years before it officially took effect, with the intention of giving city residents and landscaping companies operating within the district an extended period of time to replace equipment in violation with the policy. Violators of the ban in the nation's capital will be subject to fines up to $500, and residents can report complaints through an online form [10]. The municipal government urges landscaping companies and owners of gas powered leaf blowers to dispose of their equipment at the city's household hazardous waste drop-off point. [10]. Banning gas-powered lawn equipment is not a novel idea, and it only makes sense that New York state follows suit.

Cities are not going anywhere anytime soon. It is therefore critical that city residents learn to coexist with wildlife and adapt our behavior in order to maintain our urban ecosystems. Banning leaf blowers in New York is just the first step in a critical fight to reduce human-generated noise pollution and protect urban wildlife.

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The Future of Xenotransplantation

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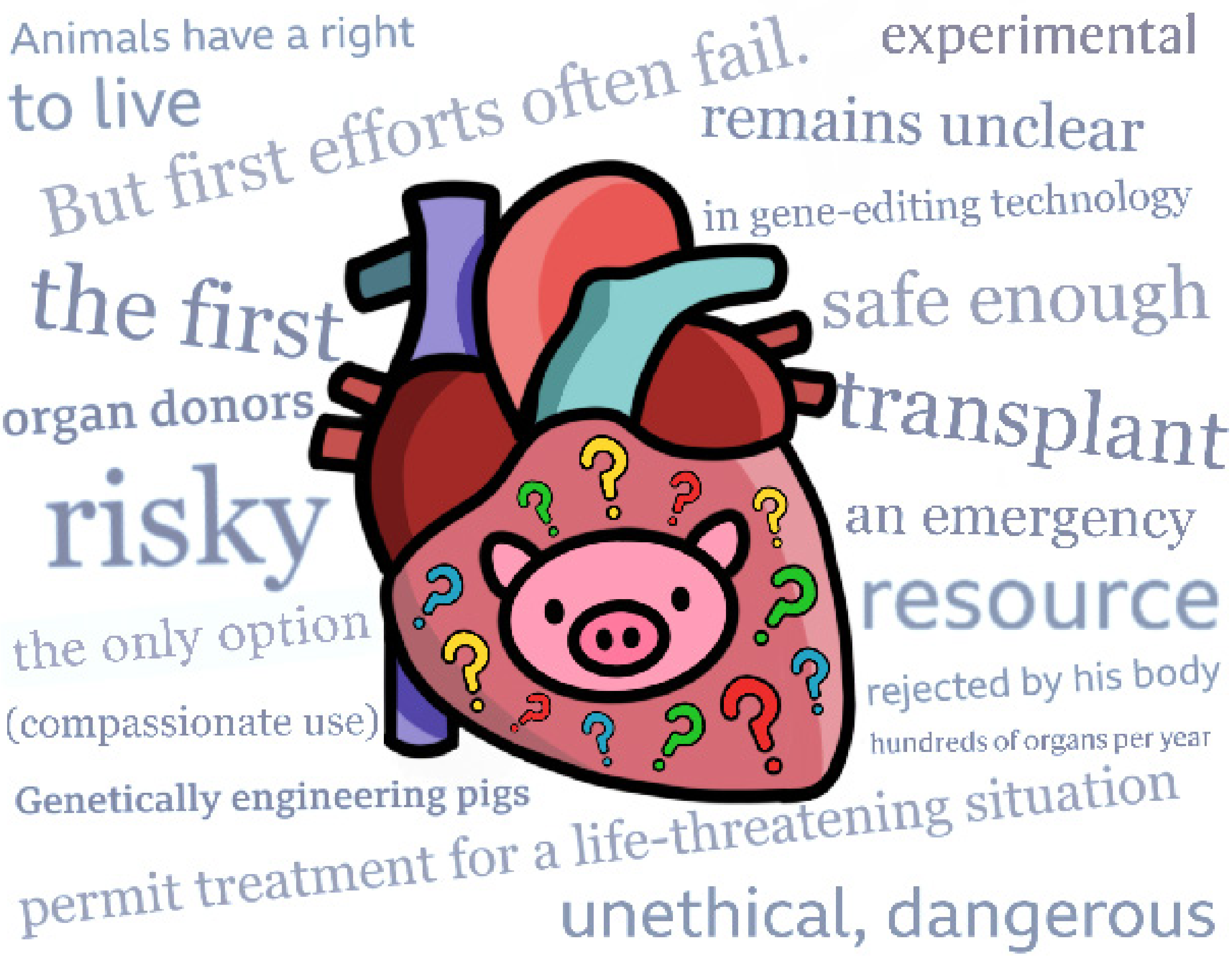

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The Ethics of Gene Editing

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In 1997, Ethan Hawke starred in the film GATTACA about a futuristic world where genetic selection and editing are used to create "biologically superior children." The main character (an "in-valid," born naturally) struggles to overcome the discrimination of inferior genetic status imposed upon him by the greater society. This film is two decades old and yet perfectly captures the concerns, consequences, and amazing opportunities of human gene editing.

Human gene editing is a tool poised to solve many of the world's most pressing medical challenges. The first and fundamental tenet of engineering ethics is to place in paramount importance the health, safety and welfare of the public, and this technology can help eliminate devastating diseases that affect the lives of millions of people. Huntington's disease and sickle cell anemia are both clearly defined monogenic diseases that could be treated with existing technology, except for the fact that a moratorium has been placed on human genome editing by the FDA in the United States. As Peter Parker so wisely remarked, "When you can do the things I can, but you don't, and then the bad things happen … they happen because of you."

In 1975, the philosopher James Rachels proposed the bathtub experiment where a man either chooses to drown a child in a bathtub or makes no move to save him upon finding him unconscious underneath the water. Rachels argues that these two situations are indistinguishable and that the man deserves the same punishment for both. Essentially: inaction is functionally identical to malefaction. Whether or not this is fair, it is undeniable that inaction confers some blame on the individual who failed to act. As such, if we have the technology to save lives and people are suffering as they succumb to potentially treatable illnesses, we must ask: is it ethical for engineers (and our broader regulatory systems) to prevent access to gene editing?

Regardless of the lifesaving applications, gene editing comes with many risks and considerations. As with any new technology, the most interesting discussions occur in pushing it to the limits. With the assumption that these procedures would be conducted safely and with consent, it's generally seen as ethical to perform gene therapy for monogenic diseases or more complex foes such as cancer or Parkinson's disease. This was the issue with the Chinese scientist He Jiankui, who illegally performed a gene editing procedure on human embryos to reduce their chances of getting HIV. The children were born in 2018, and the procedure was widely criticized for being unsafe and unnecessary given that they weren't at risk for HIV and it may have introduced other dangerous anomalies into their DNA. Additionally, it hasn't been confirmed that the mothers knew what was going on, that he had their informed consent was dubious.

Even if the procedure was performed ethically, it's still worth considering what types of procedures are ethical. If we manage to isolate the genetic causes of Alzheimers or dementia, are we ethically bound to remove those diseases from the population? Though they cause a loss of function later in life, they don't outright kill you.

Additionally, environmental factors such as smoking or depression play a role in how these illnesses develop, I thought the link between genetic predisposition and external elements is not well understood. If we declare it acceptable to perform gene editing to improve “quality of life” or preemptive prevention, this wanders into concerning territory. Do neuro divergent people experience lower quality of life (because they live in a society that hasn’t paid enough attention to inclusivity)? Does this make it ethical to edit Down Syndrome or autism out of the population? In an article for TIME, Joel Reynolds reflects on the concern that gene editing for disabilities would have radically changed his brother, whose disability was an integral part of his character and personality. Do we risk creating an artificial race of people?

Each concession we make with regards to gene editing loosens the social and political stigma that holds the technology so tightly closed. This acceptance may be a positive thing, but it also emphasizes the importance of wise and thoughtful regulations imposed by governments and engineers alike to grapple with the complicated questions that arise from this technology. Ultimately, our genetic code is the most integral piece of ourselves. Even though gene editing has so many ethically concerning attributes, it also has the potential to improve the world and the lives of millions of people.

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The Cost of Safety – an Analysis of Systemic Issues Plaguing the Aviation Industry

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"WHOOP WHOOP, SINK RATE. PULL UP." Those are the last words the pilots of Lion Air Flight 610 and Ethiopian Airlines Flight 302 heard as the terrain below filled their windshields—the stone-cold computerized voice of their 737 MAX's ground proximity warning system alerting them of their impending demise. These accidents did not have to happen. Boeing's missteps in the 737 MAX catastrophe are indicative of broad industry-wide problems, and treating them as anything less would be a grave mistake.

First, some background on the 737 MAX. First conceptualized in 2011 to rival the competing Airbus A320 NEO, Boeing sought to improve the efficiency of their best-selling airframe, the 737 NG. By keeping commonality with this older, well-established design, Boeing saved a fortune in development costs while making the MAX an attractive option for airlines looking to replace their aging workhorses while maintaining fleet commonality. With this goal in mind, Boeing made the fateful decision to implement the Maneuvering Characteristics Augmentation System (MCAS), allowing the 737 MAX's handling characteristics to qualify as "similar enough" to its older NG brother as to not necessitate costly pilot re-training. It was designed to operate out of sight, and out of mind, only coming to life if it sensed a dangerously high pitch attitude, a condition the MAX is more susceptible to because of its larger forward-mounted engines.

Problems began just over a year after launch, first with the crash of Lion Air 610 in late 2018, followed by Ethiopian 302 less than half a year later. Such a string of accidents for a brand-new airplane is virtually unheard of, and the 737 MAX was promptly grounded worldwide. The two crashes shared virtually identical accident sequences—a failed angle of attack (AOA) sensor, followed by MCAS activation, where the computerized system, interpreting junk data from the faulty sensor, pushed the plane into a nosedive, correcting for a perceived (but in reality, non-existent) nose-high pitch angle. (National Transportation Safety Board [NTSB], 2019).

Before analyzing what Boeing did wrong, it would be prudent to dispel common misconceptions by addressing what they did not do wrong. It is important to understand that the 737 MAX is not a fundamentally unstable airplane. The sole purpose of MCAS was to take advantage of loopholes that removed the need for additional pilot training by automatically correcting for the differences in handling characteristics between the two generations of 737. MCAS was in no way necessary for the 737 MAX to fly, and without it, the 737 MAX would be a perfectly airworthy machine. As such, there is nothing inherently wrong with Boeing's intent to re-engine an older plane design—the previous generation 737 NG continues to be one of the safest and best-selling airframes in the world, so Boeing's desire to capitalize on this was perfectly reasonable. Rather, this is the story of a miserably failed and grossly negligent implementation of an otherwise sound plan.

The negligence and complacency exhibited by Boeing are evident in hindsight. By skimping on testing and not fixing known problems, Boeing got their flawed plane out to market quicker, increasing their competitiveness in the industry. By not providing sufficient documentation or training materials on the MCAS system (most pilots did not even know it existed), Boeing saved both themselves and potential operators money and time. This was justified under the mistaken assumption that MCAS needed no pilot training because it would only ever live in the background as a last-resort safety feature. As any pilot would tell you, this assumption was tragically naïve. The above issues were compounded by a violation of a golden rule in aviation—redundancy. In having MCAS rely on just one AOA sensor, a single-point failure could doom the whole plane. While the latter issue may be attributed to a complacent oversight, the former two shortcomings were clearly driven by profit. The shareholders spoke, and Boeing listened.

It is also worth mentioning that Boeing charged airlines extra for "optional" add-ons, despite many of these being safety-critical features like an alarm warning of AOA sensor malfunctions (Gelles & Tabuchi, 2019). While it is unclear that these would have prevented either of the 737 MAX accidents, this practice, akin to car companies charging extra for upgraded seatbelts, highlights the disturbing attitude of profit over safety. These decisions are in clear violation of perhaps the most vital part of the American Institute of Aeronautics and Astronautics (AIAA) Code of Ethics, which is to "hold paramount the safety, health, and welfare of the public in the performance of their duties" (2013). Boeing failed to uphold this standard to save a buck, and the real price was paid in human blood.

Of course, while it is easy to pin the blame entirely on Boeing, that does not get to the root of the issue. To be sure, Boeing deserves every bit of their $2.5 billion fine, full stop. But Boeing is far from alone, and the fact that they were able to get away with their negligence is indicative of industry-wide structural issues. For starters, there is a severe lack of oversight, which, in the United States, is primarily the job of the Federal Aviation Administration (FAA). Being severely understaffed and underfunded, the FAA has resorted to allowing companies like Boeing to "self-certify" large chunks of their processes, a major loophole that allowed the problems with the 737 MAX to slip through the cracks (Davis & Lopes, 2019). Regardless of industry reputation and experience, self-certification inevitably breeds complacency, and Boeing is no exception. Self-oversight simply does not work—it never has and never will. This is not the first time such an arrangement has killed—when a cargo door blew off a McDonnell Douglas DC-10 in 1972, the FAA reached a "gentlemen's agreement" with McDonnell Douglas that the problem would be fixed, in lieu of seeing to it that fixes actually took place (Barro et al., 2011). Unsurprisingly, nothing would be done until, eventually, 346 people paid with their lives, a classic case of tombstone regulation. Nevertheless, the potential for profit seems to induce amnesia in the industry when it comes to lessons learned. Self-certification is as blatant as it gets in terms of conflict of interest, violating another key part of the AIAA Code of Ethics, not to mention Boeing's own code of conduct. A regulatory agency should never have to resort to such a hands-off approach, and the problems at the FAA represent a systemic emergency and a danger to the flying public.

Beyond the FAA, other issues also plague the aviation industry. Scapegoats are often used to direct attention away from the deeper issues that underlie accidents, and the 737 MAX case has proved to be no exception, with Boeing test pilot Mark Forkner charged with fraud (Leggett, 2021). While Forkner may not be blameless, the allegations against him only deflect attention away from the real questions: what kind of safety culture at Boeing drove him to lie to regulators, and why is it that regulatory agencies rely on the word of a Boeing employee instead of doing their own checks, and, well, regulating? Hostility against whistleblowers is also a notable concern—while whistleblower protection is not explicitly part of the AIAA Code of Ethics, it is part of other engineering ethical guidelines, including those of the Institute of Electrical and Electronics Engineers (IEEE). Whistleblowers have not fared well in the past—in 1998, John Liotine sounded the alarm on Alaska Airlines' flawed maintenance, whereupon he was promptly put on leave and slandered on the official company website (Miletich, 2001). Less than two years later, 88 people would be dead after their Alaska Airlines MD-83 spiraled into the ocean due to—you guessed it—inadequate maintenance. Despite theoretical government protections, the existing precedent almost certainly discourages people from speaking up. As former Inspector General Mary Schiavo put it, "you need to be prepared to find another line of work because you will not work in the industry, and you will not work in the government. In most cases, it's almost impossible to be a whistleblower and survive in your career" (Weir & Lanning, 2003). Boeing has committed to changing this culture on paper, and in 2014, when Curtis Ewbank lobbied for additional safety systems in the 737 MAX, to Boeing's credit, Ewbank was not fired. However, his ideas were rejected due to cost and scheduling constraints, so the outcome was practically the same—safety took a backseat to cost (Gates, 2020).

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Ultimately, no amount of colorful web pages or glowing statistics will change the grim reality of the industry's rampant ethical failings. In a sector where money does the talking and regulators look the other way, companies know they can get away with nearly anything, as the unfortunate reality is that people will forget. And companies know that people will forget. The flying public is not talking about the DC-10 accidents from 50 years ago, or the 737 accidents from 20 years ago, and 20 years from now, no one will be talking about the 737 MAX. Hoping that the 737 MAX fiasco will spontaneously shock the industry into change would be an easy assumption to make. But such an assumption would be one final, tragic mistake, in a chain of already tragic events.

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These Are Not the Drones We Expected: The Role Engineering Plays in Ethics

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A barren wasteland lay ahead: war and masses of droids came over the horizon, a soft rumble pulsing through the ground. With their tan metal bodies and guns strapped across their chests, the droids marched toward an army of Jedi and clones that awaited the incoming destruction. Under the intergalactic system, the opposition's greatest strength becomes the basis of its devastation. In a fundamentally avaricious manner, the assets each party brought forward forced millions to live under belligerent conditions in an attempt to deter thousands of planetary systems from seceding from the Galactic Republic and conforming to the Separatist Party.

I always thought of war in the 'Star Wars' sense. In Star Wars, droids lacked intelligence, whereas seemingly dispensable clones underwent training from their creation to be war heroes, capable of strategic combat. This extensive training provides an answer to the question of why robots have not been used in high scale combat—yet. Plainly, a clone takes many years to become intelligent and experienced. With the advance of artificial intelligence and machine learning, however, there is no doubt that machinery can compute and create perspicacious war strategies and execute them accordingly in a relatively short period. Simply put, there is the potential for autonomous drones being developed to save human lives, reduce human deaths, and avoid human conflict. Using automated, robotic combat, however, introduces the ethical issue of machinery malfunction and unmonitored violence against human beings by intelligent hardware.

According to a United Nations report in March 2020, a Kargu-2 quadcopter autonomously attacked a person during a conflict between Libyan government forces and a breakaway military faction. The quadcopter is an unmanned platform that acts autonomously in battle areas and leverages deep learning, advanced computer vision, and machine learning techniques, even when no data communication is available. This Turkish machinery was designed as a mechanism to fight against terrorism, a vague, convoluted term that is intended to 'affirm' the need for this technology in the name of public safety. Its primary method of obstruction is to proceed into a nose dive, detonate upon impact, and kill its target through the shards from the blast. The New York Post reported that the drone was operating in a "'highly effective' autonomous mode that required no human controller." This situation requires the urgency of conversation centred around intelligent unmanned systems, especially from an ethical stance.

The development of these "killer robots" presents issues that persist across the globe, as models have been designed, manufactured, and deployed in countries such as the United States, China, Israel, and Russia. "Killer robots" utilize electrical engines and sophisticated applications of computer science. Their development is the epitome of a failure to comply with engineering principles and the mission of humanity-focused building. In violating such terms, the development of this technology should not be established any further.

According to the American Society of Mechanical Engineers (ASME)'s Code of Ethics of Engineers, engineers advance the dignity of the engineering profession by "using their knowledge and skill for the enhancement of human welfare." In order to enhance quality of life, parties must put aside personal benefits and focus on the collective; they need to do what is right. After all, there is a difference between a human being and being human.

The Kargu-2 quadcopter, designed to detonate at a target enemy, is "likely the first time drones have attacked humans without instructions to do so." Cognitive engineering of the droids with the intelligence to execute commands is of utmost concern. With international, non-governmental bodies like the Human Rights Watch calling for a "preemptive ban on the development, production, and use of fully autonomous weapons", it is evident that preventative measures should be taken. In accordance with engineering ethics, fully autonomous drones beg the question of target misidentification, competence, and precision. The engineers working in companies that focus on military warfare and creation, whose purpose is to serve a larger defence administrative market, are not necessarily adhering to their code of conducts. According to the ASME, professional engineers are required to stay true to the values of human welfare. Companies like the Savunma Teknolojileri ve Mühendislik A.Ş (STM), which generate such trivial droids, operate more on their own beliefs than those of engineering societies, yet every engineer's moral compass must be aware of the negative potential of such impactful technologies. For companies that prioritize profit, a code of conduct often revolves around making money, regardless of what is morally correct. Further, adhering to the ASME's Code of Ethics of Engineers, every engineer "should hold paramount the safety and welfare of the public." The advancement of unmanned drone technology clearly opposes the first fundamental canon, in which the safety of humanity is threatened. From cognitive responses without human control to effective detonation and murder, "killer drones" have created conversation about the stance engineers should take when supporting the development of autonomous drones with the power to execute dangerous tasks. If an engineer abides by the code of ethics, they should recognize that it violates the principles of public safety and instead worships capitalism and greed. Therefore, it is best assumed that the development of drones with the capability to execute autonomous military commands should be prohibited. It places an inherent risk to the safety of individuals in war-stricken zones, where oftentimes, innocent citizens pay the consequences of conflict. In such scenarios, innocent individuals must fear attack from small drones, bombs, and soldiers. Considering the trauma survivors must face and an ever-expanding technological world, issues like PTSD could arise in the future that cause mistrust between humans and robots. To avoid such a dilemma, engineers should uphold the principles of moral engineering, which are guided by a compass based on "what is appropriate" and "what is right."

The ASME's Code of Ethics of Engineers attempts to uphold a standard by which humanity is best served. This constant endeavor to morally guide engineers as they complete projects that have the potential to change the world, truly works to construct a more humane society. With the world spiralling toward protecting its countries, military-focused companies aim to deploy robots that possess the intelligence to preserve "anti-terrorist" ideals. Although technologies using AI and computer vision have considerably advanced in exciting ways, it raises the question of "developing for humanity." As the Kargu-2 quadcopter delved into a deep nose dive, locked on to the rogue being, and detonated within seconds of reaching its maximum velocity, the engineering principles that governed it and the computer science matrices that allowed it to execute its task have all sparked conversation regarding autonomous vehicles of defence.

In Tatooine, Mandalore, Naboo, or any other planet of battle, droids no longer serve a military purpose. Those war-ridden planets, of course, are different; the droids there are metal-heads and absolutely useless strategically. Today, however, drones are competent and adept, implementing intense computer science and engineering fundamentals that allow for precision and intelligence. Although great advances have been made, according to engineering morals, autonomous drones must be deemed morally unacceptable as they pose a threat to society if uncontrolled by a human being.

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COLUMBIA UNDERGRADUATE SCIENCE JOURNAL

Coronavirus Vaccination and Organ Transplantation

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As the “novel” coronavirus becomes “novel” no more, protocol with regard to how institutions and governing bodies operate and take health precautions will continue to spark social controversy. Especially, one might add, when the coronavirus affects areas of life that we would not previously think would be affected. One such case is that of COVID-19 vaccination status when deciding which transplant candidates are the rightful receivers of sought-after transplants, such as a kidney or liver. Various hospitals around the United States have begun to require vaccination as part of eligibility for an organ transplant, and this decision has turned into yet another controversy about COVID-19. When receiving a transplant, the patient’s immune system is severely immunocompromised, and contracting an illness (like COVID-19) becomes increasingly likely when not taking the necessary precautions.

This debate was brought to light when Leilani Lutali, a kidney patient from Colorado, refused to get vaccinated against COVID-19, and was, therefore, reported inactive on a kidney waiting list at the University of Colorado Hospital. Her refusal stemmed from religious objections and overall discomfort about taking the vaccine, and if she didn’t start her vaccination process within the month, she would then lose her spot on the waiting list completely. Lutali would then proceed to seek care from institutions that don’t require COVID-19 vaccination in order to receive a transplant, in the hopes of getting off the waiting list there. Though Lutali offered to be tested for COVID-19 before the transplant surgery, as well as absolve the hospital of all responsibility of the risk of her not taking the vaccine prior to the procedure, she was turned down, disappointed that her own decisions toward her health were not taken into account.

Those who agree with Lutali would argue that the patient’s religious limitations and risks should be respected and should not affect her ability to receive service at the hospital. However, a key aspect of a this procedure includes concern for other prospective transplant receivers, a consideration that can change the course of hospital policy. With 107,000 candidates waiting for an organ transplant in the US, concern for the “other” in this process is paramount.

The code of ethics of the American Society of Transplantation offers some insight into how hospitals and other medical institutions dealing with transplants might decide who their patients may be. Because transplants of any kind are so coveted and, therefore, limited, this code of ethics is assumed to be an objective triage process when it comes to decision making in an area that can seem so subjective. The AST makes it clear that “Medical criteria must be the primary determining factors in transplant decision-making,” and all else is secondary. When choosing organ recipients, institutions must also consider the likelihood of a successful transplantation. This code of ethics was established before COVID-19, and many hospitals require vaccination against other diseases as a prerequisite to receiving an organ transplant, anyway. It isn't a new idea that transplant patients must work to become fit to receive a transplant— for example, smokers refrain from smoking for six months before receiving a lung transplant.

Religious beliefs should be respected (as affirmed by the AST), but a patient whose religious beliefs infringe upon the health of other patients should not be prioritized in this process. When others' lives are at stake, it is understood that restrictions must be placed. This is not to say that an unvaccinated person should not receive a transplant, but they should not be directly prioritized over another patient when they are inherently at a lower chance of success for the operation. In such an area of medicine where supplies are increasingly limited, medical criteria must be able to adapt to the changing times while staying true to our code of ethics. In this case, it means that requiring a COVID-19 vaccine to receive an organ transplant is a valid and scientifically supported criterion when deciding who should receive a transplant. Therefore, coronavirus vaccinations should be required for patients who wish to undergo organ transplantation. This isn't a "novel" discussion anymore; it is rightfully rooted in past decisions. As the medical world continues to evolve in all areas, it is this evaluation of precedent, ethical practice, and new circumstances that will contribute to the most informed decisions.

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Ethical Vaccine Mandates

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In the 2003 Code of Medical Ethics written by the American Medical Association (AMA), the preamble begins with a statement addressing the importance of physicians in our world, especially with increased globalization. Nearly 2 decades before the COVID-19 pandemic, they reference the “plagues and pandemics which respect no national borders in a world of global commerce and travel” (AMA Ethics Code), and how therefore physicians will be of the utmost importance to return our world back to normalcy. The entire code of medical ethics is based upon the ancient Hippocrates Oath (Encylopedia Brittanica, Hippocrates Oath) and for centuries, the main philosophy has remained the same - for physicians to continue to use their knowledge to heal.

But in the midst of the COVID-19 pandemic, another glaring question has been asked. What if it is the physicians who must use medicine on themselves in order to protect others? The most obvious example can be seen with the COVID vaccine as hospitals, schools, and employers across the nation put “vaccine mandates” into place. The instructions - get vaccinated or leave.

In July, Saint Jude, one of the most prominent research hospitals across the country, declared that all employees had to be vaccinated before September or their employment would be terminated. It was one of the largest mandates made by an employer at the time. Whilst many argued that it was not the position of the hospital to create and enforce this mandate, the next few months have proved how this decisive action was ethical and may have saved thousands of lives.

Saint Jude is a unique hospital in the sense that works in specialized cases with some of the most immunocompromised patients in the country. Even outside of cases such as SCID (Severe Combined ImmunoDeficiency) and Lupus, which both directly involve a compromised immune system, many of the treatments used at Saint Jude such as chemotherapy also reduce immunity (The Breast Cancer Organization, 2015). Therefore, while disease prevention is crucial in any hospital, it is even more important here. Normally, those with compromised immune systems only make up a small portion of the hospital, but at Saint Jude, nearly all of the 8,600 patients have a weakened immune system. Interestingly, for most hospitals (including Saint Jude), vaccines have been mandated for decades in order to “protect the interests of both the patient and the professionals” (Jecker, et al, 2021).
A 2009 paper written by the National Center for Biotechnology Information (NCBI, 2009) states that “No one is at greater risk of contracting contagious diseases or of spreading them than health care workers. Disease-causing organisms can easily spread from patients to health care workers and then back to other patients on a hospital floor” (Riddick, 2003). This paper was written at the height of

the H1N1 flu virus, a time when vaccination policies were once again coming under high scrutiny. This epidemic was able to be relatively controlled due to the high vaccination rates that occurred throughout the entire country. In order to make the vaccination method ethical and efficient, they also utilized a “vaccination order” where certain groups were prioritized. During the COVID pandemic, we also followed many of these procedures, such as having healthcare workers be one of the first to be able to be vaccinated - something that the Biomedical Engineering Journal states within its list for vaccine ethics (Jecker, et al, 2021). The H1N1 vaccine was required for many employers and schools in 2009 and many continue to require such vaccination proof. All 50 states (alongside the District of Columbia) require diphtheria, polio, rubella, measles, pertussis, tetanus, and chickenpox vaccinations for students to attend school (State-by-State: Vaccinations, 2022). Every state besides Iowa requires the mumps vaccine and many others mandate other vaccinations like the HPV or Meningococcal.

It has also been proven that the COVID vaccines are safe and effective. While side-effects for the vaccine do appear to be common with 77.4% of vaccine recipients reporting an effect (CDC, Vaccine Reactions and Adverse Events), more than 91% of the events are not serious (Bean and Mackenzie). When compared to the 242 million COVID cases globally, this number seems meager in comparison. In addition, with most FDA-approved COVID vaccines having efficacies of greater than 80% (Institute for Health Metrics and Evaluation), and other vaccines like the common flu shot having efficacies of ~40% (GoodRX) - it seems clear that the COVID vaccine is one of the best methods to prevent the disease and its spread.

These statistics originate from multiple independent studies as required by the National Institute of Health (NIH), particularly in the aspect of social and clinical value (NIH Clinical Center). The trials went through multiple rounds of review and testing before even being performed, thus demonstrating how careful and rigorous the entire process was. The development of the vaccine also closely followed the Biomedical Engineering Code of Ethics to make sure that it was safe for human usage. One of the first ethical obligations of a biomedical engineer is that they must “use their knowledge, skills, and abilities to enhance the safety, health, and welfare of the public” (BMES). While this obviously correlates to the development of a COVID vaccine to mitigate the effects of the pandemic, it also means that a safe vaccine must be produced, not just the first available vaccine.
In addition, while no one can advocate for a human being to put their life on the line, thousands of healthcare workers have been doing so from the start of the pandemic. As the AMA Code of Ethics states in point 4 of its Declaration, “The members of the world community of physicians, solemnly commit ourselves to: apply our knowledge and skills when needed, though doing so may put us at risk.” Healthcare workers have been doing this for ages with the polio crisis, the Ebola pandemic and now with COVID. But when a solution has been created to mitigate their risk as workers and that of the patients, should it not be considered ethically right to ensure that all are protected?

Dr. Field, a professor of Law at Drexel University, began the introduction of his paper by asking, “What would you do if you knew that by undergoing a minor medical intervention, you might save the life of another person? What if you could potentially save dozens of lives? How risky would the intervention have to be before you would even hesitate?" In a world where we are able to be living transplant donors to others, why do we hesitate for something that would protect us and those around us? Particularly as healthcare professionals, they have committed to protecting humanity and human life. By not getting vaccinated, they risk breaking their most solemn oath and commitment - they risk their own lives and those of every person with whom they interact. Therefore, it is not only the right, but the duty of Saint Jude to require that all of their employees be vaccinated in order to protect everybody's health. Vaccination isn't simply a "check" on a long to-do list, it is a disease prevention technique that can save lives - both of others and your own.

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On the Ethics of Self-Driving Cars

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Starting as early as 2009 with Google's Waymo project, autonomous cars have become a focal point of modern technology. The possibility of having fully autonomous, self-directed vehicles that once seemed impossible is now becoming a closer reality as companies such as Tesla, Google, and Ford focus their efforts on developing self-driving cars. However, not everyone is enthusiastic about this new technology. In March of 2018, a self-driving Uber car tragically struck and killed a woman who was crossing the street while the driver was on her phone (Isidore, 2018). The accident generated much dissent over the ethics of developing self-driving cars, which may endanger pedestrians, drivers, and even their own passengers. Although the conversation surrounding self-driving cars is contentious, developing autonomous vehicles is ethical because they substantially improve the safety and reduce the environmental impact of motor vehicles, all values that align with the Institute of Electrical and Electronics Engineers (IEEE) Code of Ethics.

Perhaps the most relevant tenet of the IEEE Code of Ethics is the first, which instructs engineers to "hold paramount the safety, health, and welfare of the public…" ("IEEE Code of Ethics," 2020). Safety is a looming concern regarding autonomous vehicles, since the driving algorithms must be near-perfect and extremely thorough in order to ensure the safety of the passengers, other drivers, and pedestrians. Although some find it difficult to trust driving that is controlled by a program and not a human being, studies show that human error is actually much more likely to cause accidents. In 2016, the National Highway Traffic Safety Administration estimated that human error played a role in 94% of all fatal crashes (Hersman, 2016). Autonomous driving removes the possibility of human error, which would greatly reduce the total number of car accidents. In fact, a 2015 report by consulting firm McKinsey and Company projected that self-driving cars would reduce car accidents by up to 90% and prevent up to $190 billion in damages and health costs a year (Bertoncello, 2021). Autonomous vehicles, which are programmed to always abide by traffic laws and prioritize safety over expediency, are actually a much safer alternative to human-controlled vehicles. An algorithm is never intoxicated, distracted, or emotional. Humans, on the other hand, introduce a variety of variables that could impact the reliability of their driving on a given day. Humans are also uniquely limited in what they can do, whereas technology has the enhanced capability to sense and process the world around it in a way that humans cannot. For example, human reaction time may prevent a person from braking fast enough to avoid a collision. Autonomous cars do not need additional reaction time; they react to oncoming collisions as soon as they are sensed, decreasing the likelihood of crashing (Nowak). With the removal of human error along with the implementation of advanced safety technology, self-driving cars are overall much safer than human-driven cars. By contributing to the development of these safer cars, autonomous vehicle engineers are abiding by the first tenet of the IEEE Code of Ethics and working to improve the safety of the public.

A second ethical standard electrical engineers must abide by is to follow “sustainable development practices” (“IEEE Code of Ethics,” 2020). While it is true that some technologies come at the expense of the environment, self-driving cars are not one such technology. A study conducted by the Energy Information Administration found that introducing fully autonomous vehicles onto the roads could cut down fuel consumption by up to 44% for cars and 18% for trucks by 2050 (“Study of the Potential Energy,” 2017, p. 69). By substantially reducing fuel consumption by motor vehicles, autonomous vehicles are actually helping the environment. This positive environmental impact is not limited to a case where all or even a majority of cars are autonomous, however. Even a single autonomous vehicle can influence the flow of at least 20 surrounding vehicles, with considerable reductions in velocity standard deviation, excessive braking, and fuel consumption (Stern et. al., 2018, pp. 205-221). One autonomous vehicle can noticeably reduce the environmental harm done by cars; the further development and improvement of these self-driving cars encourages the effect to take hold. By working to advance autonomous driving technology and therefore make self-driving cars more mainstream, engineers are contributing to a more sustainable future for motor vehicles and thus abiding by the IEEE Code of Ethics.

The list of benefits brought about by self-driving cars goes on— and the more this technology is developed by companies like Tesla and Google, the more effective these cars will be in improving the safety, environmental impact, and quality of life of people owning motor vehicles. Engineers who help develop these autonomous vehicles are clearly following the IEEE Code of Ethics, which emphasizes the safety of the public and sustainable development. With any new technology comes the fear of the unfamiliar and a reluctance to trust machines over people, but the tangible benefits of self-driving cars outweigh the negatives and leave a lasting impression on modern transportation.

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Ethics of GitHub Copilot

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This fall, GitHub (now owned by Microsoft) announced Copilot, a replacement for the autocomplete features found in most code editors. In fact, Copilot goes far beyond filling in variable names and function calls; it uses a machine learning model that has been trained on all publicly available code on GitHub to predict what code should be inserted at a given cursor position in any open file. In the current technical preview phase of Copilot, developers can enjoy having entire functions written for them by their computers. Given merely a function name, Copilot can leverage the hundreds of billions of lines of code in its training set to infer the developer's intent and insert the appropriate code. Copilot is an incredible technological feat. However, there are numerous ethical questions that need to be addressed if Copilot and future AI-based coding assistants are to be adopted. For instance, what does Copilot mean for copyright? Also, who is liable for complications caused by code written by Copilot?

Copyright is already enough of an issue for human coders. A key obligation for engineers, and one which makes innovation worthwhile, is to "give credit for engineering work to those to whom credit is due" (NSPE). As more developers began sharing their work with the public, standard licenses quickly became popular. For example, if a developer wished to share a library they wrote but wanted to prevent others from monetizing it, they could license the code under the GPL license. The GPL License requires that "derivative works (of the copyl eft-licensed code) must carry the same license as the original code" (FOSSA). However, it is generally acceptable for humans to take inspiration from publicly-available code—even code distributed under strong licenses. The process of creating something new and transformative out of small pieces of copyrighted work falls under fair use. On GitHub, only a small portion of all publicly available code is distributed under permissive licenses like the MIT License. Yet, to make Copilot effective, GitHub trained Copilot's AI on all public GitHub repositories. This begs the question: does training an AI model fall under fair use? In other words, can AI look at existing source code and invent something new in the same way humans can? Currently, this is more of an existential question than it is a technical one, which makes it difficult to answer. For GitHub, there are two paths: either assume that developers who have contributed public code—even decade-old projects—are all fine with an AI scouring through their work, or assume the opposite and require developers to "opt-in" their repositories to Copilot's training set. The latter option is far more ethical, although it is unlikely for GitHub to adopt anything that hinders Copilot's development in the short run.

Now, even if every developer opted into having their code used in Copilot's training set, there is still the issue of liability. For illustration, consider the (unlikely) possibility that Boeing's programmers rely on Copilot for their next commercial airplane. A few years later, a glitch in the flight computer causes one of these planes to crash, killing the passengers onboard. Who is liable? If a human developer had, say, introduced the bug in the flight computer, then that developer, or at least Boeing as a whole, would be responsible for the tragedy. But what if the malfunctioning code was entirely Copilot's doing? One could argue that Boeing is still responsible because it is the responsibility of the company's testing team to catch bugs in critical components. However, the state of software development will inevitably reach a point where developers trust AI programming assistants to the same degree that developers trust compilers today. Regardless of how battle-tested these AI assistants become, the possibility of a mishap will always be nonzero. And the lower this possibility dips, the tougher it becomes to blame companies for their reliance on tools like Copilot. Even then, it would be difficult to pin the blame on AI assistant providers like GitHub because they could not have done much more to prevent this error. It would not make sense to blame the developers who provided the training data to Copilot's AI, either—even if it were possible to identify the exact code segment in the vast training set that drove Copilot into outputting the bug. The developers behind the code in the training set could never have predicted that their work would have been used by AI in the development of a flight computer that resulted in hundreds of deaths. This example involving Boeing and a plane crash is extreme, but complications on a lesser scale (think hacked medical records) are bound to happen in the next few years because, after all, not every developer will bother verifying the code produced by Copilot. As AI becomes sophisticated enough to produce field-specific code, there is no guarantee that developers will even be qualified enough to check the generated code. Given that engineers are expected to operate in their "areas of their competence" (NSPE), this is especially problematic. At the minimum, programmers ought to establish that it is their own responsibility to vet Copilot's output. Unfortunately, this may make developers hesitant to adopt AI coding assistants.

GitHub Copilot is one of those technologies in which a tradeoff inevitably exists between progress and ethics. However, a cautious approach from both the developers and consumers of Copilot can help ensure that AI-based coding assistants change the software development landscape for the better.

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COLUMBIA UNDERGRADUATE SCIENCE JOURNAL

TikTok Tom and the Ethicality of Deepfakes

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I was scrolling through my TikTok feed one day when I came across a video that made my finger pause from its continuous swiping motion. The video featured Hollywood superstar Tom Cruise–or someone (or should I say something) who appeared to be Tom Cruise–teeing off at a golf course. My curiosity getting the better of me, I decided to tap on the user's @ to investigate whether or not the mega-celebrity had really created a personal TikTok account. I found myself quickly becoming a part of the new viral intrigue that was TikTok Tom. The comment sections were flooded with zingers: "Day 173 of not knowing whether this is the real Tom Cruise or not…", "He looks more like Tom Cruise than Tom Cruise does," and my personal favorite, "If you are being held against your will, blink twice."

Unfortunately for one hopeful fan who insisted that "That's Tom Cruise because he has crooked front teeth which are off-center a little bit to the left," it wasn't really Cruise. Instead, the videos featured a deepfake doppelganger of Cruise created by visual and AI effects artist Chris Umé with the help of actor Miles Fisher. From the slightly misaligned front teeth to the classic action-hero gait, the deepfake was incredibly convincing–and, as one viewer put it, "worryingly good." While more and more social media users gravely predicted that the TikToks were a chilling sign of an apocalyptic future, TikTok Tom was setting off similar panic in national security and intelligence circles. Ever since the first deepfakes debuted in 2016, the technology has been viewed as an emerging threat to national security, personal identity, and even truth, itself. As the Tom Cruise videos have shown, that threat is more prominent than ever, as technology is now so advanced that virtually any person with the right equipment can produce lifelike fakes.

Thus arises an important question: is the use of deepfakes ethical?

The vast majority of people seem to find the idea of deepfakes discomforting. There's just something inherently morally problematic about footage that's able to realistically portray people saying or doing things that they've actually neither said nor done. It would, however, be unproductive to be so quick to condemn an entire technology without considering all of its facets. The question I have presented is extremely broad, after all, and it hugely depends on individual circumstances. For instance, fans of the Star Wars franchise were delighted, rather than disturbed, when YouTuber Shamook created a deepfake rendition of Luke Skywalker that heavily improved his cameo in The Mandalorian.

I believe that it is difficult to confidently say that a use of a deepfake is unethical without examining the ACM code of ethics and considering 3 additional central factors, as proposed by Adrienne de Ruiter in "The Distinct Wrong of Deepfakes." They are as follows:

1.Would the deepfaked subject object to the way that they are being repre sented?

2. Does the deepfake deceive viewers?

3. What was the original intent of the deepfake?

In this essay, I'll be analyzing a specific case: TikTok Tom.

After his TikToks inspired mass panic on the Internet, Ume had to go on a media blitz to quell some of the hysteria, revealing how he made the videos and reassuring the world his intentions were only to entertain–not to spread misinformation.

However, following the approach I have outlined above, I argue that Ume's Tom Cruise deepfake, while made with no malicious intent, is unethical.

As previously mentioned, Ume explicitly states that his only purpose for creating the deepfakes was to entertain the public. The videos contain footage of "Tom Cruise" playing the guitar and marveling at a bubblegum lollipop, content that steers clear of damaging and grossly misrepresenting Tom's character. So far, the TikToks appear to honor all of the relevant ethical principles laid out by the ACM Code of Ethics. While it's difficult to say that the videos "benefit society" (1.1), they do not cause harm (1.2); actively seek deception (1.3), especially given that Ume has publicly been more than transparent about the deepfake nature of his videos, even posting video breakdowns that showcase some aspects of how he creates his deepfakes (though there will always be confused viewers who forget to read the username @deeptomcruise); nor disrespect privacy (1.6), as Ume's computer model only uses images of the actor available to the public domain. What makes Ume's usage of deepfakes unethical, then, is what I believe to be a violation of central factor 1: the aspect of consent. Ume stated in an interview that his team has reached out to Cruise's management, asking if they should take the videos down, but they never received a reply. Given that some action (legal or not) would have been taken by Cruise's management team had the videos been perceived as even slightly damaging, some may interpret the lack of objection as consent. However, in this new age of deepfakes, I argue that protection against the manipulation of realistic digital representations of our images and voices should be a fundamental human right that is carefully preserved, and that entails defining consent not as the lack of disapproval but as the clear expression of approval from the person being represented. In accordance, the lack of explicit consent from Tom Cruise means that Ume's deepfakes are in violation of Tom Cruise's right to autonomy in influencing the way he is digitally represented, and is, therefore, a violation of Code 1.1 of the Code of Ethics.

The uses of deepfakes (benign, neutral, or unethical) are vast and varied. Sadly, the most common current use of deepfake technology is for pornographic purposes. There are further concerns that deepfakes will be used in the near future to "undermine trust in the democratic process and institutions, heighten social and political tensions, commit crime, destabilise financial markets, subvert diplomatic relations, and incite violence" (de Ruiter, 2021). It is important to note, however, that the technology has been used for beneficial and ethical purposes, as well, such as in the development of software that can artificially regenerate the voices of people who are unable to speak due to illnesses like ALS. Rather than censor the technology, it is imperative that we develop deepfake threat models, ethical AI principles (similar to the ones I have outlined above), and regulations that promote awareness, encourage advancement, and do not stifle innovation. Even Chris Ume has said that he strongly believes that there should be laws that help with the responsible use of deepfakes. Though I have ultimately concluded that Ume's use of a deepfake was unethical, it is undeniable that there is a silver-lining to it all. In his own words, "I think it's a good thing I created these videos because now I'm raising awareness and they realise, 'This is real. It's coming.'"

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Ethics of the Metaverse

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On October 28th, Facebook announced that they would be rebranding as Meta—a nod to their transition into metaverse technologies. According to NPR, the metaverse Facebook hopes to create would exist as "a world of endless, interconnected virtual communities where people can meet, work and play, using virtual reality headsets, augmented reality glasses, smartphone apps or other devices" (Gillieron, 2021). However, while Facebook has paraded the plausibility of a virtual world, critics have been vocal about the dangers it poses. In fact, upon investigation, it is clear that Facebook's venture into the metaverse will be one that endangers the health, safety, and welfare of the public, and specifically the youth—violating a fundamental canon of the National Society of Professional Engineers (National Society of Professional Engineers, 2019).

Primarily, the metaverse will pose a threat to public health by enhancing the already addictive draws of technology, something about which Facebook heard its fair share of complaints in Congress this past month. Today, one in ten Americans meet the criteria for social media addiction, characterized as "being overly concerned about social media, driven by an uncontrollable urge to log on to or use social media, and devoting so much time and effort to social media that it impairs other important life areas" (Addiction Center, 2021). Social media addiction is especially impactful to our youth, who account for the majority of social media usage (London School of Economics, 2017). Furthermore, studies have shown that when we fully immerse ourselves into media, it becomes even more addictive. For example, VR gaming, which is the closest thing we have to a metaverse at this time, has proven to be even more dangerous to users than typical video games. While players exhibit the same symptoms of addiction as with typical gaming—such as depression, anxiety, and sleep disorders—there is the added risk that VR games may "damage the brain in a way that people will not be able to distinguish between VR and reality" (Rajan, 2018). This information is startling and demonstrates Facebook's willingness to endanger its users for a profit.

Additionally, there are concerns over how users will treat others in a virtual world considering the harmful interactions seen on social media today. Since the inception of social media, cyberbullying and its effect on the youth has been alarming. Statistics show that about one in two teens have experienced cyberbullying in their lifetime, which places them at a 50% higher risk for thoughts of suicide (Enough is Enough). These statistics portray what happens when bullying occurs through a screen—what happens when it becomes their reality? A study published in the Journal of School Violence found that "a majority of victims who had experienced both forms of bullying reported that being traditionally bullied was worse than being cyberbullied"; however, the potential for more frequent attacks alongside an unlimited audience size contributed significantly to the harm done by cyberbullying (Corby, 2019). By establishing a metaverse, we are opening the door for harassment with the impact of traditional bullying, alongside the frequency and audience of cyberbullying. This can only maximize the damage done to our youth through media.

Lastly, it is concerning that Facebook—currently without any competitors in their venture—may have full control over a new reality, albeit virtual. Even high-ranking Facebook executives have spoken out regarding this matter, including John Carmack, a Consulting CTO for the company. Carmack is under the impression that one poor decision by Facebook in their design of the metaverse could greatly impact users, specifically stating "I just don't believe that one player—one company—winds up making all the right decisions for this" (Orland, 2021). Monopolies are already detrimental enough in the real world; for a company to have full control of their own reality is unimaginable.

Overall, it is important to generate discourse in the face of new technologies and investigate the ethics behind the things which revolutionize society. If we are not skeptical of progress, we may soon find ourselves living in an unpleasant reality that is too late to change. The metaverse is not predetermined to be bad in the same way that it is not predetermined to harm society—however, the engineers responsible for its creation must demonstrate great care in their work if they are to uphold the ethics of their profession.

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COLUMBIA UNDERGRADUATE SCIENCE JOURNAL

The Importance of Inclusive Approaches to Artificial Intelligence

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Every day during my senior year of high school, I walked through the main building's doors and was met with a temperature scanner that would ideally prevent people with high body temperatures from spreading COVID-19. It seemed innocuous enough: it simply mapped your face, using target areas like the inner corner of your eye, and scanned your temperature using infrared rays. One thing I noticed, however, was that the scanners always seemed to falter when attempting to scan darker-skinned students such as myself. There were countless instances where I would watch students in front of me pass by with ease, only to be prevented myself. Eventually, the school nurse had to manually scan my temperature using the infrared guns; every time, she did it with pure kindness, but I knew it was a hassle for both of us. I began to think of reasons as to why the issue existed in the first place. I knew it wasn't because I was wearing a mask–the scanner was primed to work exclusively while masks were on its target's face. I also knew that it wasn't because of the type of mask I wore, either: people wore countless different kinds of masks in a myriad of different colors every day. I decided to delve into the inner workings of those machines and found the likely source of my issue: biased facial recognition software.

Errors in facial recognition software are the result of their training models heavily reflecting the people that develop them: primarily white men. In one report regarding an algorithm that caused the accidental arrest of a Black man, it was found that Black and Asian faces were falsely identified by the algorithm a shocking 10 to 100 times more than white faces. This is in direct violation of tenets II and I.i of the Institute of Electrical and Electronics Engineers (IEEE) code of ethics, by which engineers are expected "to treat all persons fairly and with respect...and to avoid injuring others" as well as "to hold paramount the safety, health, and welfare of the public [...] and to disclose promptly factors that might endanger the public or the environment."

Over the past year, the imbalance in tech has only been compounded further, as seen in the case of Google. In December of 2020, the seemingly omnipresent tech giant fired the head of its artificial intelligence ethics team, notable AI researcher Timnit Gebru, as a result of a dispute involving a paper in which she criticized its facial recognition software. Google certainly has quite a bit of history with bigotry. For example, searches in the engine have displayed horrifically oversexualized results when searching "black girls" due to algorithms loaded with bias, poor regulation of search query data collection has guided people down deep rabbit holes of bigotry and hatred, and its employees have become fearful of reporting experiences concerning sexual harassment and discrimination. Gebru's firing (which Google likes to call 'resignation') only fanned the flames of the already burning workplace culture at the company. The company's heavy-handed response to valid criticism of their practices regarding artificial intelligence further proved just how little we know about the dangers that it possesses. But why is that so?

As a result of human nature, the ethics of AI are very complicated: trying to impose any specific group's set of morals onto an AI could have unintended consequences on others. But these consequences are exactly why large tech companies need researchers like Gebru and her teammates: people who are willing to traverse the treacherous terrain that is artificial intelligence are the ones who allow us to map that terrain and potentially come out with a better understanding of how to apply it to the major problems that our world is mired in. Although we may be fearful of what lies in the darkness that is the future of tech, we also must be careful not to extinguish the bright lights that are meant to guide our path; Google's firing of Gebru and the effective dissolution of their AI ethics team most certainly was a detriment to the field as a whole and is definitive proof that we as engineers must carefully re-examine our approaches towards emerging technologies and those wielding them.

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Ethical Implications of AI Bias for Engineers

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The past decade has been marked by startling advances in the capabilities of artificial intelligence systems. However, data biases, an inevitable feature of human-coded algorithms, also emerge as a daunting challenge that must be confronted by the current society. They fuel political polarization, perpetuate the cycle of discrimination, and are often developed to prioritize the profits of the company over the welfare of its customers.

For example, Harvard Business Review has shared how a simple google image search for “professional haircuts" and “unprofessional haircuts" can reveal the problem. The former brings results that are almost exclusively white males, while the latter turns up faces with diverse racial, ethnic, and gender backgrounds. A child who performed this search could mistakenly believe that he/she can never receive a professional haircut solely due to his/her skin color. The result appears especially alarming when considering that stylish and business-appropriate haircuts are supposedly objective topics.

Since Google presents results based on articles written about such subjects, the outcome of this simple experiment clearly emanates from human editorial decisions to highlight the narratives of white men while neglecting those of others. This predicament, of course, aligns with the reality that the overwhelming majority of media outlets are owned by white males, who choose to propagate specific news stories and present them in such a way that won’t challenge the worldview of their predominantly white peers.

Although the downsides of biased data sets and algorithms have been clearly characterized, comprehending their underlying causes becomes more challenging. Haugen, a Facebook whistleblower who has previously worked as a product manager, criticizes the interest-prioritizing algorithms used on platforms managed by Facebook. She declares that “no one at Facebook is malevolent, but the incentives are misaligned.” Only through alluring the customers into consuming more content can Facebook maximize its revenues from advertisement, and unfortunately, the most efficient way of accomplishing this goal is bombarding their clients with provocative content.

Mitigating systemic AI bias requires the algorithm to be transparent, accountable, and explainable to the general public. Despite appearing unrealistic and overwhelming, there are a few practical steps that all tech companies could undertake. For instance, companies can assemble their machine learning and artificial intelligence teams from a more diverse group of applicants. By gathering individuals with distinct experiences and from different age, ethnic, and gender groups, the team can clearly construct a more representative model.

In addition, all companies should advertise platforms through which the users can give feedback. By having the end-users directly interact with the engineers behind the screen, the company can be more responsive to the needs of its clients.

Issue cannot be overcome by the computer scientists alone. Endeavor to create a mutually accountable and supportive community of experts from various disciplines is also demanded. For example, clinicians must be present while addressing AI bias in healthcare systems, while experts in the criminal justice system can also contribute to improving the performance of AI in assessing the offender's risks or needs and predicting his/her rate of recidivism.

Disentangling the myths behind systematic AI prejudice would be challenging but also equally rewarding. For example, banks' biased algorithms to predict credit scores have historically disadvantaged low-income and ethnical minorities and locked them out from the growing financial opportunities. Recently, however, many credit agencies have begun to challenge this stereotype. One such company with a vision to promote economic equality, the credit bureau Experian, has successfully developed the "Boost program," which provides financial opportunities to those who have been known as the "thin-file" clients. Understandably, with meager economic resources and limited loaning history to augment their credit scores, those marginalized communities would have been automatically placed in the category of the least priority by algorithms. With this opportunity to finally prove their reliability in the banking system, however, the results were staggering. Since the launching of this program in 2019, more than sixty-one percent of the four million participants with "poor" credit have earned their upgrade to a "fair" rating, giving them far more access to buying a car, renting an apartment, or acquiring a business loan. The lenders who took the initiative to trust these thin-file customers also received the benefit of extending far more credit to other profitable businesses.

As stated in the National Society of Professional Engineers Code of Ethics, engineers shall all be guided by the "highest standards of honesty and integrity," "acknowledge errors," and "not distort or alter the facts." These abstract words can have shifting meanings over time, but I believe that at its core, the ethical code asks for self-interrogation—are we really engineering towards a better human future? I suppose that now is the paramount time for the software engineers and computer scientists to reconsider this question. Without the capability to fully explain how their codes benefit both the wealthy and the poor, the software engineers must first acknowledge the potential flaws in their algorithms before striving to make their codes more accessible to the general public. Our collective empathy, consciousness, and morality as human beings must not be waived in the struggle for economic growth and productive efficiency.

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Planned Obsolescence

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Planned obsolescence is a strategy used by manufacturers in which aspects of a product are designed to become obsolete, unfashionable, or non-functional after a period of time. Utilized to increase sales, this technique is a financial burden on the public and is harmful for the environment as well. By intrinsically giving products a limited life span, consumers are forced to replace current products with a newer, upgraded version before they realistically should have to.

A familiar example of planned obsolescence is the Apple iPhone. As new iPhone models enter the market, buyers notice slowed speeds and reduced battery lives in their older phones. This has led to users suspecting that Apple intentionally designs its phones so that they regress in functionality over time — in this article the reality of this phenomenon is explored. Planned obsolescence has created a culture where always having the newest technology is a must. But this is not only unsustainable it is also unethical.

The Institute of Electrical and Electronics Engineers (IEEE) code of ethics outlines the values engineers should uphold as innovators and workers in industry. The first of these values is upholding the "highest standard of integrity, responsible behavior and ethical conduct in professional activities" [1]. In the case of planned obsolescence, this first value is called into question. Companies that are suspected to have engaged in planned obsolescence have never outwardly admitted to performing it. This is a moral gray area that does not speak to the ethical standard expected of engineers.

In addition, under a subsection of this first value, the IEEE code of ethics also emphasizes the use of "sustainable development practices" [1]. As a result of planned obsolescence, there is a constant need for new products to be manufactured so that they can be sold to consumers. This lifecycle of buying new and discarding the old contributes to large amounts of waste, and the environment pays the price.

According to the Green Alliance, the average life expectancy of a smartphone in the USA is less than 2 years [4]. With hundreds of millions of smartphones being sold each year, there is a correspondingly great amount of phones entering landfills as well. Many electronics contain hazardous materials in their components, including, but not limited to, lead, mercury, arsenic, and cadmium. These toxic materials can be toxic to the soil and groundwater, thus impacting local wildlife and damaging ecosystems that receive runoff from landfills.

In addition to polluting the environment, the metals required to construct electronics are finite. The highly specific materials that each product requires renders the mass manufacturing of these products to be, as is, unsustainable. While some recycling initiatives have recently been put into place, the amount of toxic waste that is lost is much greater than the amount of recovered recyclable material. Further, oftentimes this waste ends up in countries where waste-management regulations are not as strictly enforced, causing nearby populations to bear the consequences of the release of these harmful substances in the environment.

Another form of planned obsolescence is called pseudo-functional obsolescence: when “so-called innovative” features are introduced that do not, in reality, significantly impact the product [3]. This includes something as simple as a change in power adapters over time. As new ports are created or shapes are altered, older versions of adapters will slowly lose stock and nudge consumers to change to newer versions of the product. Similarly, the usage of software updates is yet another tactic by which companies make it harder for consumers to maintain their old electronic devices. By making newer versions of the software run slower on older devices or having new software not be compatible with older models, companies practically force consumers to purchase their new products in order to maintain the functionality of their devices. Even worse, for those who might not be able to afford these new products, they are forced to work with pseudo-functioning equipment.

The purposeful implementation of obsolescence in technology is a direct violation of engineering ethics. Producers that practice planned obsolescence place the generation of revenue above the welfare of their customers. When buying a product, consumers must place their trust in the business that the product is of a certain standard. And when that product cannot serve the test of time, it only serves to diminish a consumer’s trust in the brand and engineers everywhere. Even if an engineer is forced by a company to do so, they are the ones designing the products at the end of the day, and thus it is their job and moral duty to speak out against such practices.

Planned obsolescence has real-world consequences — ultimately, much more important than making excessive profits is the maintenance of sustainability in engineering practices so that innovation may continue for generations to come.

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Space Travel: Dream or Disaster?

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20 years in the making, commercialized space travel has long been advertised as the ultimate dream by mainstream media. However, as humanity is closer than ever to actualizing this ambitious vision, questions of equality, sustainability, and responsibility can no longer be avoided. Blasting into space in July 2021 with the New Shepard rocket, engineered by his own company, Blue Origin, Jeff Bezos quickly became the central figure in the space travel debate. Bezos's 'joyride' has been criticized due to the fact that he, one of the wealthiest men on earth, was consciously choosing to allocate resources to causes that are solely in the interest of his own amusement rather than donating to causes on Earth. The heated debate also brought up issues of inequality in the US class system, especially as Amazon employees have long complained of their working conditions, with reports of staff urinating in bottles for fear of missing delivery rates while regularly working 14-hour days (1). Bezos, however, isn't the only billionaire rushing to space. Richard Branson and Elon Musk have also been heavily investing in aerospace technologies, indicating that there will be many more commercial space travels to come. The question to ask now is whether these billionaires are ethically responsible for considering the environmental and social impacts of these missions.

The ethics code of the American Society of Mechanical Engineers (ASME) states, "engineers shall consider environmental impact and sustainable development in the performance of their professional duties." (2) Although the effects of a single flight are not always visible, they are bound to add up. According to Eloise Marais, a professor of physical geography at University College London, "The carbon footprint of space launches is incredibly high, close to about 100 times higher than if you took a long-haul flight." (3) In addition, rocket launches can contribute to the depletion of the ozone layer, since they directly emit dangerous chemicals into the stratosphere. As an example, Bezos's New Shephard runs on a combination of liquid oxygen and liquid hydrogen. While neither of these sources directly emits carbon when combusted, liquid hydrogen production does. Compressing and liquifying oxygen for fuel is also an energy-intensive process that, if not done using renewables, results in carbon pollution. "The Virgin Galactic flight carried six passengers and reached an altitude of 53 miles, and from information provided by Virgin Galactic, we can estimate that carbon emissions per passenger mile are about 60 times that of a business class flight," Peter Kalmus, a climate scientist at NASA's Jet Propulsion Laboratory, said, adding that "more research is needed to understand the full climate impact." (4)

Quoting the ASME ethics code, "engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.” (2) The millions of dollars spent on these travels are simply lost resources that could have been dedicated to social causes such as poverty and gender inequality. From a virtue ethics standpoint, these billionaires are responsible for giving back to their community, especially since space travel does not carry within itself real scientific value, I believe. Space tourism flights from Virgin Galactic and Blue Origin have only reached suborbital space, which is not a new frontier.

Even though space exploration contributes to our fundamental understanding of the universe and is responsible for the development of multiple technologies such as satellites, commercial space travel does not serve the same purpose. Rather, it is a selfish endeavor taken on by billionaires as a means to demonstrate their power, without any regard to environmental nor social consequences such as global warming, inequality, and justice.

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Project Nightingale: The Intersection of Medical Ethics and Engineering

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In recent years, AI and machine learning have taken hold in almost every industry, as tech giants search for ways to improve efficiency and personalize the user experience. Nowadays, online advertisements always seem to know exactly what to sell, and Siri asks why the user is running late to school, even if it isn't on the calendar. These innovations that impact daily life are to be expected in the world of big data, but at some point, there has to be a line. For many, that line encompasses data privacy and user anonymity, and no industry is more susceptible to crossing it than healthcare. In the case of the Google-Ascension Nightingale Project, this is exactly what happened.

The year was 2019, and Google was working with private healthcare system Ascension to collect patient data in the hopes of using their AI technology to enhance the healthcare sector. Such an algorithm, meant to individualize patient care, could be used to predict and find patterns that could lead to better treatments and understandings of common illnesses (Anonymous para. 2): something that the world would certainly benefit from. However, though their original intentions may have been noble, the program itself, titled "Project Nightingale" was a massive data transfer of practically all of Ascension's records, including patient data from 2,600 medical centers and hospitals–at least 50 million people [1]–to Google. This may have been understandable if the information was properly anonymized or could not be traced to any individual, but in fact, no de-identification procedure was followed—even names were left in [1]. The worst part was that both doctors and patients, the people whose personal information was at risk and being leaked, were not notified at all, meaning they never consented to this breach [1]. And if not for a concerned whistleblower, one of 150 Google employees who had access to (and may have downloaded) this sensitive information [2], the transfer may have concluded without anyone finding out.

In the wake of the whistleblower complaint and immediate public backlash, both Google and Ascension immediately tried to dismiss concerns, saying that it was "standard industry practice" for healthcare providers to work on and share medical data with contracted tech companies, even without the explicit notification of patients [2]. They even cited the Health Insurance Portability and Accountability Act (HIPAA)–the most major legislation concerning medical privacy in the United States–and claimed to follow it strictly, implementing precautions for tight data security and protection [2].

Clearly, the companies were careful to follow all legal regulations, but ethics is another issue. According to Schneble, et. al, the aforementioned "standard industry practice" is widely regarded as a loophole in HIPAA (sec. "Complex Legal Regulations"), as the disclosure of personal data to outside business associates is an ethical dilemma in itself. Instead of examining and reexamining the laws, corporations should adhere to and first consider the ethical standards that are commonplace throughout the industry they are dealing with—for medicine, this can be traced all the way back to the Hippocratic Oath, a set of standards from Ancient Greece that most medical professionals still try their best to follow. Doctor-patient confidentiality is a central tenet of the Oath [3] and remains part of the current American Medical Association Code of Medical Ethics—not just for doctors but for anyone dealing with sensitive, patient-specific information. By proceeding with Project Nightingale, Google and Ascension–one trying to enter the healthcare sector and the other long in the center of it–violated the Hippocratic Oath and the AMA Code of Medical Ethics.

Furthermore, the engineers at Google went against their own ethical standards: the National Society of Professional Engineers Code of Ethics, specifically “Avoid deceptive acts”. By disclosing confidential patient information without notifying or receiving consent from those who were made vulnerable, the engineers essentially deceived these people and did not uphold the “highest standards of honesty and integrity” that are required by the Code. The Software Engineering Code of Ethics and Professional Practice specifically mentions data privacy in the section on only acting in public interest and notes in the “Product” section that all products should “respect the privacy of those who will be affected by that software”. Perhaps more than any other set of standards, this violation is the most clear and relevant to the situation and should have been prioritized in Project Nightingale.

With the possibility of innovation and new discoveries hanging over their heads, Google and Ascension allowed their ethics to be compromised and suffered the consequences, losing the confidence and trust of both employees and customers. This era of big data is only beginning, so it is important for ethical guidelines and the laws, themselves, to be reexamined and clarified before more people are put at risk. Regardless of the purpose, people should be notified if their data is being used or transferred to other parties instead of finding out far after the fact via a whistleblower—or not at all. In their analysis of the situation, Schneble, et al. suggest that much of the controversy could have been avoided if the data was made anonymous, not just by removing the names but via k-anonymity, a procedure that ensures the remaining information is obscure enough not to be easily discerned [4]. In the future, this practice should be made commonplace so that advancements can be made while respecting privacy and the public interest. There is no need for innovation to stop, but without following ethical procedures, engineers risk losing credibility and, worst of all, actively put others at risk with their work. This undermines the motivations of so much of engineering, to do good, so it is essential that ethics are followed and respected.

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Engineering Ethics in Social Media Beauty Filters

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The exponentially increasing popularity of social media has ingrained it into almost everyone's lives, especially younger generations who have grown up posting on Instagram, sending photos on Snapchat, and making videos on TikTok. Each app comes with its niche as an online platform, yet they all share one thing: beauty filters. These beauty filters, when applied to one's image, can alter the appearance of one's bone structure and coloration. While initially created as a playful and innocent feature, these filters have been unveiled as perpetuating Eurocentric beauty standards, which violates the Engineering Code of Ethics that obligates engineers to strive to serve the public interest.

Users exposed this bias within media platforms when they began to notice that the beauty filters did not “work” on certain groups of people. These filters enhanced only European features by white-washing skin and warping and distorting the perception of its users' faces while reinforcing the idea of what people are "supposed" to look like. The popularity of TikTok's “Glow Look” filter, for example, has bolstered the damage of these filters on society, especially younger generations prevalent on the app. For younger girls belonging to minority groups, this perpetuation of an unattainable beauty standard is disturbing and detrimental to mental health. A person of color might see these facial features as the standard of being beautiful and desirable whenever they go online, which exacerbates a racial disparity where white people are considered the standard. A parallel phenomenon also occurred when Snapchat introduced its first filters, resulting in what is now referred to as “Snapchat Dysmorphia,” in which patients would seek cosmetic surgery to resemble how they viewed themselves in Snapchat filters.

Social media platforms have been sustaining unattainable and often racially biased beauty standards for years. From an ethics perspective, the engineers behind developing these media filters are held to a set of professional obligations. Chief among them is the obligation to serve the public interest. The negative impact of these filters supports that the engineers at these companies are not genuinely serving their constituents or customers. However, when confronted, Tiktok did not explicitly claim responsibility for the impacts of their filters. A facet of an engineer's ethical obligations is to acknowledge errors and promise not to distort or alter the facts, and the lack of accountability within online companies clearly violates this ethical expectation. The engineers within these companies should be pushing to take responsibility for the impacts of the software they release and, in turn, take tangible steps to better their work.

Tiktok has revealed its process for creating these beauty filters. They use a technology called deep learning, where a computer is equipped to identify facial features from images of real faces. With this “beauty algorithm,” it becomes Tiktok's duty to guarantee that the system is trained on a diverse set of faces. Recently Tiktok released a new filter, the “Belle” filter, that enhances a South Korean beauty standard. Some white users complained that the filter made them look unattractive, whereas East Asian users recognized and appreciated that the filter catered more specifically to their features. For the engineers at these companies to uphold their promise in the Code of Ethics to treat all persons with dignity, respect, fairness, and without discrimination, they must take bold strides in the direction of inclusivity, similar to the “Belle” filter. This could mean many things in practice, the most probable being to release multiple filters that would respect and belong to different groups. This way, there is no singular beauty standard, but many different aspects of different cultures that can be celebrated. Exposure to a diverse set of faces will dilute the Eurocentric beauty standards prevalent in our society. This would benefit the public and stay true to the Engineering Code of Ethics.

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