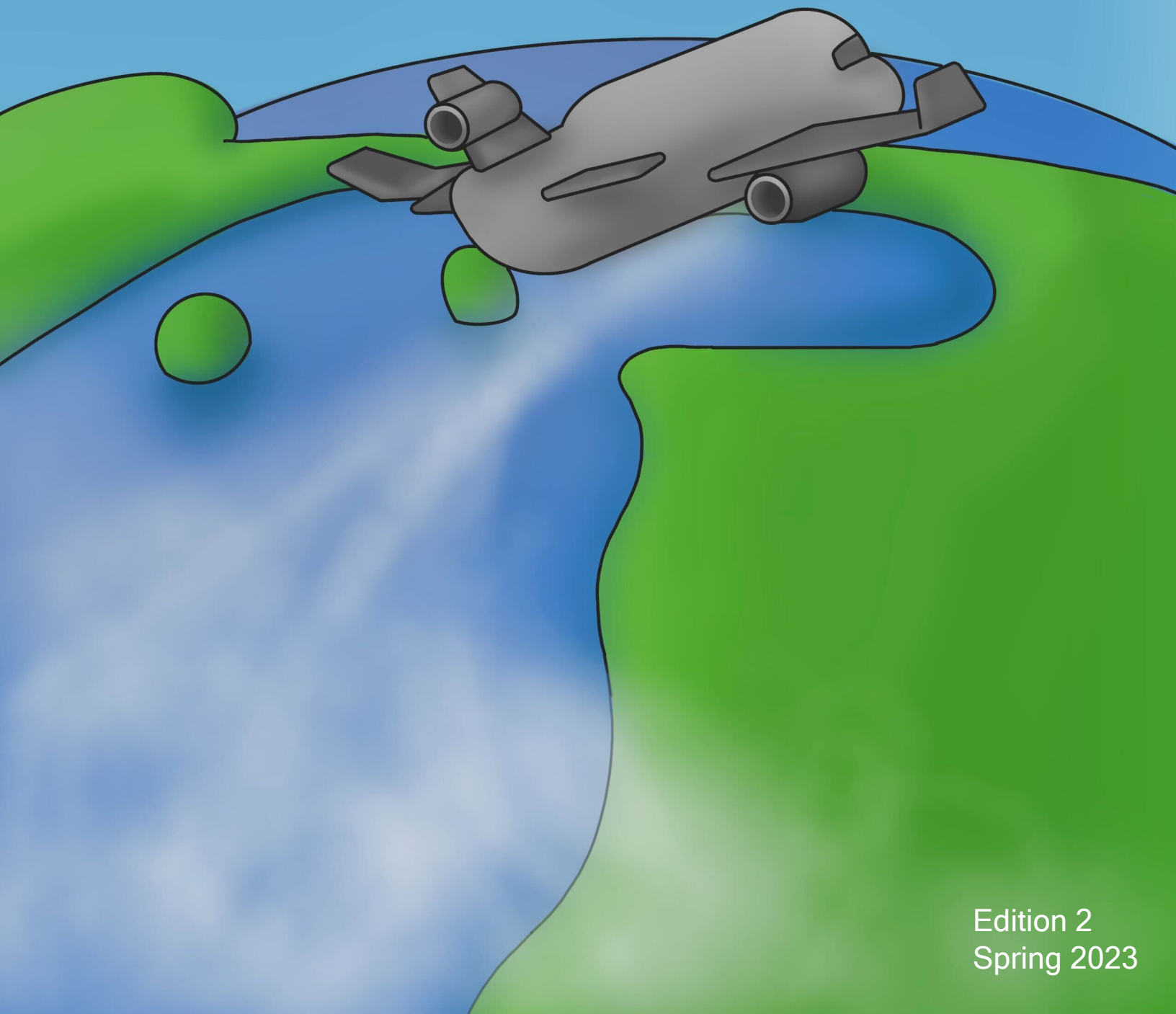
CUSJ COLUMBIA SCIENTIST



Edition 2
Spring 2023

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 I present the second edition of the Columbia Scientist. Originally started in 2022, the Columbia Scientist serves as a platform for all people to comment upon or highlight current ethical issues within any field of science. This year, we are happy to feature both essays and artwork from students across the globe. As the scientific frontier advances at an ever increasing pace, we believe it is paramount that society takes time to stop and reflect on the moral issues these advancements can cause. It is particularly hopeful to see so many young scientists discuss the ethical implications of technological advancement.

This paper would not be possible without the help of many fantastic students and faculty. I would like to thank Professor David Vallancourt for his second year of support for the Columbia Scientist, and I would like to thank all of the students in his Art of Engineering class who wrote many of the essays featured in this edition. I would also like to thank the wonderful team of editors behind the Columbia Scientist and the support of the Columbia Undergraduate Science Journal for their help in putting together this publication. Finally, I would like to thank all of those who submitted their work to the Columbia Scientist.

I hope you enjoy this second edition. It has been a pleasure watching the growth of this publication over the past two years, and I am excited to see where the future takes it.

Davis Smith
Editor-In-Chief, Columbia Scientist
Columbia Undergraduate Science Journal

Letter from the President

Dear Readers:

I proudly announce the publication of our second volume of Columbia Scientist! Within the pages of this editorial-based journal, you will find opinion editorials weighing ethical dilemmas in science, other pieces highlighting the intersection of science and social disciplines, and science-themed art.

I had the great pleasure to work on the inaugural edition of Columbia Scientist, and am pleased to see the growth both within the editorial staff overseeing Columbia Scientist and in the diversity of opinions represented. Columbia Scientist exists to highlight that science does not occur in a void: Discovery is driven by societal conditions and exists to improve them. Science and society are intertwined. Within this second volume, you will be invited to learn about developments in scientific fields ranging from CRISPR human genome editing tools to novel quantum and AI computing. I am delighted by the compelling and thoughtful considerations offered by our authors. While the topics they present may pique your curiosity and excitement, I hope your mind will be enlightened to critically analyze these and related issues.

I applaud the students on our editorial team who led and coordinated the effort at Columbia Undergraduate Science Journal to develop this publication. Behind each publication is a team dedicating countless hours and reading hundreds of submissions. I would like to highlight and thank Davis Hamilton Smith, Editor-in-Chief of Columbia Scientist for his vision and leadership this year. Congratulations authors, and thank you readers!

Aaron Jackson
President, Chief Editorial Officer
Columbia Undergraduate Science Journal

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Masthead

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An Analysis of Heritable Human Genome Editing Through the Lens of Ethics

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For decades, the idea of engineered humans was one restricted to the realm of science fiction. From Mary Shelley's 1816 novel Frankenstein to Aldous Huxley's 1932 novel Brave New World and the 1997 science fiction thriller film Gattaca, humanity has dreamt of the intersection of science and Promethean hubris for hundreds of years. In the early 1960s, however, the fantasy of modifying the human genome pivoted from fiction to a scientific possibility with Watson and Crick's discovery of the structure of DNA. More recently with the development of technology enabling the cutting and pasting of recombinant DNA, the field of genetic engineering has rapidly expanded. Initially misguided by remnants of the eugenics movement that had plagued America since the late nineteenth century, technical limitations proved too vast and the crusade for human improvement through genomic editing was put on hiatus.

Flashing forward to the twenty-first century, the current reality of the state of genetic engineering hit the scientific community in late 2018 when Chinese geneticist He Jiankui made international headlines with the claim that under his guidance, the first human genetically edited babies had been born. Made possible through CRISPR-Cas9 technology, for which the 2020 Chemistry Nobel-Prize was awarded to pioneering scientists Jennifer Doudna and Emmanuelle Charpentier, Jiankui modified a gene marker in the embryos of a couple diagnosed with AIDS with the intent of granting their children and future descendants a resistance to HIV. In November 2018, the embryos which Jiankui had implanted were carried to term and twin girls, Nana and Lulu, were born. Despite framing his accomplishment as a major step forward in human medical science, Jiankui's clinical trial was almost immediately shrouded in controversy. An international community of scientists, ethicists, and medical professionals condemned him for jumping the gun on a field that is unanimously considered to be not yet cleared for human application from a moral or ethical perspective. Driven by a hunger for success and fame, it would seem Jiankui's eagerness to achieve a major historical breakthrough and enhance his ingenuity as a scientist had blinded him to his ethical obligations as a researcher and engineer to perform sound science.

Forgoing the more sound pre-existing methods of preventing AIDS infection, such as sperm-washing and screening for healthy embryos, Jiankui designed a procedure that was neither medically necessary nor established to correct a clear genetic disorder as outlined by the Biomedical Engineering Society Code of Ethics. The gene he attempted to modify also also linked to other functions, including protection against the West Nile virus. The largely unknown effects of altering the human genome illustrate the risk undertaken by Jiankui while also highlighting the terrain yet to be covered in fully understanding the dynamics of our genetic processes. Failing to meet the guidelines that warrant grounds for a clinical trial, Jiankui misrepresented his proposal to the hospital ethics committee at Shenzhen's HarMoniCare women and Children's Hospital to gain approval in proceeding with his plan. Furthermore, close international scrutiny of Jiankui's clinical trial revealed several disturbing pieces of information. Not only had his clinical trial been rushed without a proper peer review and informed ethical consent, but it remains debatable whether it was possible to even declare it a success. As it turns out, the modification of the genetic marker had only taken effect in one of the two relevant chromosomes for one of the twins. Likewise, there was some evidence of off-target edits as well as mosaics, a term used to describe when there has been enough cell division prior to the gene editing such that some of the resulting cells remained unedited. After cell division, fewer than half of the body's cells may actually possess the modified genetic markers at birth. Apart from signaling an apparent lapse in the efficacy of the clinical trial, the evidence of mosaicism is alarming for its association with miscarriage, birth defects, developmental delay, and cancer.

Ultimately an example of failed research safety and integrity, He Jiankui's so-called "CRISPR babies" proved to be a violation of virtually every code of ethics among engineers and medical researchers. As a result, Jiankui was put on trial by the People's Court of Shenzhen at the end of 2019, where he pled guilty to illegal medical practice by forging ethical review documents and misleading doctors into unknowingly implanting gene-edited embryos into two women. Sentenced to three years in prison and banned for life from reproductive science, Jiankui's actions serve as a harsh wake up call for the international

community to produce a meaningful set of guidelines to direct further research and development of heritable human genome editing.

While often providing ground rules for the safe practice of genetic research, organizations such as the International Commission on the Clinical Use of Human Germline Genome Editing have been hesitant to address the ethical and moral ramifications of gene editing. Many organizations hold positions of neutrality just short of calling for bans or moratoriums, which can progressively become harder to lift. Instead, emphasis is repeatedly placed on the need for broad societal consensus, a task easier said than done. Will genetic editing widen socioeconomic class divisions? Is there a danger in lowering the diversity of the human species? If the technology were available to make healthier babies, would it be ethically wrong not to use it? With so many questions left unanswered, it is time to converse and construct a set of ethical guidelines to govern the future progression of the human race.

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Examining the Ethics of Geoengineering

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As the threat of climate change and its disastrous implications for all earthly life worsens, the necessity of taking action against global warming becomes increasingly crucial. In line with this, institutions are directing more attention and effort towards mitigating the associated environmental repercussions. Among the multitude of proposals from scientists and researchers seeking to solve climate change, those stemming from the discipline of climate engineering have started to gain widespread attention.

Climate engineering, also known as geoengineering, centers around influencing the earth's climate through direct and intentional intervention. The two main branches of geoengineering, carbon dioxide removal and solar radiation management, embody a wide variety of approaches including stratospheric aerosol injection, direct air capture, and ocean iron fertilization. However, these solutions remain under-researched and riddled with various flaws. Geoengineering technologies and research have historically faced staunch opposition, in part due to the insecurity and flaws of e ach proposal, including the high likelihood of unintended environmental repercussions in more radical solutions and the prohibitive cost-efficiency of most carbon dioxide removal technologies, but also because of the moral implications of such interventions.

Recently, the White House Office of Science and Technology Policy, which advises the president on scientific and technological matters, coordinated a five-year research plan to investigate potential solar radiation management interventions. The research plan was included in Congress's 2022 budget and signed by President Joe Biden in March, drawing increasing attention to an already-controversial science, which has thrown climate engineering under more scrutiny.

Michael Martin, a writer and editor based in New York City, reiterates in his Best Life article about the White House's plan that a significant concern of environmentalists is that climate engineering could prove to be a "moral hazard" [1]. Solar radiation management techniques and geoengineering would allow society to reverse the impacts of climate change without the need to address the real root of the issue—sustainable development and greenhouse gas emissions. Geoengineering practices, especially if implemented at a large scale, would enable society to ignore the status quo and deprioritize reducing carbon emissions [2].

Within the grander scheme, however, further research in geoengineering is morally necessitated, not prohibited. The National Society of Professional Engineers, a professional association representing licensed engineers, promotes an ethical code for engineers in the United States. The very first Fundamental Canon in Section 1 of the NSPE Code of Ethics for Engineers establishes that engineers should "hold paramount the safety, health, and welfare of the public" while fulfilling "their professional duties" [3]. Geoengineering technologies, particularly solar radiation management strategies like stratospheric aerosol injection, are in a unique position of being able to provide humans with immediate, large-scale leverage in the climate crisis. In comparison, more traditional proposals, such as reducing carbon emissions, tend to be less potent and require significant investment and input to create a less-sizeable impact, rendering them less immediately effective.

In the context of climate change, the life and welfare of every individual across the globe, including those of future generations, is at risk. And because some populations are already facing these issues, to deny development in a promising field that will very likely enable enhanced insight into the earth's dynamics and produce superior resources and innovations in the battle against climate change, purely to hold historically large emitters accountable, is to choose to allow people to continue to suffer. This choice, conscious or not, deviates blatantly from the fundamental ethical objective to which engineers must hold themselves accountable: protecting public health and welfare.

While it is true that the employment of geoengineering technologies may distract from the important root causes of environmental degradation, this particular issue is trivial when considering the long-term ramifications of climate change in its entirety. As the world's climate reaches a tipping point, the environmental repercussions of climate change not only outscale those of most geoengineering techniques but also out-prioritize the potential "moral hazard" of geoengineering—it is more immoral to knowingly ignore a means of directly improving the quality of life of individuals globally.

Research and implementation are two entirely different things, and only one of them is necessarily required by ethical code. Without proper investment in research to enable an enhanced insight into geoengineering technologies, all existing research and small-scale implementations would be subject to uncertainty. Moreover,

the result of further research could lead to a decision to not employ these new technologies. Even in this case, at the least researchers and environmentalists would be left with a clearer picture of the climate crisis. Most importantly, the implementation of geoengineering tactics and moving towards a more sustainable infrastructure are not mutually exclusive. Accordingly, the five-year research plan from the Office of Science and Technology Policy, and more broadly any research and investment in climate engineering, is supported by the codes of ethics of the engineering society.

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What Are Quanta?

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Navigating quantum physics is quite the conundrum. Perhaps the first thing that comes to mind is Schrödinger's cat – or maybe even entanglement. The most confusing part of it, other than perhaps the math, is its implications. The thought of many worlds and half–dead, half-alive cats [2, 3] is quite a scary notion, but it can be understood.

Let's not [1] get ahead of ourselves, and first discuss the central figure of quantum mechanics: quanta. Quanta are discrete packets of energy, or better put, small blocks of energy that all real matter is made of. Quanta's defining property is wave-particle duality – that is – it behaves both like a wave and a particle [5]. When we look at small particles, we start to see them behave less like round balls, but rather as waves. Experiments that use diffraction grating, where particles traverse through many thin slits, show that light, classically considered a wave, can interfere with itself [5]. It doesn't even need to be light; massive particles like C60 can replicate the effect just fine [6]. It's like walking through multiple doors at once – it doesn't seem to make sense. However, there is a resolution to this paradox: wave functions. Wave functions are mathematical descriptors of the small particles, or rather, quanta. Using wave functions, we can describe the quanta as traveling through multiple slits at the same time [5].

This mathematical solution creates far more questions than it answers, like how do quanta even physically achieve such an effect? When we shine a light through a diffraction grating and place a detector to check which slit it travels through, light travels straight and produces no interference [8], making the quanta behave like a particle [5]. This is called wave function collapse, where rather than going through all possible slits, it goes through one; the act of observing which slit it goes through causes the collapse itself [8]. So, when light isn't being measured, no collapse happens, and it goes through all paths simultaneously [5]. Wave functions and their collapse aren't magic, as we know that they'll always lead to a result [7, 8] (more formally, eigenvectors representing wave functions in Hilbert spaces are elements of unitary groups, but that's too much jargon).

So, the answer to the question previously posed is we don't know. Quantum mechanics itself never describes what wave functions are or why they collapse – it merely states that they do [2, 3]. Perhaps the most well-known thought experiment, Schrödinger's cat, is an example of this. A living cat is put in a box with some poison or radioactive chemical and is locked in so no one may observe. Whether the cat is alive or not depends on whether or not an atom inside the box decays. When the box is finally open, there is a 50% chance of the cat being dead, and a 50% chance of it being alive [1]. The confusion comes from inside: is the cat alive or dead? While we can replicate the experiment [1], reading the answer proves to be impossible without modifying and therefore destroying the experiment. So, we must propose some conjectures. The Copenhagen interpretation simply accepts the phenomena literally; that is, the cat is both alive and dead while in the box: a "simple" explanation [2]. The multi-worlds theory, or the Everett interpretation [3], states the universe is split into two, one where the cat is alive and one where it is dead, and the opening merely chooses one of these two universes [3].

While we don't fully understand what wave functions represent, they still do have a major use, namely, quantum computing [10, 11]. Using quantum computers we can generate truly random numbers and analyze them at a much quicker rate than we can normally [10], thanks to the inherent randomness of wave functions. This lets us create more secure applications, as well as break them, a major application and concern for cybersecurity [10]. Quantum computing isn't merely limited to the computing sector, however, as we see major applications in simulating medicine and chemical reactions, thanks to quantum computers' ability to simulate large numbers of possibilities and therefore account for more atoms [10, 11]. Furthermore, the technology has uses in finance. We can use algorithms that are highly efficient, especially on quantum computers, to better predict the safety and return value of investments [10]. While quantum computing has remained mainly theoretical and been too noisy, meaning having a lot of randomness in its results, it has recently started to gain commercial viability thanks to error-correction innovations and more efficient algorithms [11].

Both propositions sound preposterous and mind-bending, but this is part of what makes quantum mechanics a subject worth studying. Because of developments in quantum mechanics and superposition, we can create quantum computers [10], which rely on superposition, to solve many practical problems in finance, medicine, and many other fields. So, while we may not know the answer, we can still apply quantum mechanics for the benefit of humankind.

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Economic Migration to Africa: Avoiding the World's Most Dangerous Killers

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Abstract This paper reviews research on the communicability of Ebola Virus Disease (EVD)/Similar Infectious Diseases (SID) and possible preventative measures to be employed by at-risk entities. Synthesizing current epidemiological context, routes of transmission, disease control protocol, and addressing common counter arguments in light of the U.S.'s contemporary socio-political climate, this paper argues for governmental and internal regulation of migrating companies (western and Eurasian companies moving part or all of their operations to Africa) to reduce the probability of a catastrophic EVD/SID outbreak.

Keywords Ebola Virus Disease (EVD), Neglected Tropical Disease (NTD), COVID-19, Preventative Health, Public Health, Administrative Controls, Engineering Controls, Economic Regrowth, Sub-Saharan Africa, Regulatory Agency, Public Policy

Introduction SARS-CoV-2 (COVID-19), which has been contracted by billions and has killed millions of people throughout the world, is now a leading cause of death in America [1]. The pandemic has shed light on the lack of effective emergency response capabilities to public health crises in even the most advanced countries of the world. COVID-19 caused mass chaos and an incredible amount of preventable mortality (~1.4% mortality rate [2]) — but what would happen if much deadlier microbiological murderers were to enter the world stage?

One such threat is Ebola Zaire, a variant of the Ebola virus and a hemorrhagic fever that has a mortality rate of up to 90% [3] in even the healthiest of individuals. On average, Ebola spreads to 1.5-2.5 people for every one person infected, compared to H1N1 influenza (responsible for the 2009 Swine Flu pandemic) with a 1.5:1 secondary infection rate and COVID-19 with a 1.5-3.5:1 secondary infection rate [4]. Though the data show an average secondary infection rate less than COVID-19's, Ebola is endemic to areas of rural Africa with less overcrowding and fewer motor vehicles and planes that would contribute to spread in a large city; consequently, these numbers may in fact be higher if outbreaks were to occur in more developed countries. Ebola is contributing to the extinction of other primates in certain areas [5] and has caused outbreaks in humans which, up until recently, were well-confined to Africa. However, with large companies like Amazon and Tesla moving some of their business to Africa [6, 7], Ebola Virus Diseases (EVDs) and similar infectious diseases (SIDs) may quickly become more of an issue for the rest of the world as well.

Because variants of EVDs/SIDs have the capability of causing extinction-level events in humans, companies should regulate their workers' health practices, including their interactions with animals, their establishment in areas conducive to disease (based on bat migration and rainfall patterns), and their emergency response protocol in the event of infection to reduce the probability that a global outbreak occurs.

Administrative Controls: Health Practices

At a minimum, there are employable administrative controls that can reduce the spread of disease in any environment. Workers should be trained to adhere to enforced health practices such as frequent hand washing [8], quarantining when sick [9], and not interacting with wild animals – with an emphasis on known or potential vectors [10]. While it remains somewhat contested [11] which animals count as "Ebola reservoir hosts," it is known that people can contract the disease from other sick people via contact with blood or bodily fluids [9], infected non-human primates [12], and bats [12]. Workers should be trained and educated on what symptoms to avoid and which animals to not interact with.

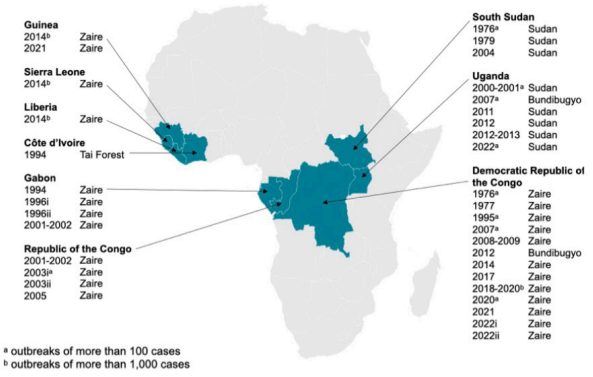
Additionally, Ebola is a highly contagious Bio-Safety Level (BSL) 4 pathogen classified as an inhalation hazard (for personal protective purposes) [13] and is also known to survive in fluids on surfaces [14]. When infected organisms expel bodily fluids through talking, coughing, hemorrhaging, or defecation (including flushing toilets), there is a chance for aerosolization of these microscopic biohazards [15], suspending infectious material in the air where they can settle on surfaces or potentially be inhaled by healthy individuals. Due to the high communicability of viral hemorrhagic fevers such as EVD/SID, it is critical that commonly handled surfaces be disinfected frequently, workers wash hands after handling potentially contaminated surfaces, and the sick be secluded from the healthy.

As the world has come to understand from the COVID-19 pandemic, these practices should be em-

ployed even when no one appears to be sick, because asymptomatic people can still spread disease while the pathogen is incubating inside of their body or once they have mostly recovered from illness [16]. These practices are extremely low cost, can be employed easily and conveniently, and could very well prevent a cataclysmic outbreak of EVD/SID from emerging.

Figure 1

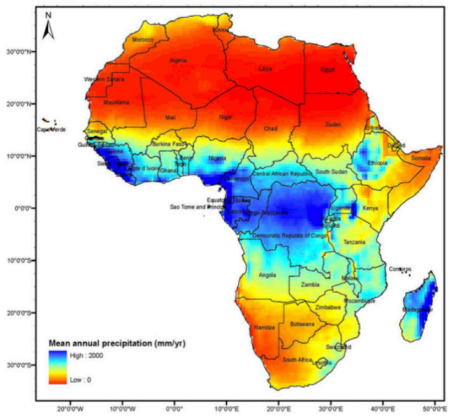
Map of countries which have reported EVD cases, up to January 2023, including year of reporting and Ebola virus



Note: Imported cases of EVD not included in this figure. From *Ebola: overview, history origins and transmission*. UK Health Security Agency. https://www.gov.uk/government/publications/ebola-origins-reservoirs-transmission-and-guidelines/ebola-overview-history-origins-and-transmission

Figure 2

Map of the African continent with country names and rainfall patterns



Note: From *A review of droughts on the African continent: a geospatial and long-term perspective* (Masih et. al, 2014). Collected using ERA-Interim corrected with GPCP v2.1; period: 1979-2010. See Trambauer et al. (2014) for detailed explanation

Engineering Controls: Geographic Barriers

Secondly, establishing business in areas not endemic to EVD/SID [17] and not rampant with displaced animals due to deforestation or annual migration [18, 19] is critical to the minimization of EVD/SID exposure probability [20]. The most effective control for reducing the spread of disease is to remove potential exposure to the hazard altogether; creating smart geographic barriers in this case could effectively remove the hazard of contracting EVD/SID while not forcing companies to change their procedures or operations whatsoever. This is an attractive option for companies who are worried implementing other preventative measures would inhibit productivity or profitability. Local and national governments should work with any prospective migrating companies and their home countries' governments to identify smart geographic choices to prevent the spread of disease. Intuitively, placing businesses in areas where reservoir (natural carrier) host to human interaction is likely – typically resulting from migrating/displaced animals [21] – will increase the chances that a worker, their family member, or their pet contracts the disease and is patient 0 for an outbreak.

Furthermore, research shows that rainfall patterns have a large effect on animal movement and subsequent animal-human interaction that would otherwise be unpredictable [22] (see Figures 1 [23] & 2 [24, 25]). In addition to establishing international businesses in areas that are not known host migration pathways and not near areas dense with animal displacement, not establishing businesses in areas with historically heavy or frequent rainfall patterns will further decrease the probability that wild infectious animals lead to human EVD/SID hosts. Though this does limit opportunities for expansion into areas of west and central Africa – particularly coastal, equatorial countries and the Democratic Republic of Congo, at-risk entities that are still allowed to and choose to migrate can substantially reduce the risk of infection by utilizing mentioned administrative and post-infection controls.

Post-Infection Control: Emergency Response Protocol

Having an emergency response protocol is essential for effective disease control in the event of an infection. As observed with the global response to the COVID-19 pandemic, when procedures are not already in-place to respond to an outbreak, humanity quickly falls too far behind to ever catch up to the pathogen and stop it.

Migrating companies should implement an infection response SOP detailing red-flag symptoms, possible routes of transmission, medical care options, quarantine protocol, and return-to-work protocol for their workers in the event of possible EVD/SID exposure. It is incredibly important with illnesses as contagious as hemorrhagic fevers to be ahead of the curve in terms of infection response to prevent an epidemiological "blitzkrieg" moment. When something is capable of spreading to an entire population in the matter of a few short weeks [26], every second of response counts and no time can be wasted on being confused about what the next steps are. For this reason, every worker should be familiar with the infection response SOP and ready to execute necessary

duties, whether it be as an infected individual or an agent of infection control.

Public Health Requirements: Necessary or Overkill?

Some might argue that we should focus solely on repairing the economy rather than preparing for the next pandemic [27]; after all, we just recovered from COVID-19, and people need to put food on the table, right?

Not quite. While these valid arguments focus on the notion that there are more important things to do than worry about getting sick all the time, they address a stasis different than that addressed by this paper. The interest of public health does not advise the economy to completely "steer clear" of the entire African continent, nor does it argue that migrating companies should not be able to generate capital for themselves, employees, and surrounding individuals. There are plenty of welcome consequences, ranging from job market and economic growth to societal progression of these nations and subject companies, of economic migration. But safety should always be a number one priority, and in cases of infectious disease, an outbreak in Africa can end up affecting every other continent on Earth. While there are important things that any reasonable person should worry about — like putting food on the table — employees and locals should not have to worry about themselves or their families falling ill with incredibly gruesome yet preventable pathogens.

Additionally, Ebola is a unique challenge, for it has the capacity to cause extinction-level events, unlike COVID-19. As such, EVDs/SIDs should be a number one priority for administration and government, even in light of financial hardships surrounding the previous pandemic. If the global economy is migrating toward Africa, we should take whatever preventative measures necessary to ensure the health and safety of locals, workers, and the world, even if that means it takes longer to migrate or companies are making slightly less money. To that point, however, the preventative measures detailed in this paper are incredibly low-cost, convenient, and worth the minimal amount of time it would take to implement them in comparison to the universally catastrophic consequences of an EVD/SID outbreak.

Conclusion Ultimately, health and security should always be a number one priority of businesses, governments, and their regulatory agencies. Failing to adhere to specific, yet common sense and easy to follow, preventative measures in geographic regions endemic to the most serious pathogenic microbes known to man risks causing catastrophes for the global community. Foreign entities that have the potential to cause an increase in migration, population density, and human-animal interaction especially, should make preventative efforts in these cases. When substantial corporations move business to EVD/SID "hot zones" without proper preventative measures, they risk the lives of their workers, their community, and the human race as a whole. Governments, regulatory agencies, and businesses should work together to train employees on preventative health practices like hand washing and isolation from reservoir hosts, choose smart locations of sites that limit disease exposure based on animal displacement and rainfall patterns, and implement the proper emergency response in the case of employee infection to reduce the spread of dangerous yet neglected tropical diseases like the Ebola Virus Disease and other similar infectious diseases.

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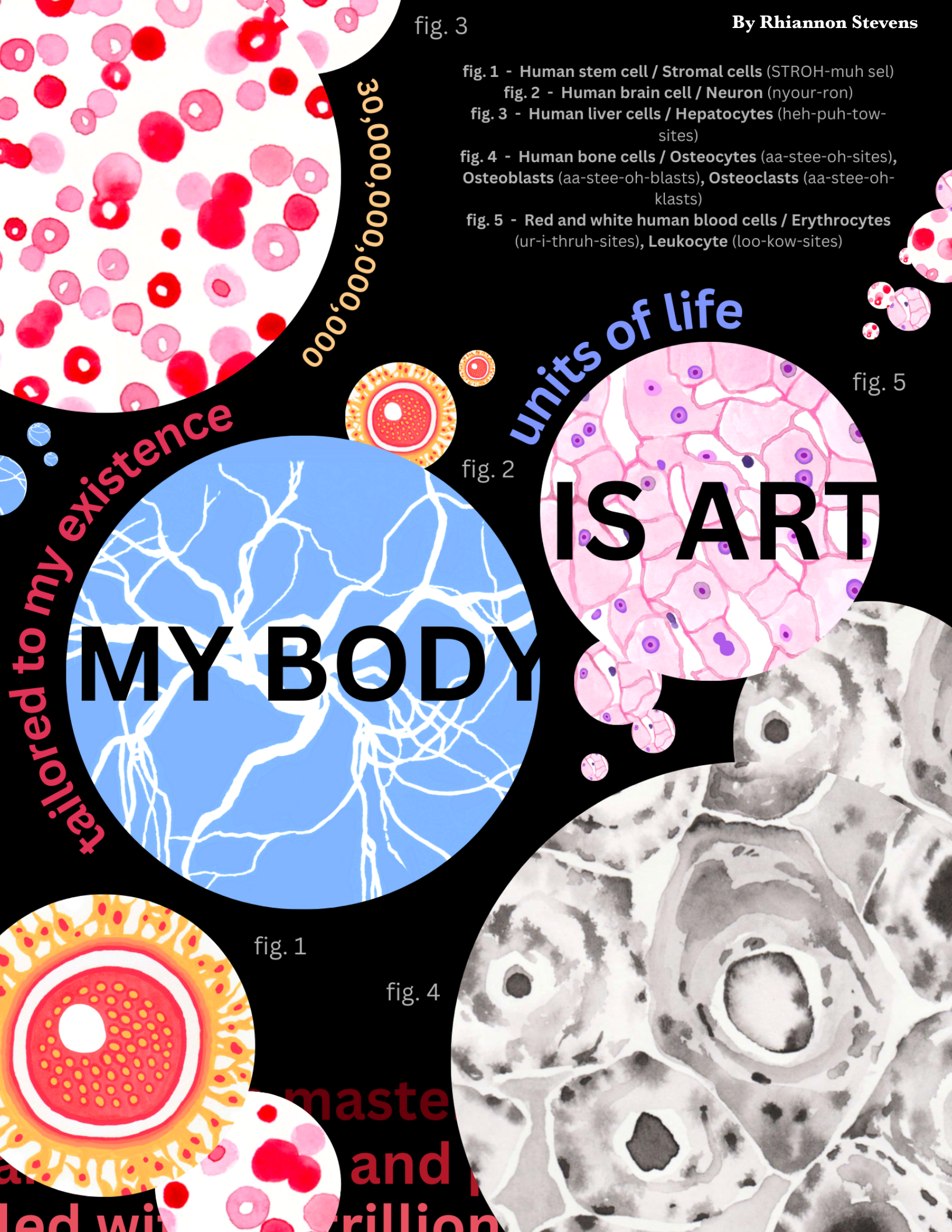
By Rhiannon Stevens
fig. 1 - Human stem cell / Stromal cells (STROH-muh sel)
fig. 2 - Human brain cell / Neuron (nyour-ron)
fig. 3 - Human liver cells / Hepatocytes (heh-puh-tow-sites)
fig. 4 - Human bone cells / Osteocytes (aa-stee-oh-sites), Osteoblasts (aa-stee-oh-blasts), Osteoclasts (aa-stee-oh-klasts)
fig. 5 - Red and white human blood cells / Erythrocytes (ur-i-thruh-sites), Leukocyte (loo-kow-sites)
fig. 3
30,000,000,000,000
tailored to my existence
fig. 2
units of life
fig. 5
IS ART
MY BODY
fig. 1
fig. 4

Potential Impacts of Arctic Development from an Environmental Viewpoint

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Climate change has sparked substantial controversy in the news during the past few years. This controversy is becoming increasingly polarizing as the effects of c limate change start to become more evident. Interestingly, as climate change has started to cause a melting and disintegration of the arctic ice, many countries have started to take initiative in developing the arctic circle. This is because of the vast amount of resources available in the arctic. According to Dr. Anke Roiger from the German Aerospace Center Institute of Atmospheric Physics, studies have shown that the arctic contains 30% of the world's untapped gas reserves and 13% of the world's untapped oil reserves [1]. However, this discussion of arctic development has led many concerned engineers and environmentalists to question what will happen to the arctic (and the world) as this development continues. Developing this area could potentially ruin the habitat of more than 400 different arctic species; according to Benjamin K. Sovacool, Director of the Danish Center for Energy Technology at Aarhus University, these changes to the arctic ecosystem would be permanent. This clearly opposes the National Society of Professional Engineers (NSPE) Code of Ethics which was created in 1934 to help "stand against unethical practices." As engineers are implored to "adhere to the principles of sustainable development in order to protect the environment for future generations," arctic development clearly violates the NSPE's ideals [2]. Therefore, the arctic should not be developed as it could ruin the world's environment on a large and irreversible scale.

As stated previously, many countries want access to the resources in the arctic and have begun to stake claims in the arctic circle, such nations include the United States. Due to the energy crisis and constant warfare in the Middle East, the US government has tried to look for new avenues in oil supply, hence turning to the arctic circle. But, studies have shown that resource drilling in the arctic has been anything but environmentally sound [3]. Arctic development could derail the entire arctic ecosystem of 400 diverse species as the arctic is characterized by a simplified food chain. This makes the arctic extremely vulnerable to change, as the death of any single species would have the potential to collapse the entire ecosystem [4]. Engineers should account for the environmental consequences of arctic development before it is too late and the arctic's unique species go extinct. Furthermore, Thomas M. Tynan, a Canadian arctic policy expert, also brings up the argument that if an oil tanker can run aground in the relatively calm waters around Nova Scotia, the likelihood of oil spills in the treacherous arctic sea is highly probable [5]. Therefore, arctic development is too risky and unethical to implement as it could ruin the world's environment. The decisions of a few unethical engineers could lead to a colossal mistake that would affect many. Additionally, the current pollution output from already developed areas is polluting the arctic circle, resulting in the "arctic haze," which refers to the mass of pollutants from heavy metals, pesticides, and organic compounds in the arctic atmosphere. In a study by Arctic Climate Change, Economy, and Society (ACCESS), it was observed that pollution stemming from land as far as Eurasia affected the arctic atmosphere [1]. Roiger also states that plumes from ships and oil/gas refineries have also contributed to enhanced pollution in the arctic. Arctic haze has developed because the removal of pollutants is extremely slow in the arctic due to the cold atmosphere [4]. This haze can be attributed to global warming and the further melting of the arctic sea ice. This haze combined with NO_2 and SO_2 emissions from power generation, the burning of natural gas and diesel as fuel, and venting/flaring activities are all estimated to cause a net warming of the world by 2030 [1]. Alarmingly, if arctic development continues, the arctic could be completely ice free by 2040 [6]. This would not only be damaging towards the arctic environment, but towards the world environment as the rising of sea levels would impact coastal regions worldwide.

Arctic development will have disastrous consequences on the environment; therefore, engineers should not engage in its development . There are multiple renewable energy alternatives to arctic drilling and development including hydroelectric, solar, wind, biomass, and geothermal [7]. Furthermore, the resources gained from developing the arctic will not outweigh the environmental losses in the future. This makes the risk of developing the arctic even more unethical as there are other safer and

equally effective solutions. In terms of cost and benefit, engineers should always put the welfare of the world and the environment over financial gain. If engineers are not careful today, the future of the environment that we all share will be ruined for tomorrow. We are already experiencing major consequences from our current careless pollution, so in order to prevent even more disastrous effects in the future, engineers should not attempt to develop the arctic circle, as its consequences would be far reaching and ubiquitously devastating.

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Gender Bias in Natural Language Processing AI

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Over the past few years, Artificial Intelligence (AI) has experienced exponential growth regarding both its scale and utility. Accordingly, it is critical we remain mindful of its potentially detrimental effects, especially in cases when inherent data bias is ignored.

In a recent BBC interview, feminist scholars Lauren Klein and Caroline Perez reasoned that because of unaccounted-for data bias, "women are 47% more likely to be seriously injured and 17% more likely to die than men" in similar car accidents [1]. The issue Klein and Perez are talking about is that the data that goes into crash simulations comes primarily from male crash test dummies. Thus, when artificial intelligence algorithms are employed to learn from these simulations and improve essential safety gear like airbags, seatbelts, and headrests, men are protected disproportionally. Thankfully, following the report of the findings, car makers have increased the number of female crash test dummies used and have taken greater care in accounting for the discrepancies in male and female datasets.

Nonetheless, in a world without AI regulation, where is the guarantee that we see this acknowledgment of bias and its subsequent correction? Furthermore, what's to stop companies and organizations from ignoring it entirely?

Society is becoming increasingly reliant on the internet, big data, and cutting-edge technologies like AI; it is thus critical that we maintain control over all the continued development.

One subfield of artificial intelligence of pa rticular interest is Natural Language Processing (NLP). NLP aims to help computers understand and respond to human text. For example, Apple's Siri and Amazon's Alexa are both excellent applications of the technology.

Vast datasets, commonly referred to as corpora, are central to how artificial intelligence operates in the context of NLP. Using these corpora, the AI models can be trained, basing their actions on the data. Subsequently, machine translation and word embedding are two ways in which this learning can be implemented.

Machine translation concerns itself with using AI to translate human language. Certain phrases in one language and their intent can be converted to a different language. For example, the word "watch" in English has more than one meaning, and since Google Translate's AI can discern the differences in context, it will return the correct word for that specific scenario. However, it doesn't always work so effortlessly. The Hungarian language is gender-neutral, meaning that there are no gendered pronouns. Despite this, when converting text to English, it is clear how bias in the data affects what we see as output: "She is beautiful. He is clever. He reads. She washes dishes."

A recent study by researchers in Carnegie Mellon's Psychology Department found that psychological gender bias was more prevalent in speakers of more gender-biased languages [2]. Thus, it is critical to prevent the propagation of this bias by being more cognizant of the extent to which machine translation can inadvertently fail.

But why exactly did Google Translate produce these results, and is the algorithm at fault? To answer these questions and others like them, it is important to further explore machine translation, and specifically the tools upon which it is built. One of which is word embedding, a technique that looks at the clustering of words in multi-dimensional vector spaces. In simpler terms, it is a way of converting words into numbers so that a computer can understand and organize them - words that appear together more often are placed closer to each other, while those with different associations are further apart. For example, when looking at different professions, you may see "doctor," "lawyer," "engineer," or "computer programmer," clustered closer to "man," while "woman" appears more often with "housekeeper," "waitress," "secretary," and "nurse." The issue here is not necessarily the dataset or its apparent bias, many of the stereotypes above may in fact be true. And since Google Translate's algorithm functions off these clusters in the dataset rather than a more nuanced semantic understanding, it is conceivable why and how the algorithm would choose a gender for each particular phrase. Nonetheless, there still remains an important distinction to be drawn. Although, for example, more men may be computer programmers than women, this is very different from saying that men are better computer programmers. In 2015, it was uncovered that Amazon's resume screening software was discriminating against women for this very misconception. Since women were underrepresented in the training dataset, the algorithm learned to associate men with being more successful software engineers and was thus throwing out female resumes at a disproportionate rate [3].

Given the potential for artificial intelligence to un-

intentionally perpetuate discrimination, it's essential to consider how to prevent bias in AI systems. Simply debiasing datasets may not be sufficient, so what regulatory measures work or are even feasible to implement?

Aylin Caliskan, Assistant Professor at the University of Washington Paul G. Allen School of Computer Science & Engineering, believes that a great place to start is increasing diversity on artificial intelligence teams: "Diversifying the pool of AI talent can contribute to value-sensitive design and curating higher quality training sets representative of social groups and their needs" [3]. Simply based on lived experiences, a more diverse team is more likely to uncover when and where bias or discrimination may occur.

An alternate solution may be greater transparency in regard to the AI technology used. Recently, Elon Musk made the Twitter recommendation algorithm open source, meaning that it is now accessible to anyone. This is a great step toward a more equitable future, and will hopefully lead to other companies following suit. Increased transparency makes it easier to catch inadvertent discrimination or bias and will make the field easier to regulate altogether, as third-party auditors and scientific researchers can locate and fix any marginalization that may arise.

In the end, regardless of the path we choose, it is of utmost importance we act sooner rather than later, as the future's AI is trained on the data of today.

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Investigating "Designer Babies" Through the Lens of the He Jiankui Case

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In 2019, geneticist He Jiankui was sentenced to 3 years in prison for genetically altering embryonic cells in pregnant mothers. Jiankui and his collaborators implanted modified embryos into pregnant mothers without their consent or knowledge, which was accomplished by misleading doctors and forging ethical review documents. The team's motive was to prevent the babies–who were children of fathers with HIV/AIDS—from contracting the deadly virus later in life. This was thought to be a stepping stone in preventing HIV/AIDS from being further contracted in much of Africa and other affected regions. With his goal unmet, Jiankui eventually pleaded guilty and was charged with medical malpractice [1]. Although Jiankui and his collaborators represent an extreme case of genetic engineering that blatantly violates engineering codes of ethics, this opens up a broader discussion on the so-called "designer baby," that is, babies resulting from engineered embryos often altered to be fitter, immuno-resilient, or more aesthetically beautiful. The ethicality of "designer babies" is incredibly complex, but we can ask two questions to help us investigate its implications: Will genetic modification impact a child later in life, and will genetic engineering, specifically the altering of embryonic cells to be genetically "better," lead to the promotion of eugenics, making the well-intent of such practices ambiguous?

The biomedical engineering and genome editing AMA code of ethics asserts that participants in a procedure involving gene alteration or genetic engineering should "receive the information they need to make well-considered decisions, including informing them about the nature of the research and potential harms involved" [2]. In the case of He Jiankui, it's easy to argue that by implanting genetically engineered embryos into pregnant women without their knowledge, he and his collaborators were violating ethical principles outlined in the AMA code of ethics. It can also be easily argued that in forging ethical review documents, he violated the fifth fundamental canon of NSPE Code of Ethics for Engineers– to "avoid deceptive acts" [3]. This extreme case clearly illustrates blatant ethical misconduct, but what about in a less extreme case? Or, in the broader scope of designer babies? Can we consider the embryo a participant in the procedure and does it need to consent for the procedure to be ethical? In the case of designer babies, there is no way to inform an embryo that it is becoming genetically modified, but it is a procedure that could change the life of the child when born. However, there is no physical way for an embryo to make a decision, and there is usually no way for babies and young children to make well-informed decisions for themselves. So it is deemed societally ethical for a parent to make a decision for the health of their child. Therefore, the ethicality of designer babies is not a question of whether they can or cannot consent, but rather a more complex discussion on the extremes and spectrum of genetic alteration of embryos.

In one case, an embryo can be altered so that the child, when born, does not have a fatal disease. This could improve their quality of life and usually does not involve direct editing of an embryo, but a selection against certain embryos. Looking at this from a purely consent/non consent standpoint, this isn't very different from a parent making the decision for their newborn baby to have a life saving procedure. In the Jiankui case if the mother had consented to the treatment, and no documents were forged, it would have been, arguably, an ethical procedure.

We might also use the Jiankui scenario to question whether privilege and wealth might contribute to the unethicality of the designer baby construct. If the genetic alteration of babies were only accessible to the wealthy, it would directly contradict how engineers strive to serve the public interest by worsening wealth disparity. Genome editing costs anywhere from $373,000 to $2.1 million [4]. This is not accessible to everyone. It's easy to reason that the trajectory of genetic modification in embryos could quickly favor the wealthy. Furthermore, we must continue to consider the implications of wealth and privilege in designer babies and genetic alteration in order to preserve its ethicality. However, as genetic modification becomes more widespread and more extreme, it becomes more difficult to justify this.

The very first fundamental cannon of the NSPE Code of Ethics for Engineers is that engineers should "Hold paramount the safety, health, and welfare of the public" [3]. He Jiankui presumably had the "safety, health, and welfare of the public" in mind; he was trying to create a procedure that would ultimately prevent the spreading

of a fatal disease that considerably decreases the quality of life and is most prevalent in developing countries [3]. However, this doesn't mean that what he did was ethical. Although the motive was ethically sound, the means were not. When investigating what the genetic engineering of embryos could mean on a broader scale, this becomes more complicated. The motive of scientists and engineers when performing a procedure—like altering an embryo—may not correlate with the effect it actually has. The issue of "designer babies" could quickly become an issue of eugenics. People with more money would have the means to alter their children to be better (in any way), which could ultimately lead to social disparities and injustices. However, that's not to say every instance of genetic alteration will lead to class disparity or a eugenic uprising—it's a spectrum of extremes and non-extremes. Saving children from life-altering diseases is different from making a child "strong" or "pretty." So it goes back to the engineer. For genetic alteration to be ethical, the geneticists/ engineers must have the foresight to see how their actions will affect the common good while considering if what they are doing would preserve the "safety, health, and welfare of the public" [3]. In doing so they must not only look at the specific case they are working on, but the broader implications of what they are contributing to.

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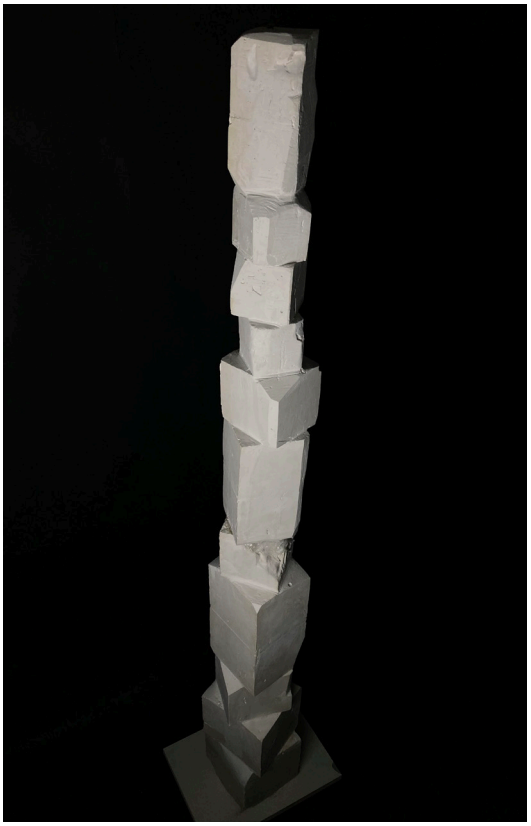
The Abnormality of Humans



Imperfect building blocks of life

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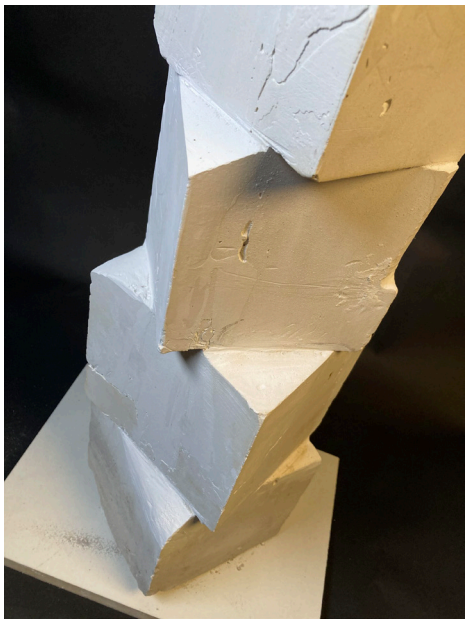

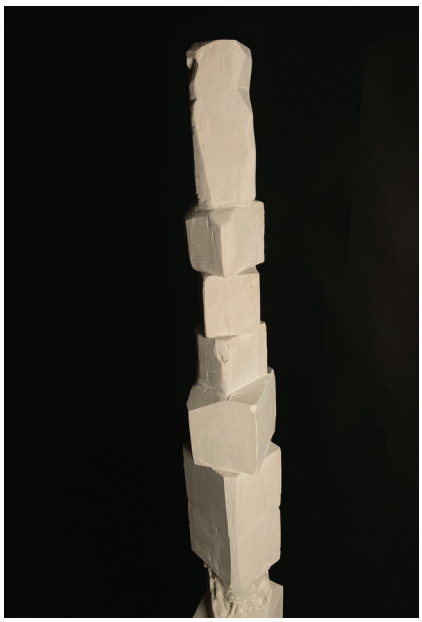

Each of the blocks are imperfect, not complete cubes. The complexity of life can be interpreted upon the building blocks of the structure, creating an interpreted view of a DNA linkage. The abnormalities in the different blocks can show how life and cells are inherently imperfect, making it human.

Ethics of Smart City Predictive Policing

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Spurred by the ethics of utilitarianism, smart cities have risen all around the world in an attempt to transform the ideal vision of urban life into reality. Even though the implementation of technology-driven solutions has bolstered the security sector to become significantly stronger and more efficient, ethical concerns have appropriately surfaced. The perfect example is predictive policing, a form of policing that uses statistical predictions and quantitative techniques to predict high-frequency areas for crime. Centered around AI algorithms and historical data, predictive policing seeks to balance the benefits of increased safety with the drawbacks of social inequality. As a result, it is often at risk of falling into a cycle that perpetuates policing prejudices and exacerbates implicit biases. This struggle to find a common ground between humanistic values and data-driven urbanism presents the question of whether this "sweet spot" really exists. However, through careful consideration of all aspects, an intersection between security and ethics can be found. Specifically, satisfying ethical standards in smart city predictive policing requires prioritizing transparency over the efficiency of streamlining operations that could potentially perpetuate racial biases in the criminal justice system.

Smart cities are modern cities that emphasize technological solutions and services to municipal problems. As the development of these areas pushes society towards a more sustainable and adaptive future, traditional forms of policing are being replaced by AI computer algorithms and advanced data analysis at an increasing rate; predictive policing serves as the catalyst for this progression towards increased safety through digital intelligence. Precisely, this approach entails improving tactical strategies by using methods such as advanced hot spot identification models or risk terrain analysis. These advancements allow law enforcement to more effectively deploy resources in criminal areas, conserving both money and time. Prior to predictive policing, historical data on criminal activity was collected by pooling data from law enforcement agencies. Since it is not uncommon for police officers to hold biases and preconceived notions regarding certain demographics, this affects how, where, and who law enforcement targets while being unaware of their tendencies. Years and years of data that have been compiled only strengthen the presence of these implicit biases, and these biases will be reinforced and amplified when fed into predictive policing algorithms..

Due to the inherent prejudices in city data, crime is often represented inaccurately, leading to a misleading reputation and flawed understanding of certain neighborhoods that could result in the unjust over-policing of targeted demographics. Law enforcement uses large amounts of criminal data to gauge the general safety of a given area, rendering human input essential to the process of predictive policing. Due to humans being at the forefront of policing for centuries, implicit biases are guaranteed to be embedded within. This unreliable data commonly results from "periods when the police are engaged in discriminatory practices against certain communities, thereby unnecessarily or incorrectly classifying areas as 'high risk'" [1]. Clearly, specific criminal populations are not protected from being overrepresented because of police's tendency to target the same areas, with the lack of a standardized data collection method being responsible for this critical flaw. Not only do racial and socioeconomic prejudices within law enforcement manifest themselves in criminal data, but the societal expectation for what crime typically consists of also results in a selection bias that skews the data. There is a general focus on "street crime," which is primarily made up of offenses like theft and drug-trafficking. This type of coverage is severely unrepresentative of the array of crimes in society, and hosts the dangerous potential of misinforming the public on overall city safety. For instance, specific areas are thought to be more unsafe than in reality, while other areas escape this spotlight. The inability of criminal data to capture all inherent nuances in crime gives rise to biases. Avoiding targeting non-stereotypical criminal types and neighborhoods only results in ethical issues when this data is fed into a predictive policing system. As a result, glossing over these limitations may enable predictive policing to become a tool more harmful than beneficial to our democracy.

The predictive policing seesaw between enhanced safety and reinforced stereotypes is one that struggles to find an ethical equilibrium point. With decades of criminal data compiled in metropolitan areas, it can be easily assumed that they are unrepresentative of the true distribution of crime. The circulation of these biases within an AI algorithmic system has the potential to magnify previous discriminatory practices to a much larger scale, creating problems that could jeopardize the fundamental liberties that form the basis of our democracy. However, transparency and accountability measures can be taken through increased community engagement and reforms

in criminal data collection, marking an increase in democratic participation that may pose significant benefits in enacting predictive policing in our society. As we become a more technologically-based and information-dense world, new approaches to advance efficiency are bound to emerge. Thus, instead of opposing and criticizing the shortcomings of predictive policing, communities should address them head on and readily adapt to mitigate its disadvantages.

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Racial Discrimination in Face Recognition Technology

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In the past decade, law enforcement, airports, and employers have employed facial recognition software as a form of biometric authentication. The adoption of facial recognition has provided quick and efficient verification systems, accuracy in identifying individuals, and is easily integrable into existing software. In Abu Dhabi, engineers are in the trial phase of testing facial recognition authentication at immigration checkpoints, paving a way for quick and efficient airport experiences. As a joint project with Integrated Health Information Systems, Singapore's largest hospital group, SingHealth, has installed biometric entry systems. Using depth sensing, the new facial biometric technology can detect masks and prevent spoofing of virtual and photo-based presentations. It's evident that facial recognition attempts to facilitate efficient decision-making algorithms for security and speed.

But are we compromising accuracy for speed? Facial recognition is implemented using machine learning and data analytics. Using computer-generated filters, the AI software transforms face and video feeds into numerical expressions to determine the similarity between a database of other known faces. This algorithm claims a high accuracy of over 90%, but research exposes racial bias due to testing inaccuracies, data privacy, and mass surveillance concerns [1]. In July 2020, an independent assessment by the National Institute of Standards and Technology confirmed that across 189 algorithms, there was a prevalent racial bias toward women of color [2]. In other words, the algorithms struggle to identify women and people of color as accurately as they identify white men.

This issue is attributed to the lack of diverse training data that these computer-generated filters are trained on. This refers to the fact that many AI systems are only as efficient as the data they are trained on. A limited or biased set of data used to train an AI algorithm will lead to algorithms that are limited or biased in their ability to identify and filter content. Thus, when datasets are composed of predominantly male white faces, a system may be less accurate in identifying people of color, as the data set lacks a diverse set of demographic groups. As a further complication, some facial recognition companies rely on external data sources to their systems, potentially compounding the biases already present in those datasets.

These inaccuracies have created an increasingly common story of injustice. In 2020, A 43-year-old black man from a Detroit suburb was arrested on alleged charges of stealing watches after police investigators employed facial recognition to identify him as the thief from surveillance cameras [3]. Despite not having been in that store for years, they kept him in custody for 30 hours. It was later found that he was wrongfully convicted as the surveillance technology was not 100% accurate. This isn't an isolated incident, as an ever-growing number of people have been victimized by unregulated and flawed surveillance systems, particularly people of color. By using face recognition, the NYPD and ICE could potentially target marginalized groups, such as undocumented individuals and Muslims.

Since 2011, the NYPD has been using facial recognition technology for several years. However, in a report by the Georgetown Law Center on Privacy & Technology, it was found that the Face Recognition Unit in the NYPD had access to a database of more than 8 million photos, most of which were of law-abiding citizens. In opposition to this practice, critics contend that it violates civil liberties and unfairly targets communities of color who are more likely to be monitored and scrutinized by the police. Similarly, ICE has been confirmed to utilize a facial recognition tool developed by Clearview AI, a controversial facial-recognition software company that has amassed billions of images from social media platforms without users' consent. This again raises privacy concerns and violates the rights of immigrants and other marginalized groups.

In the NSPE Code of Ethics for Engineers, a fundamental canon is to conduct oneself honorably, responsibly, ethically, and lawfully to enhance the reputation and usefulness of the profession [4]. It is difficult to conduct facial recognition lawfully within the code of ethics as it is subjective. This surveillance enforcement fuels a harmful and corrupt system. As stated by the Algorithmic Justice League, "face surveillance threatens rights including privacy, freedom of expression, freedom of association and due process" [5]. This breaks a fundamental code of ethics: deceptive acts. Yet, facial recognition is still a very useful tool. Thus, to combat such inequities without outright banning this technology, Representatives Ted Lieu, Sheila Jackson, Yvette Clarke, and Jimmy Gomez introduced the Facial Recognition Act, a bill that limits

law enforcement's use of facial recognition surveillance to ensure civil liberties are protected. The bill prohibits a single match from being the sole use of evidence to convict a person. If the FRT is enacted globally, law enforcement across the nation will be able to meet a universal standard that could halt racial biases while still utilizing such technologies.

These examples open the conversation about the need for diversity in spaces where such technologies are developed. Algorithms should be trained on a representative dataset and such data should be used with the consent of each individual. A standard on the image quality should be set, as well, to photograph darker-skinned people better. Researchers and engineers at Google have launched the Real Tone project to assist software developers in evaluating lighting algorithms and skin color research practices [6]. Lastly, companies can be held accountable by conducting regular assessments and ethical auditing.

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Should Google Scan Personal Files for the Public Good?

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In August of 2022, The New York Times published a story about a father named Mark whose child's pediatrician requested a photo of his son's intimate parts for a medical diagnosis. The father took and submitted the photos, and the doctor diagnosed the boy [3]. Along the way, the images were marked by Google as child sexual abuse material (CSAM), and the father was permanently suspended from all Google services [2].

This unfortunate story raises an interesting debate between privacy (whether big tech companies should have access to personal photos) and the public good (preventing child sexual abuse). Both are outlined in the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) Computer Society's code of ethics, which begs the question: How can these ideals coexist?

First, it would be beneficial to examine how Mark's photos were marked as CSAM. Neither Google nor any current major phone manufacturer scans the images stored locally on your phone. Instead, the issue arises when you upload photos to personal Cloud storage, such as Google Photos. Once in the Cloud, the hosting company, such as Google, has agency over the images. Typically, they are hashed – each image is mapped to a unique digital code called a hash and compared to existing hashes of known CSAM. However, the photos of Mark's son would not show up as CSAM using this method because Mark's photographs could not have already been in a database – they were original. Instead, Google has trained an artificial intelligence to recognize CSAM in completely original media, and if the AI detects something, it is marked for review by a human. If the human deems the photo inappropriate, a report is made and dealt with by relevant law enforcement [3]. This case highlights the debate over whether big-tech companies should be able to scan people's files, whether big-tech companies should actively participate in preventing crimes, and whether big-tech companies should suspend users from their services in cases like these.

To begin with, should big tech companies be able to scan personal files? The ACM Code of Ethics asks computer scientists to "respect privacy." They seek to prevent "accidental disclosure" of data, "allow individuals to understand what data is being collected and how it is being used," and collect "only the minimum amount of personal data necessary" [1]. The service Google provides is cloud storage, so any file one uploads to Google Photos or Google Drive will be collected by Google. However, to fulfill the service's function, Google only has to store the data. The photos a user uploads do not have to be hashed, and they do not have to be processed by an AI. Since the ACM Code of Ethics asks that computing professionals do not violate the "rights of individuals and groups," and privacy is considered a universal human right, Google violates the ACM Code of Ethics [5].

By uploading your files to Google services, you surrender to Google the right to use files as they please, as stated by Google's Terms of Service. However, the ACM specifies that users should know how their data is being used [1]. The title of the webpage for Google Drive is "Personal Cloud Storage & File Sharing Platform," with the word "Personal" having a connotation of privacy. Google's Terms of Service is irrelevant when most users are oblivious to what it contains. Users understand what is made most clearly available to them, and a claim of "easy and secure access to your content" gives the impression that the content is yours, not Google's. However, Google Photos is not only a storage service but also a file sharing platform. Should users still maintain their right to privacy when they begin sharing their photos with others? What about if they create a public link? When the user shares files publicly, the expectation of privacy is lost. When CSAM and other illegal content is distributed through public links that point to Google Photos, the action taken by Google is entirely justified because the user is using Google Photos as a means of distribution rather than solely a means of storage.

This scenario raises another question about Google's involvement: should Google, and big-tech companies in general, take an active role in enforcing the law and preventing harm? The IEEE Computer Society's Code of Ethics states that "the ultimate effect of the work should be to the public good" [4]. Based on this condition, Google is doing a great job – ethically speaking – as CSAM is against the public good. Additionally, upholding the public good should be a primary concern when designing a software project. Google is taking an active involvement in CSAM prevention. They have employees dedicated to this work and have delegated much funding on AI research and development. They have gained public support because their cause is deemed noble.

But, what about when the "public good" is not so publicly agreed upon and poses questions of legality against questions of morality? For example, what if Google started having an AI scanning text messages for signs of drug deals, domestic abuse, or plans of political demonstrations? Yes, Google may prevent crime, but are they acting for the public good? When companies like Google show this capability and get involved in issues of legality, they open themselves up to questions about why they aren't taking more action towards other causes that might create just as much public harm. Unfortunately, there are no right answers, and the solutions to these problems remain unknown, which is why healthy discussion on tech companies' involvement in harm prevention is needed.

Finally, even after being cleared by his local police department of wrongdoing, Google still refused to reinstate Mark's Google account. Google provides countless services, from storage and email to backend web development and YouTube channels. All of these services are tied to one user; if a user is suspended from their account, they can no longer access any of these services. Technically, Google should have no legal obligation to reinstate Mark's account after being cleared of legal wrongdoing. After all, Mark was found in violation of Google's Terms of Service, so they should not have to reinstate him if they choose not to. However, even though they do not have to reinstate Mark legally, they should still reinstate him based on morals. In this case, locking users out of their accounts before determining their guilt gives the impression that Google is acting as a judge and jury while toying with people's digital livelihood.

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What are the Bioethics of Genetic Testing?

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Abstract The role of society in bioethics centers around genetic technology, which has led to the emergence of ambiguous challenges within the two extremes of genetic disease: unethical usage and a dependence for medical aid. Genetic testing is revolutionary as it influences the medical care an individual receives by predicting future diagnoses. For example, genetic testing can diagnose genetic conditions and diseases including cystic fibrosis. Furthermore, testing can determine risks for disease, which is especially valuable for pregnancies. Although it seems as if genetic testing only has beneficial impacts, it is hindered by bioethics over questions of how it could affect research and the treatment of p atients. Both positive and negative impacts abide by different research purposes, all with similar vulnerabilities and theories, specifically within medical fields such as oncology, gynecology, and obstetrics. Additionally, opinions may be influenced by negative psychological factors such as generational trauma and dependency. Even though society divides bioethics between minor and significant conundrums, such as empirical issues within science and medical discovery, genetic testing will remain a dependent variable on different fields of medical research.

Keywords Genetic technology, genetic disease, cystic fibrosis, oncology, gynecology, obstetrics, generational trauma

How does genetic testing for disease affect our society? Genetic testing checks for mutations in genes, chromosomes, or proteins. Data collected from a genetic test, which confirms or rules out a suspected genetic disorder, can be used to evaluate an individual's chance of developing or passing on a hereditary illness. For genetic testing, a sample of blood, hair, skin, amniotic fluid (the fluid encasing a fetus during pregnancy), or other tissue is utilized. Additionally, a little brush or cotton swab is used to collect a sample of cells from the inner surface of the cheek during a procedure called a buccal smear. Professionals in a lab analyze the sample for modifications in its genomic makeup. The laboratory sends a patient's doctor or genetic counselor a written report of the test results, or, if the patient desires it, the patient directly. More than 77,000 genetic tests are now in use, with many more being developed.

Bioethics has been responsible for constructing guidelines for responsible use of genetic technologies, primarily surrounding the protection of individuals involved in genetic counseling, research, and testing. For instance, doctors and researchers might treat patients and research participants paternalistically to follow the highest ethical standards, which would harm genetic and biological testing and research for the supposed benefit of patients [1]. Most available tests identify untreatable genetic diseases, such as Huntington's disease, although geneticists have identified numerous gene mutations associated with other diseases and have consequently developed suitable genetic tests. Due to these factors, many individuals have been satisfied with the variety of options available for testing. This strikes a more positive vision of the future of genetic testing for families with rough histories of disease.

While bioethical concerns about genetic testing have been extensively discussed, they are now more urgent due to the field's rapid advancements following the accomplishment of the Human Genome Project. The goal of this 13-year, multibillion-dollar program was to determine all existing genes and make them accessible for further research. However, the initiative raised several ethical issues, and Congress recognized the need to create programs to address ethical, legal, and societal issues when crafting the legislation that authorized the federally funded Human Genome Project. Therefore, based on the research of the ACOG, "the ethical obligations of clinicians start with the need to maintain competence in the face of this evolving science" [2]. Clinicians and physicians may vary recommendations depending on the patient's background and/or reason for testing.

Reactions to genetic testing are also of grave concern. Individuals' reactions usually depend on their results. When those at risk for disease obtained negative test results, catastrophic reactions, including suicide, were predicted but were not realized. Indeed, the psychological discomfort experienced by those who received positive test results has often decreased as the uncertainty surrounding their genetic status has diminished. According to Marteau, T. M., & Croyle, R. T., the manner in which genetic information "is given varies widely—as relative and absolute risks, probabilities and percentages, and numerous verbal descriptors" [3]. Unexpectedly, some persons who receive negative test results struggle to accept their updated risk status. Based on the aforementioned research, the outcome of predictive DNA testing for breast cancer among women appears to have minimal bearing on anxiety levels in general. This has concerned researchers due to the lack of awareness of a patient's psychological response to the results of genetic testing, creating a more negative image of genetic testing

in the social eye.

Advocating for genetic testing has generated mass amounts of data aiding how genetics are relevant to human lives. Throughout the years, this field has advanced, and much research has been conducted into reactions in different societies. Additionally, researchers have identified how paternalism has changed and how it factors into bioethical considerations in genetic sciences. Psychological research into genetic testing has also suggested new, irrational biases against the procedure. These factors show how the future of genetic testing will continue to depend on several medical research sectors, notwithstanding society's division of bioethics into minor and significant conundrums.

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Ethical Considerations for an Aerospace Engineer: An Examination of Approaches

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How far does responsibility and culpability go for heinous crimes and human rights violations? When egregious violations of international law—say, indiscriminate bombings of civilian populations—are committed, it can be generally agreed that the direct perpetrators are primarily responsible. But what about all those who created the conditions that allowed for such crimes to happen? Governments, militaries, manufacturers: if you draw far back enough, you will see culpability in all of society. So, who must take responsibility? If a war crime occurs, does responsibility fall on the governments and corporations that sell these weapons? If so, do the employees of these states, agencies, and companies have blood on their hands? Finally- if that is the case, what should a conscientious employee do in such a predicament? Let us take an example in the aerospace sector, to examine this case.

On August 8, 2021, the world was shocked by footage coming out of the rural village of Dahyan in war-torn northern Yemen. Debris and dust covered the scene, and at its center stood the wreckage of a school bus. Around it lies the remains of its inhabitants: anywhere between forty and fifty-two dead, the most of them children under fifteen years old, on their way to a school picnic. These scenes inspired international outrage over the conduct of the Saudi intervention in Yemen. Debate roared once more over the United States' funding and fueling of a regime infamous for human rights violations and war crimes. When an issue of such moral resonance and outrage occurs, one feels compelled to take a stand.

However, one side of the atrocity less examined is the domestic origins of these munitions. The bombs were Mk. 82 General Dynamics munitions, the bombers, likely McDonnell Douglas F-15s, the refueling aircraft, Boeing KC-135 Stratotankers. Engineers in America's most prestigious and profitable aerospace firms designed and manufactured these aircraft and munitions. Millions in profits flow from Arabian oil fields to American defense contractors, money made from contracts facilitated by the U.S. government. When it comes to pointing fingers and accepting responsibility past the perpetrators the majority of the blame lies with the governments and corporations which made these deals for their own geopolitical and economic reasons. However, to what degree are the ordinary engineers implicated in this chain of profit and crime?

I would argue that engineers are, to a degree, implicated in this military-industrial complex. This ought to be an uncontroversial point. If you make a weapon with the knowledge that it can be used for purposes that go counter to any just, moral, or ethical use, then you are an abettor of violence; even if you do not know for sure, the ambiguity should lead to one to desire to secure an arrangement that guarantees ethical use. Engineers financially benefit from these unethical practices; the 2017 US-Saudi Arms Deal precipitated a significant rise in the stocks of many aerospace and defense contractors, and individual workers see the benefits of it in their wages and stock options—blood money, as it were. If you abet and benefit from exploitation and crime, you are, to an extent, responsible for it. .

In addition, this conduct is inconsistent with various professional and established codes of conduct that (supposedly) govern the practice of engineering. Article I of the American Society of Mechanical Engineers Code of Conduct states that engineers ought to honor their profession and dignity by "using their knowledge and skill for the enhancement of human welfare". I would consider creating tools that are used to kill children and violate the Geneva Convention are quite the opposite of the "enhancement" of the human condition. Furthermore, article II of the American Institute of Aeronautics and Astronautics Code of Ethics says that engineers have an obligation to "report [...] contravention[s] of law, regulation, health, safety or ethical standards." Once more, I need not explain how abetting war crimes violates this article, among others. According to these codes of ethics and good practice, it is dishonorable to do work as so.

In the face of such injustice and inability to change the status quo, resignation may seem like the only ethical option. Indeed, that is the route some individuals go. One model that may be worth learning from is the Google tech workers' efforts organizing against involvement with the Pentagon and Project Maven. Through mass petitioning employees, Google workers were able to make the case to their employers that working on Project Maven violated Google's core principles. This is a strategy that is much less likely to work in the aerospace sector,

and a proposal that is likely to fall on deaf ears in companies purely engaged in defense contracting. However, in certain companies that engage in both the civilian and military sectors, petitioning may be one of the only routes open to conscientious engineers to reform the organization from within. Contributing to advocacy outside of work is another avenue; for example, volunteering for political campaigns that support ending exports to countries that violate international law. Ultimately, it is up to engineers to use whatever avenues they have to oppose corporate contributions to violations of human rights and international law, and if no possibility of change is possible, then perhaps a publicized resignation in protest really is the only way to resolve this ethical contradiction.

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The Ultimate Quantum Detective: Nuclear Magnetic Resonance

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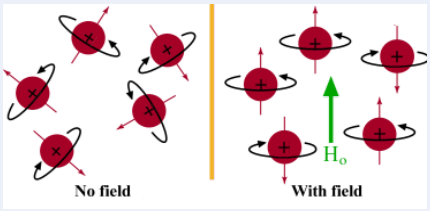
Nuclear magnetic resonance (NMR) is an **advanced characterization technique** widely used in chemistry, physics, and biology. It allows scientists to determine the molecular structure of a sample at the atomic level by analyzing the behavior of its atomic nuclei under the influence of a magnetic field [1].

How it works:

The basic principle behind NMR is that atomic nuclei with an odd number of protons or neutrons possess a property known as *spin*. Spin is a quantum mechanical property that describes the intrinsic angular momentum of a particle. In the presence of a magnetic field, atomic nuclei will align themselves either *with the direction of the field* (α-spin) *or against the direction of the field* (β-spin). β-spin is the higher energy state since it takes more energy to align against the magnetic field [2].

Shielded atoms describe nuclei that are surrounded by a high electron density such that the inner electrons "shield" the outer valence electrons from feeling the full attraction of the nucleus. Shielded atoms have a smaller energy difference between the alpha and beta spin compared to deshielded atoms.

1. A sample is subjected to a strong, constant magnetic field.
    - Some nuclei will align themselves with the direction of the field, while others will align themselves against the direction of the field, resulting in two possible spin states at two different energy states.
2. A radio frequency (RF) pulse is applied to the sample. Absorbing this pulse allows nuclei in the lower energy state to transition to the higher state by flipping their direction [3].



Nuclei interact with the RP pulse differently depending on the strength of the magnetic field and the *chemical environment* of the nucleus. This chemical environment is determined by a nucleus' surrounding atoms and relative position in a molecule, as well as whether the nucleus is shielded or deshielded. The intensity and shape of the absorption signal reflect the *number and arrangement* of the atomic nuclei in the sample [2]. The nucleus' level of absorption of the RF pulse contains information about the chemical and physical properties of the sample.

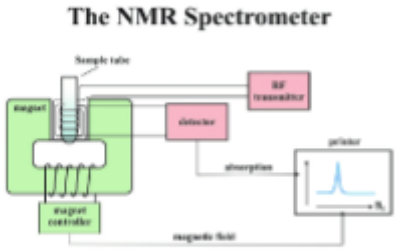


Figure 1: Schematic of a typical nuclear magnetic resonance spectrometer [4]

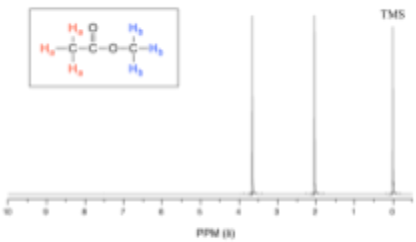


Figure 2: The ^{1}H NMR spectrum of methyl acetate. [5]

On the left is the ^{1}H NMR, or proton NMR, spectrum produced by methyl acetate. This means that it is the proton in the nucleus of the ^{1}H isotope that is observed. It's also important to note that the peak at

the far right labeled TMS is for the standard reference compound, not for the compound of interest.

Therefore, only 2 of the peaks in this spectrum are associated with methyl acetate. On the right is the actual molecular structure of methyl acetate. The reason that there are only 2 peaks for a compound containing a total of 6 hydrogens is because the hydrogens are grouped by their *chemical environment*- the 3 hydrogens in the methyl group bonded with C=O are one group and the 3 hydrogens in the methyl group bonded with O are the other [5].

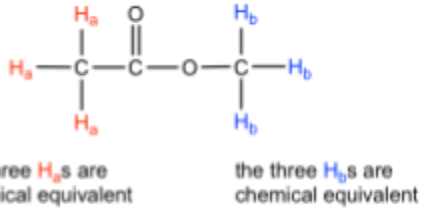


Figure 3: The molecular structure of methyl acetate. [5]

That's pretty cool! But how is this useful to us?

NMR is a powerful tool that's used in a wide range of applications, from determining the structure of small molecules to studying the dynamics of large biological systems.

Food safety testing: NMR spectroscopy is used to test food products for quality and safety. For example, NMR can be used to analyze the sugar content of soft drinks, detect the presence of pesticides in fruits and vegetables, and verify the authenticity of food products such as olive oil and honey [6].

Magnetic resonance imaging: NMR is a fundamental part of magnetic resonance imaging (MRI), a noninvasive medical imaging technology. MRI machines use strong magnetic fields and radiofrequency pulses to excite the nuclei of hydrogen atoms in water molecules, generating a detectable NMR signal. The intensity and frequency of the NMR signal are then processed to generate high-resolution images of the body's internal structures [7].

Environmental monitoring: NMR spectroscopy is used in environmental monitoring to analyze soil and water samples for pollutants and other contaminants, such as the EPA-regulated per/poly-fluoroalkyl substances (PFAS). For example, NMR can be used to detect the presence of heavy metals in soil samples or to analyze the composition of oil spills in water [8].

Conclusion and Looking Ahead

NMR is a powerful technique used in a variety of scientific fields. By analyzing the behavior of atomic nuclei under the influence of a magnetic field, scientists can determine the molecular structure of a sample at the atomic level. The versatility of NMR makes it a useful tool for solving some of the world's most pressing problems today in areas such as food safety testing, medical imaging, and environmental monitoring.

Looking to the future, NMR spectroscopy is bound to continue to play an important role in scientific research and innovation. Advances in technology- such as a greater availability of benchtop, portable instruments and the miniaturization of RF spectrometer electronics- have increased the accessibility of NMR spectroscopy to a broader community of scientific researchers [9]. Indeed, in recent years NMR has been used heavily in the field of metabolomics- the study of small molecules, known as metabolites, in a biological system [10].

With its ability to reveal the hidden world of atoms and molecules, NMR is sure to be a valuable tool for years to come.

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How Gender Reveal Parties are Destroying our Environment

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In 2008, blogger Jenna Karvunidis made a Facebook post of herself cutting into a cake and exposing its pink icing to celebrate being pregnant with her oldest daughter. After suffering several miscarriages previously, the new mother wanted to commemorate the milestone when doctors could determine the baby's sex [1]. Recently, gender reveals have gained widespread popularity among expecting couples as a means of announcing their unborn child. These parties are known for their mixed blue-and-pink theme, leaving guests wondering whether the baby is a boy or a girl. Then, in a grand finale, the hosts uncover the hidden truth [2]. Large crowds burst into cheer, congratulating the parents on their new son or daughter [3].

Once as simple as dyed cakes and letters pulled out of envelopes, these 'pre-birth rituals' have quickly derailed, often going so far as to pose a risk to human and animal life. An emerging reveal party trend involves explosive and pyrotechnic devices like fireworks [3]. For example, in October 2019, an Iowa family's homemade powder dispenser became a colorful pipe bomb, hurling shrapnel and debris over 150 yards and killing the grandma-to-be [4]. In February 2021, an upstate New York father died after his makeshift device for an upcoming gender reveal exploded [5]. Earlier that month, a Michigan man was killed by shrapnel after a small cannon blew up in a backyard during a gender reveal [6]. These are but a few of the various cases in which careless celebratory behaviors led to injury or death.

Among the most destructive products used in gender reveals are binary explosives, which are made of highly reactive oxidizers like ammonium nitrate (NH4NO3) and a metal fuel. Families have started using these color bombs because they are easily accessible and unregulated by the Bureau of Alcohol, Tobacco, Fireworks, and Explosives since their components are sold separately [7]. Unsurprisingly, these makeshift weapons can cause considerable environmental damage. For instance, in 2017, Tannerite (a binary explosive brand that uses powdered aluminum as fuel [8]) used in a gender reveal caused the Sawmill Fire in Arizona's Coronado National Forest that cost nearly $8.2 million to suppress [9]. Bureau of Land Management public lands within Las Cienegas National conservation area closed to the public, and 412 citizens were rapidly evacuated from the Rain Valley area as wildfires ravaged 46,991 acres of land within 11 days. The Coronado fire was the second-largest fire in the state that year. Although it primarily burned through grass, the fire also reached the chaparrals and oak brush, damaging conifer-oak and piñon-juniper forests [10]. This tragedy greatly resembles the El Dorado Fire, which was caused by fireworks used by a family during a gender reveal igniting dry grasses in Yucaipa, California, on September 5th, 2020 [11]. In the aftermath, 22,982 acres of land and sixteen buildings were damaged, one firefighter died, and over $8 million was spent on the fire's containment. A Mississippi State University study led by James Kellogg analyzed soil affected by the wildfires and found that, on average, the pH increased by 4.4% compared to unaffected soils. [12]. pH levels above the optimal range can signal nutrient deficiencies and stunted plant growth [13].

While engaging in many of these catastrophic party games may seem relatively avoidable, even more traditional party items, like glitter, can damage the environment in their own ways. Glitter is a three-layered microplastic composed of a plastic core coated in aluminum and another thin plastic layer. Usually, this plastic core is made of a stretched polyester called biaxially-oriented polyethylene terephthalate (BoPET), and the thin outer coating is styrene acrylate [14]. A 2020 study led by Danielle Senga Green of Anglia Ruskin University compared the measured environmental effects of plastic and biodegradable glitters on an aquatic ecosystem. In both sample groups, the root length of Lemna minor (common duckweed, a freshwater plant) decreased. Chlorophyll content also decreased, indicating a decline in phytoplankton biomass [15]. During photosynthesis, chlorophyll harvests light that excites electrons used in the production of nicotinamide adenine dinucleotide phosphate (NADPH) and a form of chemical energy known as adenosine triphosphate (ATP). Both of these compounds are necessary for the second step of photosynthesis, known as the Calvin-Benson Cycle, to take place [16]. In the scope of the study, the presence of glitter is correlated with a decline in chlorophyll production, which leads to less energy production during photosynthesis. Stunted duckweed growth can harm marine ecosystems because the species is pivotal in preventing eutrophication, which is the oversaturation of aquatic environments with nutrients. Without regulation, eutrophication can lead to

oxygen depletion and animal death [17].

With all of this in mind, the intent of this article is not to discourage you from hosting gender reveal parties. Having a child is an extremely significant milestone, but before inviting friends and family to a big reveal, consider how it might contribute to environmental degradation. Instead of buying balloons and glitter that will end up in our landfills and oceans, consider alternatives, like leaf confetti and paper chains, so as to aid in the restoration of our planet. If gender reveal parties are to continue, maybe it's time to return to tradition: simple cakes filled with dyed icing.

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Say "No" to Student Monitoring Software

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School-issued devices have rapidly made their way into millions of American students' lives following the virtual schooling brought on by the COVID-19 pandemic. Yet embedded into these devices is surveillance software that not only enables teachers to view and control their students' screens, but also thoroughly scans each student's laptop content and sends alerts to educators and law enforcement [1].

With mental health issues on the rise and safety concerns aggravated by the mass school shooting in Uvalde, Texas, the initial goal of this software was to identify youth at risk of harming themselves or others [2, 3]. Software companies like GoGuardian, Securly, Bark, and Gaggle were quick to rise to the challenge. In fact, 89% of teachers reported that student monitoring tools are used in their schools, according to a national survey by the Center for Democracy and Technology (CDT) [2].

Despite its widespread dissemination and good intentions, student monitoring software fails to achieve its advertised goals due to various shortcomings – it invades student privacy, encourages punitive rather than protective measures, discriminates against disadvantaged groups, lacks proper mechanisms for intervention and erodes teacher-student relationships.

First and foremost, students have a right to privacy. Although students are generally informed about the software, the surveys suggest that not all students are fully aware of the extent of it [4]. Many of these programs allow teachers direct access to their students' laptops outside of school hours, giving teachers the power to override keyboards and close problematic tabs. Students cannot feel safe and respected in an environment of such extreme control and surveillance.

In fact, activity outside of school-issued devices may also be detected. One associate principal [1] said that Gaggle would send him email alerts of pornographic photos exchanged by students even though they were not done via students' Chromebooks. After investigation, it turns out that the student was charging their phone through their Chromebook, which meant private conversations were also unwittingly scanned by the surveillance software. One of the primary tenets of the Institute of Electrical and Electronics Engineers (IEEE)'s code of ethics is to protect the privacy of others, yet this pervasive technology intrudes students' private lives.

Secondly, punishment for breaking school rules seems to have become the norm. 78% of teachers who use monitoring tools said the software has been used to flag students for discipline and 59% said kids end up getting punished [2]. On the other hand, just 45% of teachers said the software is used to identify violent threats and 47% said it is used to identify students at risk of harming themselves. These findings are a direct contradiction of the tool's stated goal.

Even more concerning is how monitoring software can exacerbate "the school-to-prison pipeline by increasing law enforcement interactions with students", according to a report by Democratic Senators Elizabeth Warren and Ed Markey in April [2]. In the CDT survey, 44% of teachers reported that at least one student at their school had been contacted by law enforcement as a result of flagged behaviors.

"Schools have institutionalized and routinized law enforcement's access to students' information," says Elizabeth Laird, the director of equity in civic technology at the CDT [1].

Inevitably, this perpetuates discrimination between different student groups. Those from lower-income backgrounds are less likely to own private devices, so they will have less privacy when it comes to doing the embarrassing things all teenagers do [4]. Furthermore, if students' online language related to drug use, pornography, or violent thoughts are alerted to law enforcement, the kids already subjected to more frequent interactions with police are likely to suffer. Disproportionate disciplinary action along racial lines is emerging too: in a youth survey, researchers found 48% of Black students and 55% of Hispanic students reported that they or someone they knew got into trouble for something flagged by a monitoring tool, whereas just 41% of white students reported similar experiences [2, 5].

This discrimination can have even higher stakes: according to a report by The Boston Globe, the sharing of Boston Public School student records with a police department intelligence group exposed undocumented students, putting them at greater risk of deportation [1]. The engineering ethical code to "treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression" is clearly violated in these scenarios.

Recent policies targeting LGBTQ youth and people seeking abortions raise more concerns about how this data might be weaponized [1, 5]. Nearly a third of

LGBTQ students said they or someone they know experienced non-consensual disclosure (outing) of their sexual orientation or gender identity as a result of activity monitoring [2]. Some companies, such as Gaggle, claim to identify references to words like "gay" and "lesbian," to protect LGBTQ youth, who face a greater risk of suicide. But, survey results suggest that this heightened surveillance comes with significant harm [2]. In a letter to the Education Department's Office for Civil Rights, advocates said the disparities shown in the survey run counter to federal laws prohibiting race-, sex- and disability-based discrimination.

"Student activity monitoring is subjecting protected classes of students to increased discipline and interactions with law enforcement, invading their privacy, and creating hostile environments for students to express their true thoughts and authentic identities," the letter mentions [2].

As states implement anti-abortion laws following the repeal of Roe v. Wade, civil rights groups have cautioned that data from monitoring tools could help the police identify and criminalize youth seeking reproductive health care. A student using a search engine to find out-of-state abortion clinics, or chatting online with a friend about an unplanned pregnancy, could be reported to local law enforcement [1].

There is also the tricky promise of "intervention". The goal of surveillance, according to these software companies, is to allow for "early intervention" [4]. This "intervention" can manifest as involving police, who are known to enter into private homes and engage in force with households without warrants. Many officers have not received training for household crises, even though many lives have been saved by police in these situations, according to Gaggle in its letter to the senators [2].

In January, Baltimore required officials to train on trauma-informed care through the Healing City Act. But as Baltimore Teachers Union Vice President Zach Taylor tweeted, City Schools are exempt from the Healing City Act: "It could still sign-on, engage in the trainings, agree to follow the protocols, etc… but they've been silent on the matter and appear uninterested." Crucially, information about the child's attempts to access external help might also be forwarded to their possible abuser: their parents [6]. The Rape Abuse Incest National Network (Rainn) reported that during the pandemic more than half of their callers seeking assistance were minors, who were more likely to be trapped in their homes with abusive family members [4]. As engineers consider the responsibility to "hold paramount the safety, health, and welfare of the public", these potential repercussions should be dealt with the utmost care.

Ultimately, the misuse of monitoring software may erode teacher-student trust [7]. When teachers use technology to monitor and punish behavior, students can come to believe that school is merely an environment of compliance, limitation, judgment, fear and ultimate surveillance rather than a space to develop the love of learning. On the other hand, positive teacher-student relationships can increase student learning and decrease student behavioral issues. There is also evidence that when teachers develop an atmosphere of trust in their classrooms, students will talk to them if they need help with mental health or safety issues. Classroom management needs to focus on developing positive behaviors conducive to learning rather than the control of misbehavior.

The IEEE code of ethics emphasizes the safety, welfare, fairness and privacy of technology users. Yet student monitoring software clearly goes against these principles.

"Are we, in the name of keeping students safe, actually endangering them?" asked Laird [2].

"The answer to our lack of privacy isn't more tracking," argued the Electronic Frontier Foundation, a non-profit focused on digital privacy and free speech, in a report [2].

Indeed, if teens are in need of help, the best way to protect them is to ensure they have trusted adults in their lives they can turn to. A snooping AI is no replacement for that. Teens deserve privacy for the same reasons we all do: to not feel paranoid, to not be disciplined for their minor transgressions, and most importantly, to not have their rights trampled on.

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