IMRS

Institute for Management & Innovation Review by Students

Food Security in Canada: Lessons from a Pandemic

Ethics & Artificial Intelligence

Big Tech takes on Environmental Sustainability

ISSUE 3

Responsible Innovation

Institute for Management & Innovation
UNIVERSITY OF TORONTO
MISSISSAUGA

EDITOR'S NOTE

Hello!

Thank you so much for picking up the third edition of Institute for Management and Innovation Review by Students (IMIRS)! IMIRS started in 2017 as a platform to showcase student work as engaging op-eds and we are honoured to continue this initiative. Graduate students across IMI have collaborated on these articles to think beyond the classroom and reflect on the world around us.

When we called for article submissions, we made the initial theme vague so that writers felt open to explore their personal curiosities. Once the articles were finalized, it became clear the articles could fit under the theme Responsible Innovation. This theme was so relevant for the 2020 issue as we reflected on what made the news – the world's response to COVID-19, the Black Lives Matter movement, and increasing conversations of human rights issues. Now more than ever it seems that responsible innovation is needed. As graduate students within IMI, we know that innovation has a cost, and these articles reflect on strategies to manage the negative impacts associated with change. As we leave UTM and enter the workforce, we will continue to ask what it means to be responsible and strive for responsible innovation.

We sincerely hope you enjoy reading these articles. Thank you so much to our stellar editorial and graphics team, your leadership and creativity is always appreciated. Thank you to the writers for contributing your thought leadership. And thank you to everyone else who supported us with your time and encouragement—you made this all possible!

Best Wishes,

A Vrbensky

Amanda Vrbensky

Managing Editor
Institute for Management & Innovation Review by Students (IMIRS)

FROM THE DIRECTOR'S DESK

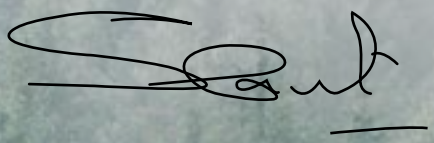
I am pleased to write a few words about this impressive issue of IMIRS, which is an excellent example of intellect, research capability, commitment, and leadership of our students who want to transform this world. Our students are known for their innovative minds and insightful curiosity. The 2020 issue of IMIRS, with the theme "Responsible Innovation", reflects the thoughtful conversations and collaboration taking place within the Institute for Management and Innovation.

What stands out in this issue is the diversity of topics covered. The topics range from timely issues such Nelsen Elsholtz's lessons from a pandemic, and Tayyab Pirzada's take on the biotechnology innovations defining the 21st century to Jillian Elman's ethical debate of AI and Syeda Hasan's philosophical discussion of sustainability language. On the economic front, Kelly Goncalves questions if innovation can be "used up" and Brandon Verkerk examines the impact of AI on the labor market while Ty Bryant uses behavioral economics and "flight shame" as a nudge for the air transportation industry. Similar to the previous issue, the topic of Sustainability continues to dominate this issue, covering a broad range of topics within sustainability. Joelle Pang discusses technology companies' commitment to environmental sustainability, Madeline Collins investigates the environmental impacts of next day deliveries, and Raguram Bhaskar stresses the role of nuclear energy in a net-zero world. All articles are thoroughly researched and bring diverse perspectives to our understanding of this world. I am thrilled by the passion and the perspectives that our students have to offer.

I would like to express my sincere gratitude and heartfelt congratulations to all the amazing authors who have contributed to this issue despite the numerous challenges faced due to the COVID-19 pandemic. I am also greatly thankful to the Editorial and Graphics Teams for producing such an imaginative, inspiring, and inclusive issue.

With love and best wishes to all.

Yours sincerely,



Shashi Kant

Acting Director,
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RESPONSIBLE INNOVATION

ISSUE 03 - FALL 2020

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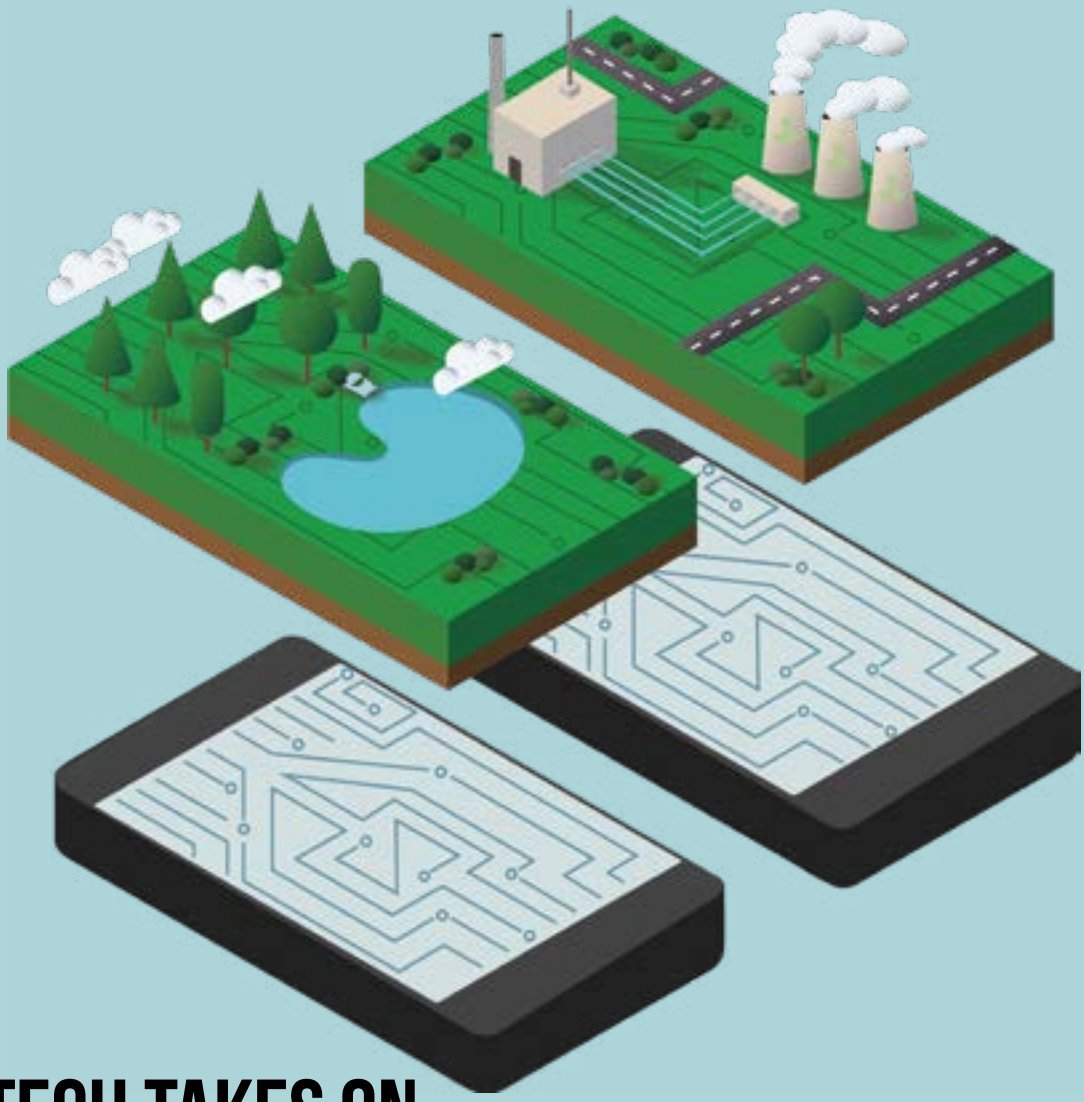
INDUSTRY TRENDS

OPINION

Illustrations by Athbah Almuhairi



BIG TECH TAKES ON ENVIRONMENTAL SUSTAINABILITY

Author
Joelle Pang

Editor
Allegra Bethlenfalvy

It is difficult to imagine a world without technology. In an ever connected society, electronics are an essential component of our livelihoods. So how does our dependence on technology relate to climate change? Why is this important? What are companies doing about this?

The constant need for economic growth is fueling carbon emissions and the acceleration of climate change. The technology sector currently makes up 2% of global emissions. Traditionally, a company's supply chain is a linear process that involves a take, make, use, and throw approach where every step produces emissions. Our growing dependence on the internet results in the increased electricity consumption from data centres which currently consume 200 terawatt hours annually. This is more than the national energy consumption in Iran.[1] As the exponential growth of AI technologies in products increases, training an AI model could emit five times the amount of carbon dioxide compared to the lifetime of a car.[2] Electronic consumption is on the rise as the average household now has 11 electronic devices.[3] In a society that is heavily reliant on owning new products, this increases the rates of technology turnover. With more products containing electrical components and shorter life spans, this makes electronic waste one of the fastest growing waste streams across the world.[4] Current waste disposal methods are insufficient in addressing this growing problem.[5] Additionally, these electroni products have toxic materials that are often improperly disposed of rendering negative human health and environmental impacts.

Climate change is an issue that transcends all industries. For the first time in history, the top five global risks were climate-related.[6] Science tells us that we must keep Earth's temperature

increase to well below 2 ºC by 2030 or we face irreversible and unimaginable damages. Prioritizing climate change is important for the survival of humanity but also for a company's safety as they could face detrimental financial and reputational consequences if insufficient action is taken.

Global approaches, such as the Paris Agreement, have attempted to unify countries to achieve the common goal of climate action. However, barriers such as disconnected approaches, politics and a lack of action remain. While international efforts lag, an increasing number of local governments have implemented stringent legislations that address electronic waste. Extended producer responsibility is a type of legislation that holds companies accountable for their products. It pushes for compliance with new standards but also urges companies to go beyond compliance and see this as an opportunity to declare ambitious environmental commitments. These commitments, if comprehensive enough, can qualify for global initiatives such as the Science Based Targets and the Carbon Disclosure Project which will provide added value to the company's image. Since 70% of millennials value companies with an environmental agenda and overall consumer awareness for sustainability is on the rise, these commitments and actions help improve their brand while also reducing the negative environmental impacts from their supply chains.[7]

Under new government regulations and increasing scientific evidence, it will be interesting to see how tech companies evolve in their environmental sustainability commitments and how consumers can hold these companies accountable. The environmental sustainability approach of the largest tech companies based on total market capitalization will be further explored.

Microsoft

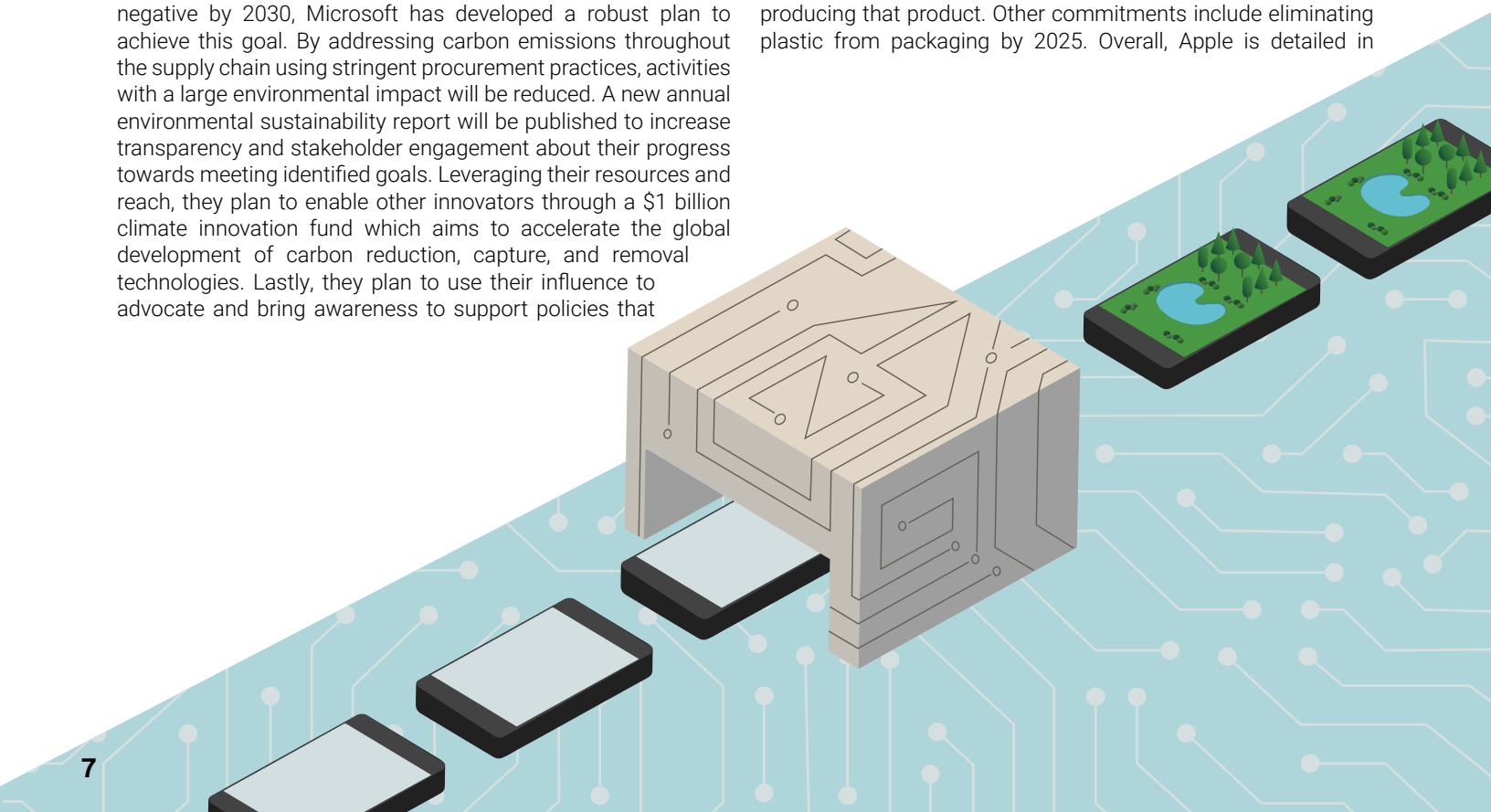
Microsoft's global operations are currently powered by 10% renewable energy. With an ambitious commitment to be carbon negative by 2030, Microsoft has developed a robust plan to achieve this goal. By addressing carbon emissions throughout the supply chain using stringent procurement practices, activities with a large environmental impact will be reduced. A new annual environmental sustainability report will be published to increase transparency and stakeholder engagement about their progress towards meeting identified goals. Leveraging their resources and reach, they plan to enable other innovators through a $1 billion climate innovation fund which aims to accelerate the global development of carbon reduction, capture, and removal technologies. Lastly, they plan to use their influence to advocate and bring awareness to support policies that will accelerate opportunities for the reduction and removal of carbon.[8]

Google

In 2018, carbon neutrality was achieved for 12 consecutive years and 100% of electricity consumption in Google's global operations were matched with renewable energy. A commitment has been made to power all of their facilities with carbon-free energy however, a date has yet to be set. Sustainable supply chain commitments are seen from the Circular Google strategy. The Conflict Minerals Program, which began in 2012, can improve transparency and develop conflict-free sources of these materials. The minerals are tracked using blockchain technology and this project is the first of its kind in the world. Google also has a zero waste commitment for all data centres where 87% of waste was diverted in 2018. Downstream supply chain commitments include partnering with various companies for recycled plastics in their products.[9] The growing number of initiatives are a good start for environmental sustainability at Google.

Apple

Apple's environmental sustainability commitments are broken down into climate change, resources and smart chemistry. In 2018, Apple reached its goal of powering all of its own facilities with 100% renewable energy. Their commitment towards environmental sustainability in 2019 was seen by the expansion of their materials recycling program to focus on innovative solutions using robots and machine learning to improve traditional end of life processing methods. A current robot can disassemble 15 iPhone models at a rate of 200 iPhones per hour. This contributes to diverting over 48,000 metric tonnes of electronic waste from landfills.[10] Apple previously stated that future products will be made with 100% recycled materials, however, there has yet to be a clear strategy and implementation for how this will be achieved. For some of their products, an environmental report card is available so consumers can understand the impacts of producing that product. Other commitments include eliminating plastic from packaging by 2025. Overall, Apple is detailed in



reporting what they have achieved however improved disclosure needs to occur for publicly stating their goals and future plans.

In conclusion, big tech is using its scale and influence to move environmental sustainability commitments within the industry forward. Several key themes identified across the industry are as follows. Companies have made bold commitments that seem like moonshots to achieve. Achieving these goals within the next decade will require moving faster and further together. Uncharted strategies of collaborating such as competitor collaboration towards a common goal will be required. Addressing carbon emissions in supply chains, specifically Scope 3 emissions, will be critical. The ambitious commitments and achievements from the three large technology companies discussed are a great start for the industry. Hopefully, their actions will motivate consumers and other industries towards stronger environmental sustainability commitments as continuous innovation is required to achieve the 2030 global climate goals.

About the Author

Joelle is a recent MScSM graduate with a Bachelor in Life Sciences from McMaster University. She is fascinated by the intersection between corporate sustainability, technology and data analytics. She recently started Green Disruption, a website to share sustainability insights with young professionals. She hopes to pursue a career in corporate strategy development. In her spare time, she enjoys reading, eating, travelling and being outdoors.

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Illustrations by Roxanne Ziman

THE ENVIRONMENTAL IMPACT OF NEXT-DAY DELIVERIES

BY MADELINE COLLINS
EDITED BY AMANDA VRBENSKY

The quarantine months of 2020 have undoubtedly required adjustment in many areas of our lives. While social distancing measures have led to a significant uptick in online orders, we have learned to accept significant delays, giving up the expectation that our orders will be at our doorstep 1-2 days after clicking the checkout button. We have had to reconsider how urgently we need certain items, shifting away from last-minute, often impulsive, orders toward planning ahead.

If we were to carry this newfound patience forward post-quarantine, it could have significant environmental benefits. Slowing down deliveries is an effective method to reduce greenhouse gas emissions resulting from e-commerce, and will likely be necessary to align with a future scenario in which we limit warming to 1.5°C by 2100.[1] As consumers, we could support companies in meeting their climate goals by using our power to shift demand away from express delivery options and reduce the carbon intensity* of our orders.

Environmental impacts of express delivery

Selecting express delivery options forces providers to adopt emission intensive practices. This is driven by two major factors: transportation mode and order consolidation.

Transportation mode

Comparing across different long-distance transportation models for parcel delivery – namely air, rail and heavy-duty vehicles (i.e., transport trucks) – we find, perhaps unsurprisingly, that faster options are also more emissions intensive. For instance, heavy-duty vehicles are 3 – 4 times more emissions intensive compared to rail, when transporting the same amount of freight over the same distance.[2,3] Air transit is even more carbon intensive. Transporting a package over the same distance by air ranges from being 2 – 10 times more emissions intensive** when compared to heavy-duty vehicles.[4] As consumers continue to demand express delivery options, providers are forced to compete on speed. Therefore, they rely more on emissions-intensive options, such as air and heavy-duty vehicles. Retailers may even opt to transfer goods from one warehouse to another using planes to further increase speed.[5]

Order Consolidation

In the race to satisfy express orders, retailers find themselves under strict time constraints. They cannot afford the time required to maximize cargo space with tightly packed deliveries or execute the most efficient delivery routes.[5] As a result, a larger number of partially-filled vehicles are sent out, increasing the GHG emissions associated with each parcel onboard.

A study published in the Journal of Cleaner Production found that basket size was a critical factor in the environmental sustainability in e-commerce. By maximizing the number of items per delivery, companies can reduce emissions from last-mile*** delivery.[6] Another study by consultancy Bain & Company found that by doubling the average number of items per order and avoiding split shipments, retailers can reduce average per-item emissions by 30 per cent.[7] Further, unconsolidated orders increase the number of delivery vehicles on the road, thereby increasing emissions from traffic congestion.

What companies are doing and why it is not enough

In May of 2019, the UN Climate Change Executive Secretary, Patricia Espinosa, delivered a speech that urged global postal services to pursue bold climate goals to reduce their greenhouse

gas emissions. She cited that organizations would need to reduce emissions by 50% by 2030 and become net zero by 2050 to align with a 1.5C future.[8] Most notably, Deutsche Post has championed this target through their "carbon neutral by 2050" strategy.[9]

The reality is that it will not be easy to achieve such ambitious targets by relying on technology improvements alone. Companies can retrofit vehicles to improve fuel efficiency, but the emissions reductions are not likely to exceed 30%.[10] Another option is alternative propulsion vehicles (such as EVs or hydrogen fuel cell technology), but these have their limitations as well. The technology may not be commercially feasible soon enough to meet these targets (i.e., by 2030), and require significant investment in refueling / charging infrastructure. This is especially limiting in countries with long travel distances and harsh weather conditions, such as Canada. Further, the production and scaling of these technologies will also result in externalized emissions.

What companies can do

Ultimately, companies will have to think beyond low-carbon technology and consider a shift in their current business models and logistics to achieve the emissions reductions aligned with a 1.5°C future. A simple example of this is UPS's commitment to only using right turns in their routes, significantly reducing idling time and fuel consumption.[11] Similarly, instead of competing on speed, companies could seek market opportunities from slower, low-carbon delivery options. This can be as simple as replacing existing nudges for express delivery options with nudges for low-carbon options. For example, instead of advertising "free, next day delivery", they could advertise options such as "reduce carbon emissions by 50% with one-week delivery", whereby the company could guarantee that within the one-week window, the most efficient delivery option would be used.[12] For companies like UPS and DHL Group, who already offer their customers the options to purchase offsets for the emissions from their deliveries[13], this option could be a seamless integration into existing offerings.

What we can do

It is important to remember that we, as consumers, have the power to create these market opportunities and facilitate the transition to low-carbon delivery. We created the demand for express delivery and the subsequent race to instantaneous fulfillment among retailers; and we have the power shift this demand once again. Of course, the simplest solution is to consume less, but if we must consume, we can practice patience and mindfulness. By planning ahead, we allow companies the flexibility to use slower, lower emissions transit modes, such as rail. Exercising foresight also affords us more time to consolidate online orders ourselves at checkout, instead of ordering as our needs arise. These responsible purchasing behaviours will further alleviate inefficient and carbon-intensive delivery logistics. We can advocate for low-carbon options to signal a shift towards more responsible consumerism that reprioritizes a clean future over rushed deliveries.

*Carbon intensity is calculated as the tonnes of greenhouse gas (GHG) emissions (tCO2e) per unit of output. For delivery companies, a relevant carbon intensity metric would be tCO2e per parcel delivered
**Freight placed in the belly of a passenger aircraft is approximately twice as emissions intensive, while short-haul air cargo can be over ten times more emissions intensive
***Last-mile is the final step in the delivery process, typically involving multiple stops in residential areas

About the Author

Madeline is a Consultant on the Sustainability & Climate Change team at Deloitte. Since graduating from the Masters of Science in Sustainability Management (MScSM) program at U of T in 2018, she has worked with clients in a variety of sectors to manage their greenhouse gas emissions and climate-related risks. She is excited about the increasing focus on climate change in the private sector and hopes to see it continue as we work towards economic recovery.

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FOOD SECURITY IN CANADA

Lessons from a Pandemic

BY NELSON ELSHOLTZ

EDITED BY JASMINE RUSICA

Illustrations by Amy Haddlesey

What if you were asked, "Are you worried that you will run out of food before you have enough money to buy more?" Statistically speaking, your answer would likely be "no". However this concern is a reality for a growing number of Canadians, as loss of income and food insecurity spurred by the COVID-19 pandemic sweep the nation. It is suggested that COVID-19 traces back to a wet-market in Wuhan, China, where butchering for meat consumption is especially susceptible to the spread of viruses.[1] In fact, it has been shown that 70% of human diseases emerge from conflict and contact with animals, as seen with swine flu, SARS, H1N1 and Ebola.[2] Many top scientists agree that the conditions for pandemics are interconnected with major climate change-inducing factors, including rapid deforestation, uncontrolled expansion of agricultural land, and unsustainable industry practices in farming, mining, and infrastructure development.[2] In order to effectively address pandemics like COVID-19 now and into the future, we must deal with these underlying drivers of climate change and fundamentally rethink how we do business.

For over a month now, we have been seeing the effects of COVID-19 on the stability of the food supply chain. Like other global crises, COVID-19 is an "income shock" to the economy, affecting individuals and society as a whole. Social distancing policies limit the ability of nonprofits, volunteer groups, and government funded support services to help stabilize household income, increasing overall food insecurity. Food banks, as essential support services, have been seeing an average use increase of 20% and even with $100 million in government funding, great challenges are still anticipated ahead.[3] A recent study from the Canadian Journal of Agricultural Economics poses three major long term concerns for food security in the face of the current pandemic: financial stability of farms, international trade, and transportation.[3] On April 16, 2020, the Canadian Federation of Agriculture (CFA) called on the federal government to prioritize food production, second only to health, to ensure farmers are able to produce enough food to feed 36 million Canadians.[4] Normally around this time of year, Canada hires 60,000 seasonal migrant workers across the country for essential labor in planting, maintaining, and harvesting crops, tasks that domestic workers won't do.[5] Under COVID-19 restrictions, the number of entries is tightly controlled and will clearly be insufficient to meet the country's demands. Farms have also had to comply with regulations for minimizing the spread of COVID-19, including social distancing and self-isolation among workers, practices that will reduce productivity and efficiency.

The meat industry has been hit especially hard across North America as thousands of plant workers have become affected by the spread of COVID-19. As of May 1st, at least one worker has died and more than 900 others have contracted the virus at a Cargill meat factory near High River, AB.[6] The plant is responsible for 1/3 of Canada's beef processing capacity, and has since been forced to close operations.[7] Hog farmers have market-ready animals that now cannot be shipped, causing a chain reaction effect in the food system and leading to the euthanizing of livestock.[8] This is not only a tragic waste of animal lives and food source, but further points to the massive carbon footprint of meat production. The relative carbon footprints of red meats are especially high, with pork at 7 and beef at 60 kg CO2-equivalents per kg of product, compared to plant-based protein sources such as chickpeas, at just 0.9.9 Additionally, many moreexcessive acresacreage of land areis needed to grow animal feed in comparison to plant crop land use for direct human consumption, an especially detrimental practice during these critical times of growing food insecurity. Since self-isolation began back in mid-March, I decided to start making strictly meatless meals, which I have found to be more convenient, less expensive, and leave me feeling healthier overall. While the trend toward plant-based diets is often met with skepticism and backlash, a growing number of scientists now advocate for reducing animal proteins in the diet, and during a pandemic, consumption of nutrient dense fresh fruits and vegetables is even more important in supporting a strong immune system in its front-line defense against viral infection.[1] Given the negative impacts of COVID-19 on international trade

and transportation and the carbon footprint associated with food mileage, Canadians can change course and become leaders in more localized food production. This means supporting local farmers' markets and growing your own food. The Toronto Environmental Alliance, in a recent letter to Toronto mayor John Tory, advocated for greater investment in local food production and public ownership of land, including community food gardens.[10] While campaigning for these policy changes, we can begin growing our own food as a way to improve food security at home. The rising trend in balcony gardens among apartment tenants demonstrates that you don't need a backyard to grow a garden. Hydroponic farming companies, like Just Vertical, take the hassle out of home gardening with indoor, soil-free food plants that use significantly less water and energy to grow. Innovative solutions exist, we just need to support them.

Source: justvertical.com/

The global lockdown has caused a lot of anxiety and a desire to return to normal as soon as possible, but perhaps this challenging time can be used beneficially to reflect on our economy and how society operates. Perhaps we can think more about society's most vulnerable and how we are going to ensure food security for a growing global population. Perhaps we can rethink what things in our lives are most important and necessary to us, and which we take for granted. Perhaps we can give more consideration to how things are produced and the impact they have on the environment and on society. One thing is for sure, whenever things do begin to stabilize, our society will have a new-found appreciation for social interaction and personal relationships. Why not have a new relationship with the food that we put on our plate as well?

Governments also play a role in providing support to further develop hydrogen fuel technology from research and development to deployment of fuel cell systems. Thus far, billions of dollars have been invested by various levels of government around the world over several decades. In Canada, revenues reached $207 million in 2017 and the industry employed more than 2,000 people.[3]

In conclusion, growing the market through increased manufacturing will help reduce costs across the industry help develop infrastructure, increase consumer acceptance, and address other challenges. Hydrogen fuel, while still emerging in Canada's market, has a hopeful future and has the potential to take over for gasoline and diesel as vehicle fuel sources. Canada is certainly a primary contributor to the hydrogen technology field and hopefully will be able to continue building on its momentum and become a global leader in the field.

About the Author

Nelsen is currently studying in the MScSM program at University of Toronto Mississauga. He has worked with Toronto hydroponics company Just Vertical since January 2019 to develop their content marketing and social media strategy, and advocates for more local, sustainable food production. His main interest is in the social side of sustainability, influencing public thought about climate change and humanity's relationship with the planet.

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UNDERSTANDING THE INFLUENCE OF 'FLIGHT SHAME' AS A NUDGE FOR THE AIR TRANSPORTATION INDUSTRY AND CONSUMERS

BY TY BRYANT
EDITED BY NIKITA KUMAR

Illustrations by Amy Haddlesey

In 2020, we are exposed to unprecedented levels of media content from various online platforms and sources.[1] As online news media is circulated extensively across the globe, the messages being delivered have an increasingly significant role in shaping our perception of climate-related issues. As readers, how does this wealth of information challenge pre-existing social norms about typically unsustainable behaviors such as air travel? What role does the media play in promoting the integration of environmental stewardship into travel-related decision making? And what does this mean for the air transportation industry and the natural environment?

With elevated public discussion surrounding the topic of climate change, online news media has been quick to report on emerging sustainability trends from around the globe.

Flygskam: A trend you should be paying attention to

Originally coined by Swedish climate activist, Greta Thunberg, one emerging trend is known as "flygskam", translated to English is "flight shame". In late 2018, Thunberg embarked on a zero-emission round-trip transatlantic voyage in a solar-powered yacht to attend the United Nations Climate Summit. This set the ultimate precedent for selecting low-carbon travel alternative, while also giving rise to a novel anti-flying movement.[2] Having contributed an estimated 3% to global anthropogenic emissions in 2017, the air transportation industry has been recognized for the disproportionate level of emissions compared to other modes of transportation.[3,4] Despite the industry's central role in maintaining global economic and social systems, the flight shame movement has ignited, boasting wide-spread international media attention that ultimately challenges the necessity of frequent flying.[5] In order to better understand how the flight shame movement may influence social norms surrounding air travel, this article used media content analysis of 205 news articles to examine and explore common trends in media reporting on flight shame.

The Flight Shame Movement and Nudging: How are they similar?

The novel flight shame movement draws several parallels with a concept that is recognized by Thaler and Sunstein (2014) as *"nudging"*.[6] Nudging can be defined as any influence on individual decision making that alters one's behavior in a predictable way without forbidding any options or significantly changing their economic incentives.[7] Nudging is a tool that recognizes the role that social norms play in challenging, typically impactful human habits and how they can be leveraged to help reduce climate related impacts at the individual and societal level.[8] Nudging-related strategies can be used to help influence behaviour without using rational persuasion or limiting an individual's freedom to make decisions.[9] In the case of flight shame, nudging through online media sources can boost pro-environmental behaviour by using the spread of information to adjust social expectations. As a result, this may shame individuals away from flying opportunities and other salient behaviours.[10] Examples of nudging by shaming in the media include statements such as "no matter what airlines can boast at achieving, the fundamental crux to solving the climate crisis and taking better care of the environment comes down to the individual".[11] This type of statement uses shaming by placing social pressure on individuals who do not consider the environmental consequences as a result of personal flying behaviors.[12]

By using nudging by shaming as a means to communicate information, readers may be further motivated to fly less or to integrate elements of environmental stewardship when making decisions related to air travel.[13] The media-based evidence to support this notion helps to further demonstrate the potential of online media as a catalyst in challenging previously existing social norms with respect to individual flying behaviors. However, the findings illustrate that online media reporting not only addresses flight shame by nudging the demand (downstream) side of the sector, but also the supply (upstream) side (*see Figure 1*). Thus, to effectively manage the climate-related impacts of air transport operations, transformation must take place across industry firms. Nudging directed towards industry in online news media can be identified in various forms, including a focus on the disproportional impacts of aviation compared to other modes of transportation, highlighting the changes in market conditions, or a blatant accusation that the industry is not doing enough to manage its climate-related impacts.

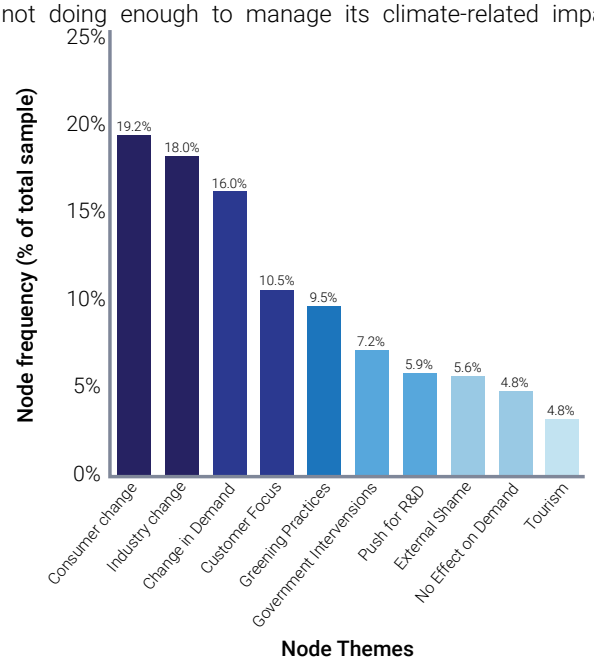

Figure 1. Prevalence of online news media node classifications by percent of total nodes coded.

While flight shame begins to influence consumer decision making, alternate means of transportation may become more attractive for individuals. However, the impact of flight shame on consumer demand for air transport is fairly limited beyond domestic air travel due to the lack of viable transportation alternatives for long-haul routes.[14,15] This limitation is re-enforced by society's deeply entrenched social and economic dependence on air travel, which acts as a barrier to any major changes to the demand for air transportation.[16] Ultimately, this evidence illustrates that although online media covering flight shame includes content that could act as a nudge for industry and consumers, the success of the flight shame movement is limited by several decision-making factors. These include an absence of viable alternatives, individual failure to accept responsibility, and climate crisis denial.[17]

Due to its novelty, the long-term influence of flight shame remains unmeasurable. However, a recent survey conducted by UBS Bank assessed 6000 individuals within the UK, Germany, France, and the USA on personal flying behavior.[18] This survey

identified that 21% of respondents have reduced their personal amounts of flying, which demonstrates that some individuals are transitioning away from using air transport.[19] Although some media content describes shifts in global air transport demand, these articles are largely focused on particular market segments in Europe, such as Sweden, Germany, and Norway, where reductions in domestic passenger air travel were recorded in 2019 relative to years previous.[20,21,22] While online news media may encourage a reduction in the use of air transportation, additional research is required to draw significant links between flight shame and changes in industry demand.

Beyond the consumer, online news media frequently uses shame as a method to criticize the lack of effort placed towards meeting emission targets set by the International Air Transport Association. This technique has the potential to encourage firms to boost initiatives that focus on emissions reduction, which could increase the attractiveness of flying to eco-conscious travelers. The results of the analysis propose that regardless of online news media content, the nudging potential of flight shame placed upon the air transport industry and consumers is limited. Thus, I suggest that alternative nudging strategies be used in combination with regulatory intervention in order to create effective reductions in air transport emissions while empowering consumers as active agents of social change.

The originality of this study as it pertains to nudging pro-environmental behavior by shaming, marks an exciting beginning of future research in recognizing the correlation between growing social expectations and behavioral changes in flying. As society witnesses upstream and downstream shifts in air travel, it is vital that the research community continues to examine this subject in order to assess the associated environmental benefits in the form of emissions mitigated from a shared reduction in flying. As this study concluded, collective action has the potential to impact societal norms and turn the dial within the realm of air travel and beyond.

About the Author

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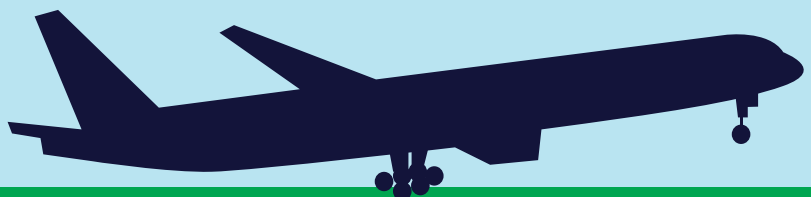
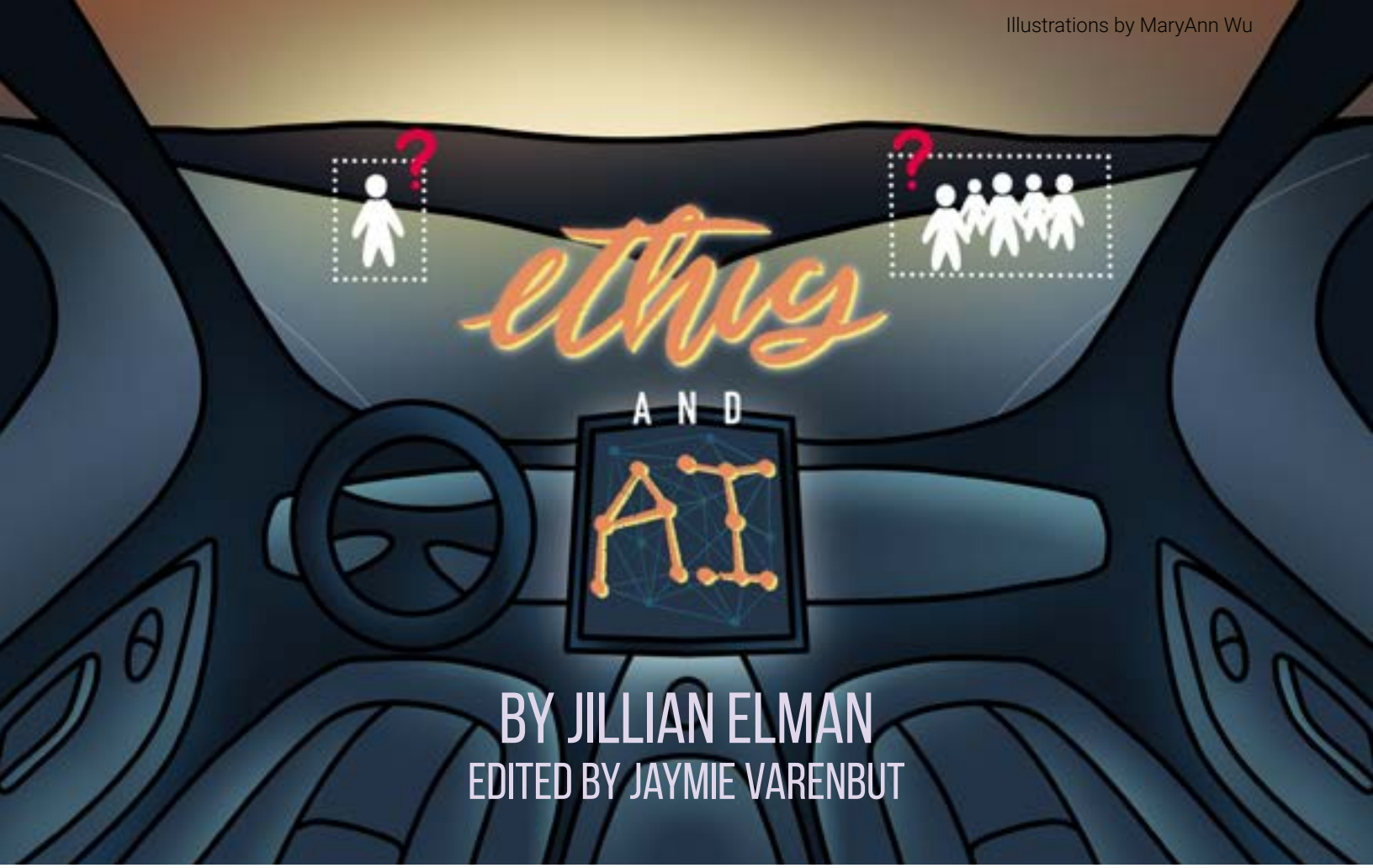


Illustrations by MaryAnn Wu



BY JILLIAN ELMAN

EDITED BY JAYMIE VARENBUT

Artificial Intelligence (AI) is defined as any program that has the ability to perform a task according to an embedded instruction (an input). Machine learning is when the inputs are infinite, so the program must acquire the experience to determine the best course of action on its own.[1] The application of ethics to AI and machine learning with regard to autonomous vehicles can be explained through "The Trolley Problem." In this scenario, a train is on a track with five individuals tied down to it. There is a fork in its path, which would reroute the train to a track with only one person tied. The option to kill five or one individuals is up to the conductor. In the development of autonomous vehicles, there are two courses that programmers can take; (1) is to input all possible scenarios into the program before implementation and (2) is to use machine learning and teach the car to make these decisions itself.[2] In the former option, it is the developers that solve "The Trolley Problem" on behalf of the car and its passengers, whereas in the latter, the car will make the decision on its own.

Utilitarianism is a philosophical practice that involves taking the best course of action for the greatest number of people.[3] Option (1) is known as the utilitarian approach to self-driving cars, which would involve programmers always instructing the car to minimize the number of expected casualties (i.e. the trolley would change paths at the fork and kill the single individual, as opposed to the group of five). In a straightforward sense, this option is highly attractive, as it saves the most human lives. Many also struggle with the machine learning approach, as its mechanisms will never be entirely understood by humans and therefore, there exists uncertainty about their course of action.[4] However, there is a lot more to the problem than simply asking "should we kill one person or five" and the utilitarian approach is not as straightforward as it may seem. This approach can be challenged because it ignores context, vehicles have the potential to outsmart humans and it gives the engineers behind the algorithms the power to make decisions for consumers.

It is integral to consider the contextual questions a human would ask prior to drawing a conclusion to "The Trolley Problem." What if the single individual was a close relative or friend? What if the five individuals were participating in reckless behaviour and irresponsibly got themselves into this position? The possible answers to contextual questions are infinite and it is therefore necessary to equip autonomous vehicles to evaluate the context on their own.[2] Further, in reality there exist an infinite number of possibilities the vehicle could evaluate in addition to killing one or killing five. How much time is there to stop the car without harming the passengers? Is there a large, inanimate object the vehicle could hit instead? With experience, machine learning vehicles will become increasingly able to ask these questions and respond accordingly. It would be ideal for all autonomous vehicles to sync their software, so that only one machine will need to have the experience for all others to learn from. It is also necessary to operate the vehicles in a simulator for ample time, so that they can gain the experiences without harming real people.

Another challenge to the utilitarian approach is that machines may be able to outsmart the humans that program them. This is because they can process an abundance of data at an abundance of data at a speed that is unfathomable. For example, Google-programmed AlphaGo took a mere three days of observation

to defeat the world's master at Go—a human-designed grueling strategy game.[4] In the context of vehicles, this goes to show that machines have an unmatched ability to predict the probability of outcomes and consequences. One algorithm, the Partially Observed Markov Decision Process, is showing particular promise in helping machines predict the likelihood of a wider range of outcomes than just casualties.[5] Not to mention, autonomous vehicles are less likely than humans to be distracted, increasing their likelihood of avoiding "The Trolley Problem" in the first place.

"The Trolley Problem" is inherently difficult to solve and utilitarianism is just one of many ethical approaches. Another common approach is the Kantian approach, which relies on a code of moral conduct that cannot be altered, despite the outcome. If, for example, your code states that actively killing is less ethical than being a bystander to death, you would opt to stay on the path with five people.[6] This is not to argue that Kantian ethics are better or worse, but rather to raise the point that there are a multitude of stances. Programming cars with the utilitarian approach would force all consumers to abide by the same moral conduct (the conduct of the engineers).

In summary, infinite contextual questions, the intelligence of machines and the multitude of moral philosophies are all valid challenges to embedding the utilitarian approach in the algorithms for autonomous vehicles. While the idea of causing as few casualties as possible is of course attractive, there are many complex factors involved in this decision and the answer is not as clear-cut as it seems. Instructing the vehicles to always kill one person instead of five people inhibits the vehicles from processing other options and learning to deal with more complex situations. "The Trolley Problem" is a major oversimplification of reality but stands to show that even the simplest of instances entail many questions, contexts and approaches to consider.

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Jillian is working towards her Master of Management of Innovation degree and is a Chemical Engineering graduate from Queen's University. She is currently interning as a Technical Associate at GlaxoSmith Kline. In this role, she is using her technical and business acumen in tandem to drive positive change in the healthcare space.

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By TAYYAB PIRZADA
Edited by JOSH DUBE

BIOTECHNOLOGY INNOVATIONS

TO DEFINE THE 21st CENTURY

Modern medicine has significantly improved human life expectancy beyond our wildest dreams.[1] In the next few decades, hopefully it will improve our life expectancy even further, improving clinical outcomes for severely debilitating diseases such as cancer, heart attacks, strokes, and Alzheimer's disease. Some of the most promising innovations in medicine include CAR-T cell therapies, antibody-drug conjugates to fight cancer, revolutionary gene technologies such as Crisper Cas-9, and medical devices such as regenerative bone scaffolds.

Illustrations by Ariadna Villalbí

Biopharmaceutical Therapeutics

CAR-T cell therapy is a ground-breaking novel way of fighting treatment-resistant cancers like leukemia, initially developed by the biotechnology companies Novartis and Gilead. In this form of treatment, some of the patient's white blood cells (T cells in particular) are physically extracted from the patient (a process known as 'leukapheresis'). The patient's cells are then genetically engineered in a laboratory to carry a chimeric antigen receptor (CAR) on the cell membrane to attack cancer cells, and then are re-inserted into the patient.[2] This type of therapy has thus far shown amazing results in hard-to-treat cancers like leukemia, with clinical trials showing remission rates of up to 94% of patients – which is surprising considering that patients enrolled in such studies are non-responsive to other available therapies.[2] However, there are some safety concerns with CAR-T therapies currently on the market, with side-effects like neurotoxicity and cytokine release syndrome being reported on occasion, and certain late stage CAR-T clinical trials leading to patient deaths.[2] However, biotechnology companies like Collectis are working to develop safer versions of the therapy, and in the future we can expect the biotechnology industry to further refine CAR-T to the point that it may possibly become the standard treatment for leukemia.

In addition, antibody-drug conjugates show promise in the oncology sphere. Normally, chemotherapy presents a risk to the patient due to the fact that the drug compounds themselves are cytotoxic even to healthy tissue.[3] A novel workaround for this is the antibody-drug conjugate, a pairing of antibodies with toxic anticancer drugs that allows for precise targeting of the anticancer drugs to the tumor cells while limiting toxicity elsewhere in the body.[4] This presents a far superior approach to fighting cancer than the current standard of care, namely chemotherapy alone. Due to this, the market for antibody-drug conjugates is predicted to be upwards of $15 billion by the year 2030, outlining its remarkable foray into the biotechnology industry.[5]

Gene Technologies

CRISPR Cas-9 (known as 'Crispr' for short, and 'Clustered Regularly Interspaced Short Palindromic Repeats' in full) is a revolutionary gene-editing tool that may change medicine as we know it. Crispr works by allowing for bacteria to edit out pieces of DNA in a gene segment, representing one of the most revolutionary breakthroughs in biotechnology today.[6]

In the Crispr system, a virus infects bacteria by injecting DNA or RNA into the bacterial cell, which responds by releasing Cas9 — a nuclease — to take a snippet of the RNA and store a 'genetic memory' of the infection, allowing for future defense against infection from the virus. Crispr works in a similar way, whereby it consists of bacteria that utilize the Cas9 nuclease to snip out DNA or RNA strands, and then replace the strands with a DNA strand of our preference.

This technique holds great promise in being used to simply delete problematic DNA fragments within genes and potentially eradicate disease at the root. Animal studies are already showing its curative application for diseases such as type 2 diabetes[7], Duchenne muscular dystrophy[8], and cervical cancer.[9]

Medical Devices

In the world of medical devices, regenerative bone scaffolds present far-ranging applications in orthopedics and sports medicine. These tissue scaffolds are biodegradable, highly porous 3D structures made of polymer fibres engineered to allow for tissue growth inside them.[10] The scaffolds are surgically inserted into injured bone tissue – often with the addition of osteoblast proliferative drugs – and eventually dissolve into the blood to be replaced by new, healthy bone tissue.[11] The scaffolds can be generated in a number of ways using techniques such as selective laser sintering and stereolithography, but the most popular method is via additive manufacturing or 3D printing.[11]

The scaffold works by allowing damaged cells to attach to it and rebuild missing tissue (e.g. bone) through pores in the scaffold. Growth factors and drugs may also be applied to the scaffold to further stimulate growth. Eventually, the scaffold degrades and is absorbed by the body. This is because the goal of the scaffold is not to serve as a permanent implant, but instead act as a support structure to allow regenerative tissue growth. The rate of degradation should correlate roughly with the rate of cell growth, so as to prevent premature degradation.[10]

Regenerative scaffolds are made of biopolymers (e.g. proteoglycans, collagen fibres) or synthetic polymers (e.g. polylactic acid (PLA), or polyglycolic acid (PGA)).[10] Biopolymer scaffolds present the benefit of being biocompatible with natural

bone tissue while promoting its growth, however, it is difficult to control the rate of degradation of such scaffolds. On the other hand, synthetic polymer scaffolds may be easily controlled in relation to their degradation rate but may not be as biocompatible. Scaffolds can also be constructed as composites of biological and synthetic materials.[10]

With such scaffolds, we can envision a world where athletes who are injured may not need more than a month to heal injuries that were previously viewed as career-ending. Beyond this, the technology has numerous potential commercial applications. In 2018, the global orthopaedic implants market was valued at $45 billion USD, and is expected to reach $66 billion USD by 2025 due to a combination of an aging population, and the high prevalence of sports injuries and accidents.[12] Bone scaffold technology occupies $610 million USD of that market as of 2015.[13]

There are also currently a number of bone scaffolds already on the market, such as Pro-Dense (Wright Medical Group), which is the first injectable calcium phosphate-calcium sulfate composite bone scaffold (FDA approved in 2006)[14], and Healos (DePuy Orthopaedics) - a scaffold made of collagen coated with hydroxyapatite used for spinal fusions.[15]

Future of Medicine

In summary, we live in exciting times when it comes to medical treatment. In the next couple of decades, biotechnology will bring humans to new heights— whether it be through treating knee injuries, or eradicating cancers altogether – through methods such as CAR-T therapy, or antibody-drug conjugates.

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Tayyab is a medical consultant at EVERSANA, a life science firm. At EVERSANA, he helps leading pharmaceutical companies guide new therapies into the hands of patients who need them. Tayyab is an MBiotech candidate at the University of Toronto, Mississauga, and also holds a BSc in Neuroscience from the University of Toronto. He is passionate about healthcare, biotechnology, and neuroscience, and is excited by the future of medicine.

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Illustrations by Amy Haddlesey

THE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE LABOUR MARKET

BY BRANDON VERKERK

EDITED BY KELLY GONCALVES

Introduction

We are living in a time of astonishing transformations from digital technologies and artificial intelligence (AI) – profoundly beneficial transformations that revolutionize our choices and freedoms.[1] For organizations, AI not only benefits labour costs, operating costs and asset life extension, it also allows for significant increases to scale and production speed. For example, Toyota halved the time it took to move from product design to production, while Nissan reduced their machine downtown by 40%, trading minimum investment for massive economies of scale.[2] Although accelerating AI adoption is vastly improving efficiency and creating value for firms, it is also transforming the nature of labor-intensive industries. While many jobs are at risk of displacement by developments in AI, others will stabilize with a need for human performance.

Changing Landscape

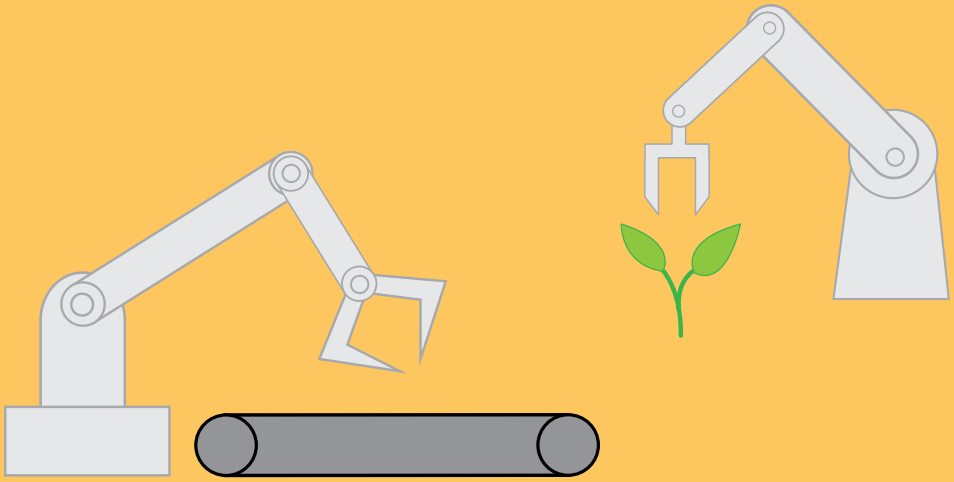
For the first time in history, AI advancements and digitization are enabling machines to perform complicated tasks requiring judgment, perception, and reasoning. Economists, technology leaders and futurists have long warned that developments in AI will permeate throughout our daily activities during the next decade. The fear of job displacement is not new; however, reductions in demand for human labor and adverse employment effects are quickly dominating debates as AI evolves to capture and process information and tasks formerly considered too abstract and complex to automate.

While some argue that AI is no different than any other technological innovation, select empirical findings validate the threat of digitization replacing human jobs. In 2019, McKinsey & Company experts demonstrated that up to 33% of all current work activities are displaceable by 2030. Varying by region, Canada and the US are projected to experience greater effects than developing countries due to higher wages and more opportunities for industrial efficiencies creating more incentives to automate.[3] Supporting this forecast, the World Economic Forum's Future of Jobs Report suggests that over 50% of all work activities will be performed by machines compared to 29% today.[4] Understanding the distribution of this effect across industries is critical.

Labour Displacement

The displacement of jobs most susceptible to automation is expected to occur at a quicker rate in countries with developed economies and high wages like Japan, Canada and Germany. In contrast, jobs that require unpredictable physicality, specific expertise, interaction with others, coaching, management, or a high degree of social and emotional skills will be less susceptible to displacement from automation.

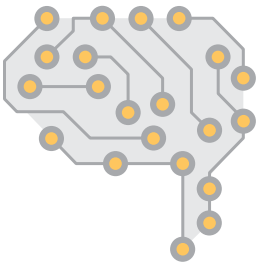
It is anticipated that the two industries with the highest number of predictable physical jobs– manufacturing and farming—will witness a large displacement of workers as the adoption of automated machines and robotics continue to advance rapidly. From 2013 to 2018, the number of industrial robots nearly doubled from 1.2 million to 2.3 million, and this figure is expected to reach over 3.2 million by the end of 2020.[5] Furthermore, a study conducted by the Oxford Martin Programme indicated that nearly 50% of U.S. industrial manufacturing jobs risk being lost to computerization over the next two decades.[6] Historically, technological advancement has gradually shifted



employment trends in these two sectors. US manufacturing fell from 26% total employment to under 10% from 1960 today while US farming fell from 60% to less than 5% of total US employment from 1850 to today. These historical trends seem likely to continue as the sector becomes increasingly automated.

Labour Growth and Shifts

Beyond job displacement by automation, the World Economic Forum estimated that 130 million newly created roles could compete with the 75 million expected to be displaced from AI by 2022.[4] Under the current market, impacted by COVID-19, these numbers may be erroneously overinflated; however, the optimistic perspective of long-run, pre-pandemic growth and stability remains. In the short run, COVID-19 and social distancing precautions are predicted to catalyze AI adoption, shifting societal preferences towards safe interactions, products and environments. For example, there has already been a strong surge in sales for robots to optimize warehousing, disinfect hospitals and fulfill retail transactions.[7] Typically, this type of automation is more quickly adopted during economic downturns, such that firms treat recessions as a time of 'cleansing' to restructure their production and operations in alignment with technological change. These recession-induced investments in productivity enhancements are attributable to a decline in opportunity costs, a shift in managerial attention from growth to efficiency, and the costs and benefits associated with layoffs.[8]



Just as Brynjolfsson and McAfee allude to in The Second Machine Age, in a rational economic system, humans are expected to occupy more jobs where they have a comparative advantage over computers and machines. Deloitte's examination of this assumption unsurprisingly suggested that computers are less capable of managing people, applying expertise and communicating with others. Further, they stated that humans will continue to perform work that requires more advanced cognitive capabilities like logical reasoning, creativity, social skills and developing emotional connections for the foreseeable future.[9] This divide is primarily due to key limitations: while machines can learn a wide variety of tasks, they struggle with contextualizing information, improvising, and comprehending basic humanistic characteristics and emotions like sarcasm or love.

For those occupations that seem safe from automation, including categories such as care providers (doctors, nurses, elderly and childcare workers), teachers, managers and executives, professionals (engineers, scientists and academics) as well as technology professionals like computer specialists and engineers, it is likely that continual development of skills such as communication, creativity, and teamwork will be required. Highly technical fields such as data science and analytics are not excluded (Exhibit A).[10]

Although occupations like these will likely continue to be performed by humans, it is expected that there will be large shifts in the quality, location, format and stability of roles. As an example, digital capacities are allowing for more flexible scheduling, hours, increased occurrence of self-employment, and less time spent between jobs due to digital job matching platforms. Combined, these changes will be magnified with social distancing measures and are expected to make labour markets more fluid, transparent and mobile.[11]

Adaptation and Education

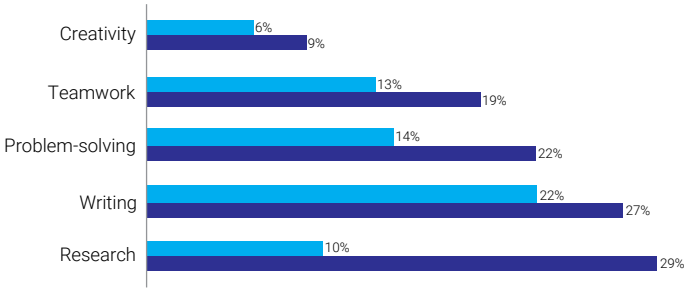
An interesting correlation that ties all of these examples together with the level of expected displacement is the associated educational requirements for the occupation. Taken from a 2020 report from the US Bureau of Labor Statistics, as the level of education increases, the rate of automation potential decreases (Exhibit B). For example, the technical automation for jobs requiring no high school diploma is 55%; with a college diploma it is 52%; and with an undergraduate or graduate degree, the potential significantly drops to 22%.[12]

With correlations like these, it is clear how important of a role educational attainment plays in this shifting labour divide. Often referred to as the "challenge of our time", businesses in all industries will need to take a proactive approach and support their existing workforces through continuous education, reskilling and upskilling as employment demands change and the adoption of technology increases.[13] Education efforts must also leverage the initiative of individuals to further their own development, and gain governmental support in enabling a dynamic workforce. Simply put, the fate of our workforce is dependent on a network of stakeholders with the potential to support workforce shifts

across industries due to AI and automation. The technology is here to stay, and employees and firms must all adapt to survive.

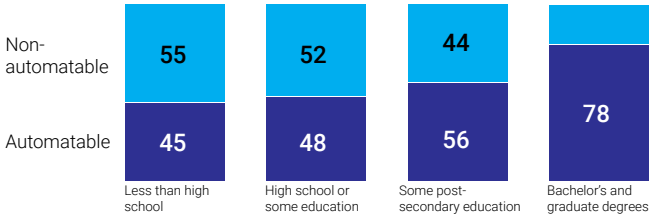
Appendix

Exhibit A: Soft Skills required by Data Science and Analysis Jobs vs. All Jobs



Source: Matt Sigelman, "By the numbers: The job market for data science and analytics," Burning Glass technologies, February 10, 2017

Exhibit B: Technical Automation Potential (%) of Work Activities by Education Level [22]



Source: Mckinsey Global Institute (2017), Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation, McKinsey & Co., December 2017

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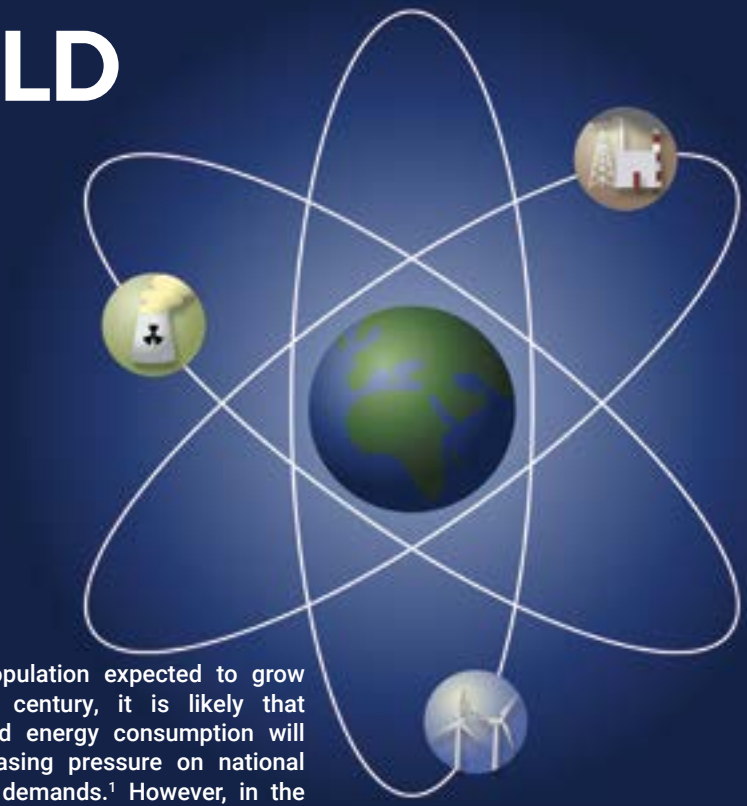
WHY NUCLEAR ENERGY IS CRITICAL FOR A NET-ZERO WORLD



With the global population expected to grow significantly this century, it is likely that demand for energy and energy consumption will increase, placing increasing pressure on national utilities to meet those demands.[1] However, in the context of climate change, achieving meaningful reductions in greenhouse gas emissions (GHG) emissions by pursuing decarbonization and cleaner forms of energy production is of paramount importance. Hence, governments and businesses must consider the future of energy production and how best to achieve low levels of GHG emissions while, at the same time, meeting growing demand in energy from a growing population.

BY RAGURAM BHASKAR

EDITED BY JASMINE RUSCICA

Illustrations by Athbah Almuhairi

Nuclear power can play a critical role in the global transition from fossil fuels to renewable energy sources, filling gaps in the power grid due to decommissioned fossil fuel power sources, as well as supplement renewables during times of low output to meet the power requirements of the grid. Both the International Panel on Climate Change and the International Energy Agency (IEA) recognize nuclear power as a viable alternative to fossil fuel-based energy production.[2] In fact, the IEA estimates that nuclear energy needs to double globally in the next 20 years if we are to limit global warming to the 2-degree Celsius target adopted by signatories to the 2015 Paris Agreement.[3] Yet, many young people are not aware that nuclear power is a 'low-carbon' energy source.[4] It seems the discourse around climate change mitigation does not give enough attention to nuclear energy. The purpose of this article is to showcase the advantages and disadvantages of nuclear energy, as well as to highlight why governments should consider a future with nuclear energy. While some countries have committed to maintaining, expanding, or introducing nuclear industries, others have capitulated to political pressure from anti-nuclear movements, opting to phase out nuclear energy entirely. Given the need for the global community to mitigate climate change, it is unwise for nations to pursue nuclear phase-out strategies. Achieving 100% renewable energy generation is often touted as the ultimate goal in our global battle against climate change. While that scenario is ideal, renewable energy still has some way to go before it can be considered a stable and secure source of energy. In the last decade, prices of solar panels and wind turbines plummeted as global uptake of renewables surpassed IEA forecasts 10 times with $2 trillion invested into solar and wind infrastructure.[5] Yet, these developments achieved only incremental improvements in decarbonization and added very little electricity to the grid. Carbon intensity, the amount of emissions per unit of energy consumed, only declined by 4%.[5] The suboptimal performance of renewable energy technologies can be attributed to the intermittency of solar and wind, which also raises the cost of electricity and diminishes the benefits of renewables.[5] Moreover, renewable energy requires a greater amount of space and operates at 20% of its capacity while nuclear reactors can fit into large buildings and operate at 93% of their

capacity.[6] Hence, renewable energy is said to be more "volatile" and "unpredictable" than nuclear energy since it cannot guarantee energy security and electricity supply "in times of peak demand".[7] Nuclear energy, on the other hand, provides a low carbon base-load energy source that can aid in climate change mitigation and greatly reduce GHG emissions from energy generation.

Although nuclear energy generates clean and low carbon power, the production of radioactive waste—which needs to be safely stored for an indefinite period— and the potential for radioactive contamination from leaks or nuclear accidents, present major challenges that may hinder the expansion of nuclear energy.[8] Opponents of nuclear energy are especially concerned about the management of radioactive nuclear waste, as no successful method to dispose of such material has been found.[9] As of 2015, the Canadian nuclear industry has produced more than 2.6 million bundles of highly radioactive spent fuel that is temporarily stored on-site at nuclear power reactors awaiting a more permanent solution.[10] Besides radioactive nuclear waste, anti-nuclear activists are also concerned about the continued operation of nuclear reactors and their effects on public health and safety. However, Reinhard Wolf, Professor of International Relations at Goethe University, concludes that radiation emitted by nuclear reactors is 100 to 1000 times less than "natural background radiation", noting that other epidemiological studies have not provided convincing evidence that communities living near nuclear reactors are more susceptible to health risks.[2] The hazards of nuclear accidents are also concerning to the public. The Chernobyl accident was a result of deficient "Soviet nuclear safety, technology and transparency standards".[11] It was also estimated by the World Health Organization to have caused 9,000 cases of cancer.[2] Fukushima uprooted entire communities and required an enormous amount of money to decontaminate the area.[6]

Despite concerns stemming from these accidents, Ontario continues to rely heavily on nuclear energy, with the industry contributing 61% of the province's electricity production in 2019.[12] In 2006, then Ontario Premier, Dalton McGuinty, pledged to phase out highly pollutive coal-fired power plants, seeking instead to install two new nuclear plants and to expand existing nuclear plants to reduce GHG emissions and provide for increasing energy demands.[13] This energy transition resulted in an 87% decrease in GHG emissions between 2005 and 2015.[14] Germany's energy transition, on the other hand, contrasts greatly with that of Ontario. After announcing US$4.45 billion in subsidies to refurbish the country's nuclear plants in 2010, German chancellor, Angela Merkel, retracted this decision due to the Fukushima accident. Anti-nuclear demonstrations incited by the accident prompted the government to commit to phasing out all NPPs by 2022 and to attain 80% renewable energy by 2050.[15] While the renewable energy industry in Germany is strong, the country cannot rely solely on renewables just yet. In fact, as nuclear reactors are decommissioned, fossil fuel generated power will have to ramp up to compensate for the reduction in power from nuclear reactors.

This decision neglects the advances in nuclear technology, with newer reactor designs incorporating passive safety features that deploy in the event of an emergency and innovative designs for offshore floating plants that are able to evade natural disasters.[16] The emergence of thorium as a viable nuclear fuel has also been found to produce much less nuclear waste than the conventional uranium fuel cycle.[8] Innovation in nuclear technologies has the potential to make nuclear power plants safer and more efficient. A nuclear phase-out, however, undermines the potential of advancing technologies and must be avoided if we are to successfully mitigate climate change.

About the Author

Raguram is in his second year of the Master of Science in Sustainability Management program at University of Toronto. Having co-chaired UTM Sustainability Week 2020, he is passionate about creating dialogue and engaging students at University of Toronto on the topic of sustainability. Ragu is also an advocate of nuclear power and believes that not enough attention is given to the potential that nuclear energy has in the global effort to mitigate climate change.

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CAN INNOVATION BE 'USED UP'?

BY KELLY GONCALVES
EDITED BY AMANDA VRBENSKY

Illustrations by Chloe (Xiaoyi) Ma

Innovation: an extremely high-level overview

Today, definitions of the word 'innovation' are plentiful. Whether it relates to a product, a process, or a business model, there is one thing that an innovation is NOT: an invention. An invention is widely regarded as something that has never been made before, often patentable.[1] While innovation requires novelty and could stem from an invention in some cases, it is more often regarded as a process-based, iterative cycle.[2] Generally, innovation has been said to flow in stages; idea generalization and mobilization, advocacy and screening, experimentation, commercialization, and finally diffusion and implementation. Screening is the systematic evaluation of ideas where those that lack potential are rejected.[3] The final step, diffusion and implementation, is critical to understanding innovation, according to the perspectives of Erik Brynjolfsson and Andrew McAfee, faculty at MIT Sloan School of Management and authors of The Second Machine Age.

> ***"Generally, innovation has been said to flow in stages; idea generalization and mobilization, advocacy and screening, experimentation, commercialization, and finally diffusion and implementation."***

A Snapshot of The Second Machine Age: Recombinant Innovation

The Second Machine Age (2014) dives into a fascinating exploration of the impact of digital technologies on humanity and the economy, and what may come next. As they argue, innovation is fundamental to productivity growth (the increasing output per worker over time).[4] As such, the relevance of diffusion and implementation in the innovation process becomes apparent. To maximize the potential productivity growth resulting from a given innovation, it seems logical that the likelihood of achieving this would relate directly to how widely it is adopted. This was true of the innovations of the Industrial Revolutions that accelerated economic progress so drastically that they were classified as General Purpose Technologies (GPTs): pervasive, improved over time, and able to spawn innovations.[4] These were the steam engine, electricity, indoor plumbing, running water, and internal combustion engines, to name a few. However, Brynjolfsson and McAfee present the point of concern that perhaps productivity growth, since these great one-off innovations, has slowed markedly. Indeed, since the 1970s, the radical and disruptive innovations central to progress were largely traded for mere marginal improvements.

This is where their debate comes into play. Brynjolfsson and McAfee argue that despite low productivity statistics in recent years, the world is not entering into a longer period of stagnation. Rather, they define the second machine age as having sustained exponential improvements in computing, extraordinarily large amounts of digitized information, and recombinant innovation, as well as revolving around a critical GPT: information and communication technologies (ICTs). The reason for this is three-fold: innovation is recombinant, current GTPs are immature, and GDP may not suffice as a growth metric during the Second Machine Age.[4]

1. Contrasting Views: innovation-as-a-building-block versus innovation-as-a-fruit

The way in which new innovations are perceived is critical to this conversation. If innovation is considered like low-hanging fruit, without a steady stream of new innovations to sustain high economic growth rates over time, GDP growth will peter out. This view perceives that the benefits of ICTs have already been captured and 'used up', leaving questions as to what lies next in society's pipeline for innovation. Conversely, the building block or recombinant view of innovation perceives that innovation creates growth by rearranging existing resources (building blocks), to make them more valuable. Recombinant innovation views ICTs as a creator of accumulating progress and ideas as building blocks. With exponentially increasing capacity to create and filter ideas, our growth is only limited by our ability to identify valuable combinations. ICT-based tech companies are a clear demonstration of continual economic value-creators that contribute to productivity growth. For example, Apple is quoted as a master assembler that reserves its creativity for the novel recombination of existing technologies.[5] To innovate, tech giants often aggregate and integrate the innovative efforts of other organizations into one of their own.[6] In the era of ICTs, an extended period of economic stagnation seems unlikely if ideas continue to be created and combined, and value is captured efficiently and effectively.

2. GTPs today are still immature

For the true effects of an innovation to be realized, time is required for complementary innovations and investments to arise. The sooner we achieve efficient processing ideas, the sooner growth will improve. Brynjolfsson and McAfee's second argument stated that complementary innovation requires time to develop. This was true in the case of steam engines, which eventually revolutionized land travel, and with electrical power, leading to improvements in manufacturing by lighting factories and office buildings. These changes improved the quality of work conditions, the number of operational hours and output from a single factory, all of which increased productivity. The same must be the case for ICTs. A clear complementary innovation to ICTs is the internet of connected things (IoT), machine-to-machine communication technologies as a series of networked smart devices equipped to communicate.[6] The IoT is a recent improvement since ICT's 1970's inception but is already projected to generate anywhere from $2.7 to $14.4 trillion in economic value globally by 2025.[7]

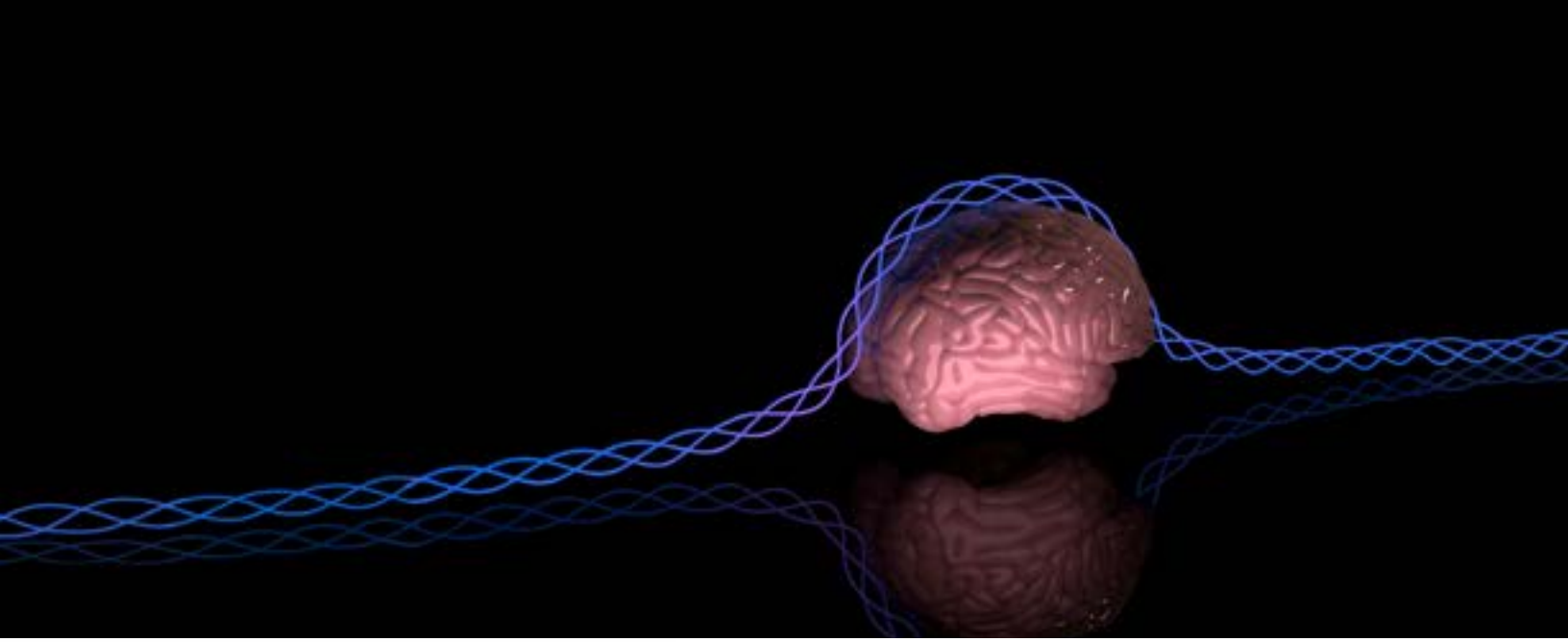
3. The relevance of GDP

GDP per capita serves as the primary measure of economic productivity. However, Brynjolfsson and McAfee's final argument suggests that GDP in the second machine age is an imperfect measure of economic growth or overall wellbeing. Leading economists agree with this claim and believe that GDP can not sufficiently detect change when ideas are prioritized over things.[8] GDP has limitations, such as when cost decreases due to efficiency, convenience or lower transaction costs, which ultimately lowers GDP. Additionally, GDP does not account for growth in consumer surplus—the value added to our wellbeing from efficiency, convenience and lower transaction costs—or intangible assets such as patents or trademarks. These ever-growing components of the knowledge economy are more

difficult to quantify, and have been estimated to add over $2 trillion to the US economy's capital assets.[9] Without improvements to how we measure productivity growth, every new complementary investment or innovation has the potential to distance estimates from reality. The World Economic Forum has gone so far as to develop an entire series titled Beyond GDP, advocating for alternatives to this metric, spearheaded by leading world experts.[9]

Summarizing the Conversation

Based on their arguments of recombinant innovation, the immaturity of current GTPs and complementary innovation, and the future relevance of GDP, Brynjolfsson and McAfee argue a strong case for sustained economic growth due to ICTs. Only time will tell what the next decade of innovation will bring, but it seems inevitable that innovation will be essential to address the complex problems looming over the future of our global society, such as possible food, water, and climate crises. It seems safe to say that innovation will drive the steady growth of our economy in spite of these challenges.



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Kelly is a student in the MMI Class of 2020 at the University of Toronto. Prior to the MMI program, she completed a BScH degree in Life Sciences concurrently with a certificate in Business from the Smith School of Business at Queen's University. Kelly is a curious and creative problem-solver, keen on driving tangible impact through her work. Professionally, she is interested in innovative business strategies and management practices, leveraging storytelling to communicate data-driven insights, and cross-industry collaboration.

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"Only time will tell what the next decade of innovation will bring, but it seems inevitable that innovation will be essential to address the complex problems looming over the future of our global society, such as possible food, water, and climate crises. It seems safe to say that innovation will drive the steady growth of our economy in spite of these challenges."

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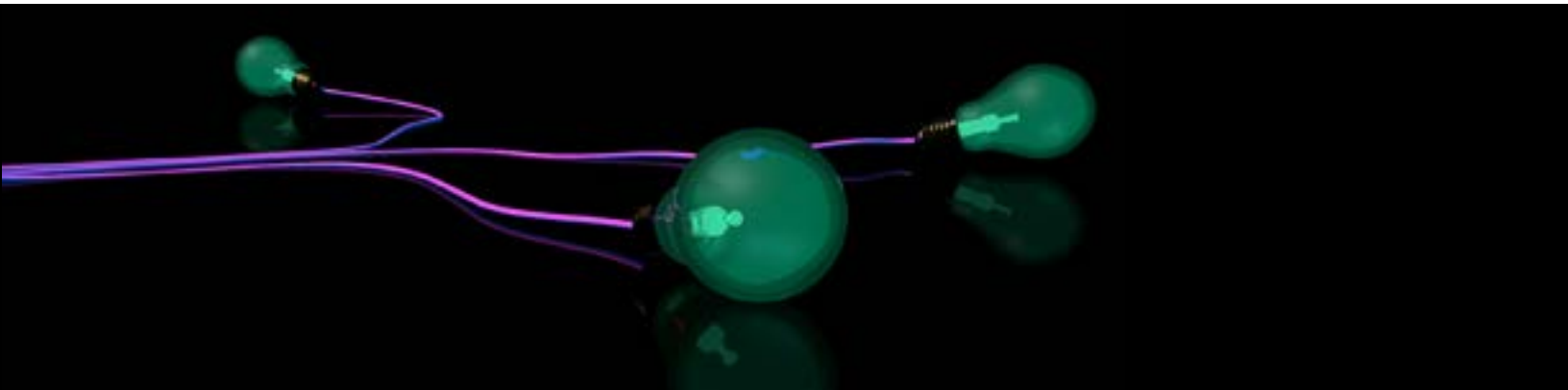

LOST IN TRANSLATION:

HAS THE TERM 'SUSTAINABILITY' EXHAUSTED ITS PURPOSE?

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There is no doubt that language has the unique capability to influence thoughts and perceptions and thus serve as a medium through which those very thoughts and sentiments can be communicated. Many of us have the ability to think in one universal language, but what happens when we reach the end of our knowledge of the English vocabulary? Are our thoughts and feelings then condemned to be "constrained by the words we use"?[1] While the language of our respective ancestors continue to live inside many of us, how many are there to actually understand and listen? In fact, are we ourselves, capable of listening to others in the same position who have a river of wisdom flowing within them but are restricted by 26 alphabets and around 170,000 words that are in current use[2] – some of which are never even learned within a person's lifetime. Is the English language failing us and our ability to express ourselves? Take the word 'love' for instance. There are 96 words for it in Sanskrit, 80 in ancient Persian, around 18 in Urdu, three in Greek, but only one in English.[3] When a person claims to 'love' their significant other, to 'love' the taste of melted chocolate, to 'love' their dog, to 'love' their country, to 'love' the smell of Hydrangeas, to 'love' binge-watching Peaky Blinders, are they claiming to hold the same level of sentiments for each of these entities? Surely, some hold more weight and importance than others. Thus should people not be entitled to have variations at their disposal, having the ability to pick and choose which word better expresses the 'type' and 'intensity' of emotion they are feeling at a particular moment in time? Speakers of certain languages have the ability to view the world "in a way that is dissimilar to other languages".[4] According to the literary critic George Steiner, when a language disappears from amongst us, the users of that language lose their ability to understand the world around them through the medium of those words.[5] Possibly, it is the ubiquitous and universal nature of the English language that has limited, or made it difficult for people to think of certain concepts through a different lens, and perhaps it is the lack of variety for particular words in this language that have resulted in many words slowly losing their meaning.

Dare I say that while simple terms such as 'love' and 'sorry' have lost their meanings due to over-use and limited alternatives, the increasingly-popular term 'sustainability',which is a more complex concept, has jumped onto the bandwagon too over the last couple of years. 'Sustainability' is derived from the root word of 'sustain' which originated in the 14th Century and literally translates to "endure without failing or yielding".[6] While 'sustain' is the action of maintaining, 'sustainability' refers to the ability of an entity to be maintained. In 1987, the United Nations Brundtland Report gave context to the idea of sustainability. They linked it to the idea of development, defining sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".[7] The UN's invitation to place sustainability and development in tandem has allowed corporations to latch on to the term and bandy it about freely into many different ways to the extent that the definition has become quite elastic.

The term has become a corporate weapon which allows most, but not all, organizations to use more resources to produce more goods under the banner of 'sustainability', thus defeating the purpose of working to revolutionize the current system using the resources already at hand. Corporations may have taken too much liberty in using the term, providing a false notion that anything to do with the environment must be sustainable. Let us not forget the addition of the term 'green' that is often used to accessorize sustainability claims. However while the term 'green' immediately directs attention to the environment, 'sustainability' lacks clarity as it can refer to a multitude of concepts that fall under the famous Triple Bottom Line approach of people, planet, and profit. The widespread use of a single term to describe multiple con-

cepts has resulted in the actual meaning of 'sustainability' becoming elusive to a majority of the public. This risks making the public disinterested and disassociated with what sustainability has to offer. According to a survey by Shelton Group, only 59% of consumers understood what sustainability actually referred to, while 76% considered it to be "expensive".[8] The term's overuse and misuse has resulted in it losing its "semantic strength"[9] resulting in "semantic satiation'. The area of our brain responsible for storing the term is "jammed by steady repetition" thus temporarily blocking the relation that we have created between the sound we hear, and the definition we associate with it.[10] It no longer holds enough power to influence radical change in behavior, and that is possibly why we are still struggling to keep the conversation going around achieving ultimate sustainability.

Sustainability has become a buzzword, even a 'plastic word' of sorts that is polluting our language.[11] The concept of 'plastic words' was introduced by German linguist Uwe Poerksen, to describe words that originate from the science and technology field and have become hollow due to a lack of definition.[12] Such words often sweep complex terms under the blanket of a broader word that often does little to define the complexities, but hold a lot of authority. It is safe to say that 'sustainability' has started to show a lot of the symptoms of becoming a 'plastic word' and if it is not re-evaluated, then it may soon be added to Poerksen's list of words—a list that is ironically compared to plastics in its detrimental impact on the ocean environment. It is high time that the word is snatched from the hands of politicians and corporations who are stringing it together with other meaningless words under the pretense of false promises to bring about change, while ultimately working to withhold facts. It is high time that the language and dialogue around sustainability be reframed to allow words that reinforce positivity and are able to better capture the essence of what it means to recreate the current system to last longer, whether that involves using the French word for sustainability; durabilité which translates into a more robust concept of growth, or the Arabic word, 'al estidama' which translates into a condition of continuity and permanence, as crutches.

"THE LIMITS OF MY LANGUAGE, MEANS THE LIMITS OF MY WORLD."

-Ludwig Wittgenstein

About the Author

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