DAKOTA DIGITAL REVIEW

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FALL/WINTER 2024-25

DAKOTA DIGITAL ACADEMY
NORTH DAKOTA UNIVERSITY SYSTEM

Introduction to the DAKOTA DIGITAL ACADEMY

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Digital transformation and the emergence of artificial intelligence (AI) are reshaping culture, education and the workplace. The Dakota Digital Academy (DDA), established by the North Dakota University System (NDUS) in 2020, aims to help North Dakota navigate this pivotal moment of both promise and challenge. As an alliance among North Dakota's research universities, regional universities, community colleges and affiliated tribal colleges, the DDA fosters collaboration and the cross-pollination of innovative online learning in computing, cybersecurity, and data and AI sciences. The DDA seeks to cultivate a critical mass of shared talent and resources across the state to address challenges and unlock opportunities related to digital transformation and AI that might otherwise be unreachable by any single institution.

Due to its small size, North Dakota has many advantages, such as greater access to institutions and leaders, as well as the organizational effectiveness stemming from interconnected social networks in a rural state. However, this small size can also pose challenges in attracting talent and establishing infrastructure in cutting-edge technology domains. Despite these challenges, the state has successfully nurtured competence in technology, with thriving software, ag-tech and bio-tech companies founded by a workforce largely educated through NDUS institutions. To ensure we win the future, we must pool our resources and collective will to prepare North Dakota's workforce for an AI-driven landscape.

The DDA collaborates closely with North Dakota's 11 public colleges and universities, including two research universities, four regional universities, and five colleges, along with the state's five tribal colleges. This partnership of talented faculty enables the design and delivery of innovative workshops, courses, targeted skill-specific training and certificate programs. The DDA is committed not only to enhancing the technical skills of professionals entering the workforce, upskilling people in the workforce, but also to improving continuing education and credentialing for K-12 teachers. Furthermore, the DDA supports ongoing statewide initiatives to incorporate digital literacy into general education curricula at all levels. North Dakota is leading this pioneering effort to ensure that our future workforce is computer and cyber literate, and the DDA is dedicated to supporting this initiative and keeping programs current in emerging areas such as AI.

North Dakota University System & Affiliated Tribal Colleges

- Bismarck State College
- Dakota College at Bottineau
- Dickinson State University
- Lake Region State College
- Mayville State University
- Minot State University
- North Dakota State College of Science
- North Dakota State University
- University of North Dakota
- Valley City State University
- Williston State College
- Cankdeska Cikana Community College
- Nueta Hidatsa Sahnish College
- Sitting Bull College
- Turtle Mountain Community College
- United Tribes Technical College

DAKOTA DIGITAL REVIEW

- **Dakota Digital Review** publishes articles, in print and online, about digitization and related technologies, as well as digitization's profound implications for our culture, economy, military, political institutions and policies, legal frameworks, moral foundations, and the arts and humanities.
- **Dakota Digital Review** is non-partisan, dedicated to free speech and academic freedom. The articles are written by subject experts in business, industry, government and academia for the general educated reader.
- **We aim to better prepare** students, faculty, fellow residents, and business, community and political leaders to make the critical decisions about our collective future and about our individual and family lives.
- Please contact Patrick J. McCloskey, Editor, Dakota Digital Review, for submissions, comments or questions: **patrick.mccloskey.1@ndus.edu.**

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Design / Jerry Anderson

UNPLUGGING GROWTH?

AI, the Cloud & Electricity Demands

MARK P. MILLS
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Author of *The Cloud Revolution*

The year 2024 will go down as the pivot when the growth in U.S. electricity demand reverted to normal. After a two-decade interregnum of no growth, many forecasters, including those in the electric utility industries, thought that was the new normal. Planning for a static future is quite different from meeting the needs of robust growth.

Now we find myriad power-demanding hot spots around the country, from Georgia and Virginia to Texas and California and a huge swath of the northeast, as well as states like North Dakota reporting radical increases in requests for power, and soon. In nearly every case, the demands that will materialize in the next one to three years vastly exceed current plans to build sufficient generating capacity, of any kind.

The reason for this surprise? If you believe the headlines and hype, it was because of the staggering electricity demands coming from the artificial intelligence (AI) boom. Thus we saw headlines echoing a new trope, such as "Can AI Derail the Energy Transition?"[i] With AI as the piñata for putting the "transition" at risk, Silicon Valley's potentates scrambled to explain what happened and to endorse—in some cases fund—new nuclear power ventures, as it quickly became clear that favored wind/solar power can't come close to meeting the scale of demand coming soon enough, reliably enough or cheap enough.

It is true that AI is very energy intensive, as chronicled in one of my previous articles in Dakota Digital Review: "AI's Energy Appetite: Voracious & Efficient."[ii] It's also true the emergence of more useful applications for AI tools is leading to a rapid increase in installations of energy-hungry data-center hardware. But, while AI is driving new demands for power, the reality is that conventional computing and communications—the existing Cloud—account for well over 90 percent of those forecasted rises in power demands.

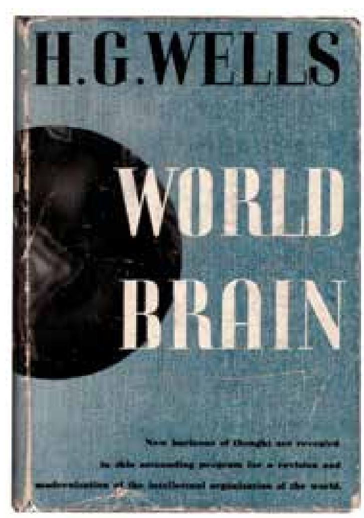
It is also true that other sectors boost electric demand including, though far less impactful, electric vehicles. The more relevant and big-demand wildcard is whether and how soon goals to reshore manufacturing will be realized. Of course, if AI delivers on its promises, economic growth across the board will be greater than earlier forecast. Then there'll be the old-fashioned 'problem' of economic growth itself boosting electricity uses.

AI is accelerating a trend that was already underway. In the coming decade, even as AI takes up an increasingly larger share of total digital power appetites, the uses of conventional silicon will also expand and are forecast to still account for more than 70 percent of total digital electricity consumption by 2030.[iii] And those expected digital demands are at scales shocking to local and state utilities and regulators everywhere. In North Dakota, The Bismarck Tribune reported near-term plans for a handful of new data centers that would alone consume as much power as all that state's residences.[iv]

This all distills to a rediscovery of a simple reality: Planners and policymakers need to refresh their views about how to meet society's electricity and energy needs based on *growth.* One thing is clear, if planners fail to ensure adequate supply, and there isn't enough electricity, then the growth won't happen. Planners and forecasters might want to know whether this is a bubble or a trend and, in the latter, just how much more global and local digital demand is yet to come?

"World Brain"

The idea of something as remarkable as a global, interconnected information and knowledge-supplying and knowledge-creating infrastructure is not new. Back in 1938, H. G. Wells's novel *World Brain* imagined such a thing during that era of revolutionary globe-spanning telephone and telegraph networks. A couple of decades later, in 1962, the Council on Library Resources launched a project to imagine the "Libraries of the Future" and asked MIT computer scientist J. C. Licklider to provide a technology roadmap, the same year that President John F.



H.G. Wells, *World Brain,* Methuen Publishing, 1938.

Kennedy made his famous "within this decade" moonshot speech.

Futurists of the 1960s were not only inspired by rocket ships but also by the arrival of the mass production of transistors, the proliferation of mainframe computers and the first communications satellites. In 1962, there were about 2,000 computers in the world, then a seemingly remarkable number given that, just two decades earlier, there were only two, the ones built secretly here and in England during World War II.[v]

The possibilities of a computerized "world brain" were clear to the prescient Professor Licklider, and he knew that it would be much more than a mere electronic "library," that it would be an information system. He also wrote that it wouldn't be possible without radical technological progress, including new inventions.[vi]

He was right. It turned out to be far easier and cheaper to put a dozen men on the moon, than to build an information infrastructure connecting, in real time, billions of people on earth. But now, global Cloud-centric information services businesses are approaching $1 trillion a year,[vii] built on tens of trillions of dollars of hardware, providing an entirely new classes of commerce, much more than libraries of cat videos or AI-created "deep fakes" for fun (and malicious meddling). At the core of that infrastructure are the massive data centers—the thousands of "warehouse-scale" computers, *each* consuming more power than a steel mill. For students of the history of technology forecasting, none of the futurists of only a few decades ago anticipated the nature and scale of today's Cloud infrastructure.

One thing that can be forecast today is that we're at the end of the beginning, not the beginning of the end, of building it all out. Since the Cloud is an energy-using, not energy-producing infrastructure, the implications are consequential. The future will see far more, and far bigger, data centers—the digital cathedrals of our time.

Data Centers as Digital Cathedrals

The world's first modern data center was built in 1996 by Exodus Communications in Santa Clara, California, a half-century after the first computer centers. The Exodus facility was a 15,000-square-foot building dedicated to housing the silicon hardware for myriad Internet Service Providers (ISPs).[viii] By coincidence, that year also witnessed a massive power blackout over seven western states, shutting down everything including already internet-centric businesses and services. That is, except for those ISPs that had equipment housed in the Exodus data center, which remained online with its backup power system, enshrining one of the key benefits and design features of data centers.[ix]

The term "data center" is an anemic one, failing to telegraph the nature and scale of how those mammoth facilities have evolved. It's a little like calling a supertanker a boat. The data center term evolved naturally from the early days of computing, when buildings had rooms called computer centers in which banks, universities and some companies placed mainframes. But when it comes to the physical realities of scale, including energy use, there is a world of difference between a shopping center and a skyscraper. So too data centers, more aptly skyscraper-class energy demands are, in commerce terms, the digital cathedrals of our time.

Civilization now fabricates more than 10,000 times more transistors annually than the combined number of grains of wheat and rice grown on the planet.

In 1913, the world witnessed the completion of the world's first skyscraper, the 792-foot-tall Woolworth building, then the world's tallest habitable structure. It had taken 600 years to best the 524-foot tower of England's Lincoln Cathedral (completed in 1311). Public awe wasn't only inspired by the height but also about the technologies—electricity, elevators, engines—that made it possible in the first place, and in particular the commercial implications of such structures. Hence, in 1913, The New York Times enthusiastically declared that building a "cathedral of commerce."[x]

In the three decades since the Exodus data center, the expansion and networking of digital cathedrals has led to the creation of an entirely new, and now essential infrastructure, the Cloud. It is an infrastructure that, even more so than in 1996, must be insulated from the vicissitudes of the (un)reliability of public power grids. But unlike skyscrapers, digital cathedrals are essentially invisible in daily life. That may help explain how easy it is to believe a popular trope that the digital revolution somehow promises a kind of dematerialization of our economy—that the magic of cyberspace, or instantaneous banking and advice (from mapping to shopping), has de-linked economic growth from hardware and energy use. It has not.

Just as skyscrapers grew in scale and proliferated in number, so too have data centers, but only far more so. There are more than 5,000 enterprise-class data centers in the world now, compared to 1,500 "enterprise-class" skyscrapers—that is, Woolworth-sized and bigger (in square feet).[xi] Smaller data centers number some 10 million.[xii]

In the U.S., the square footage of data centers—under construction or planned for the next few years—is greater than the entire existing inventory. Today's typical digital cathedrals is bigger by some tenfold, or more (in square feet) than those of three decades back. And each square foot of data center inhales 100 times more electricity than a square foot of a skyscraper.[xiii] The latter reality is intimately tied to the rise in computing horsepower, a trend that AI accelerated.

Because the Cloud is an information infrastructure, instead of square feet, one could count its growth and scale in terms of the metric of data traffic, the bytes created, moved and processed. Today, a few days of digital traffic is greater than the annual traffic of just 15 years ago. And the growth hasn't slowed; indeed, with AI, the appetite for and use of bytes has accelerated data traffic in a way that's impossible for the physical traffic of humans and automobiles. That unprecedented reality has implications when it comes to forecasting energy consumption.

The Woolworth Building, an early skyscraper at 792 feet tall in Lower Manhattan, was the tallest building in the world from 1913 to 1929, and remains one of the 100 tallest buildings in the U.S.

Energizing the Infrastructure

The energy cost to move one byte is miniscule and still shrinking, but there is an astronomical quantity of bytes. And the creation, transport and storage of bytes—that is, their physical and energy costs—rests with the power-using transistors that create, store and move bytes. Civilization now fabricates more than 10,000 times more transistors annually than the combined number of *grains* of wheat and rice grown on the planet.[xiv]

The nature of the Cloud's energy appetite is far different from that of many other infrastructures, especially transportation. For the latter, consumers literally see where 90 percent of energy is spent when they fill up their gas tank. (The other 10 percent or so is consumed in producing the hardware in the first place.) When it comes to smartphones or desktops, more than 90 percent of energy is spent remotely—hidden, so to speak, in the electron-inhaling, digital cathedrals and in the sprawling information superhighways.

The physics of transporting bits leads to a surprising fact: An hour of video using the Cloud infrastructure uses more energy than a single person's share of fuel consumed on a 10-mile bus ride.[xv] That leads, at best, to a tiny net energy reduction if someone Zooms instead of commutes in a bus, and a net increase if a student, say, Zooms instead of walking or bicycling to class. But the fact is there are exponentially more uses for Zoom and all forms of software services, than for replacing older energy-using alternatives.

Apps—application-specific programs—provide a window on the appetite for software services. The power of apps resides in the fact that an easy-to-use interface (on a smartphone) taps into, seamlessly and invisibly, the Promethean compute power of remote data centers to provide all manner of services and advice that have become a staple of everyday life for billions of people. There are already millions of apps competing to meet consumer and business needs and desires. Those services, in every sector of the economy, are what collectively drive the scale of data centers that aren't just measured in bytes or square feet, but now more commonly in megawatts and even gigawatts. Hidden from sight within *each* of the thousands of nondescript digital cathedrals, there are thousands of refrigerator-sized racks of silicon machines, the physical core of the Cloud. *Each* such rack burns more electricity annually than do 50 Teslas.

Back to the Future Normal

The global information infrastructure has grown from non-existent several decades ago to one now using twice as much electricity as the entire country of Japan. And that's a stale estimate based on the state of hardware and traffic of several years ago. Some analysts claim that as digital traffic has soared in recent years, efficiency gains have muted or even flattened growth in data center energy use.[xvi] But such claims face countervailing factual trends. Over the past decade, there's been a dramatic acceleration in data-center spending on hardware and a huge jump in the power density of that hardware, not least now with the advent of widely useful but energy-hungry AI.

How much more power the Cloud infrastructure will demand depends on just how fast innovators innovate new uses and services that consumers and business want. The odds are the pace of that trend will exceed the pace of efficiency gains in the underlying silicon hardware. The history of the entire century of computing and communications shows that demand for bytes has grown far faster than engineers can improve efficiency. There's no evidence to suggest this will change, especially now with the proliferation of AI, the most data-hungry and power intensive-use of silicon yet invented.[xvii]

The Switch SuperNAP 8 is the eighth data center at the Switch Core Campus in Las Vegas, Nevada. When completed, the campus will cover up to 3.9 million gross square feet with 495 MW of power. There are five Switch campuses across the U.S. with military-grade security.

As with all energy-intensive industries of every kind, ultimately any such business will seek to locate—to paraphrase the great Walter Wriston's aphorism about capital—"where it's welcome and stays where it's well-treated." For data centers, that translates into sufficient power, and soon, that's both reliable and cheap enough. Thus, we should expect to see the rising attractiveness of those great shale basins, from Texas to North Dakota, where the on-site surplus of natural gas can be rapidly translated into a surplus of digital power. ◙

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INTENTIONAL USE *of* SOCIAL MEDIA

TAKING OUR ATTENTION BACK *from the* ALGORITHM

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Can you read this article from start to finish without picking up your phone? The odds are against you.

Our devices are constantly beckoning us, our brains lighting up at the sight of notifications or the sound of our phone buzzing nearby. Even those of us who have resolved to avoid the distraction of our phones to be more present with family and friends still find ourselves spending large chunks of time on social media such as Facebook, Instagram and TikTok. We open the app without really thinking about it. We spend hours scrolling through content when we intend to spend just a few minutes decompressing from a stressful day.

The good news is that this behavior is not a personal failure on your part, as many people experience it. The bad news is that it is incredibly difficult to limit the use of algorithmically driven social media through willpower alone. We need deeper structural changes.

As a researcher, college instructor and parent, I spend a lot of time thinking, talking and writing about the social impacts of technology. In my research, I study how people integrate, negotiate and make rules for using new communication technologies, such as Zoom or TikTok. In my classes at North Dakota State University, I teach students how to use emerging technologies, such as ChatGPT and other AI tools more ethically and effectively.

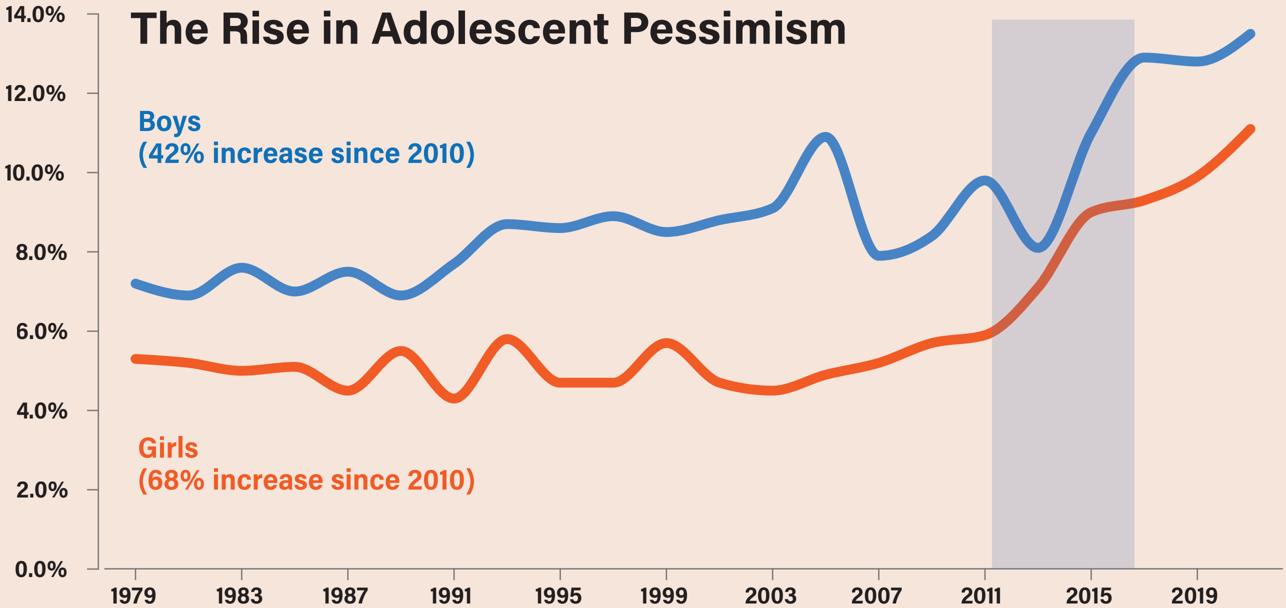
The impact of technology on young people is also personal for me—having two elementary-aged kids who love playing video games and watching funny cat videos online. Our family has frequent conversations about how to balance screentime with the other activities that help children learn and develop. My husband and I have learned to speak up when we feel we are competing with the phone for one another's attention. You may be having similar conversations with your children, partner or colleagues.

These everyday conversations on the promises and perils of new technologies reflect a broader societal turn from viewing mobile phones and social media as democratizing technologies that will empower all users. We are becoming more aware of the social costs we pay for living in a world of 24/7, user-generated content. In response to an increasing body of research linking social media use and rising rates of anxiety and depression amongst adolescents, the U.S. Surgeon General has called for warning labels on social media platforms. California is seeking to ban the use of phones in public schools across the state.

There may not be a direct correlation between social media and anxiety or depression. Many researchers studying the impact of social media on younger people point to how social media consumption and online interactions displace activities that are known to contribute positively to mental health, such as physical activity, spending time outside and interacting with others face-to-face. But the distraction of social media, its impact on our ability to focus or tolerate boredom, is difficult to deny. We can feel this change, firsthand, in the speed with which we switch our attention away from a challenging task at work or pick up our phones when waiting in line. Understanding what makes social media so hard to resist is the first step in taking control of our attention back from these platforms and focusing on what really matters.

Algorithmically Driven

Social media platforms, such as YouTube, Instagram or TikTok, are unique in that the content you see is algorithmically-drive. In the simplest terms, social media platforms operate as giant recommendation engines. They collect data about your behavior—what you click on, how long you linger on a post, what you like, share and comment on—to create a profile of your interests. Then they use complex algorithms to analyze this data and predict what content you are most likely to engage with in the future. The more time you spend on the platform, the



Percent of U.S. 12th graders who agreed with the statement, "People like me don't have much of a chance at a successful life." The blue box marks the years Instagram was being rapidly adopted by teenage users, marking a sudden rise in anxiety, depression and other mental health issues. Source: Monitoring the Future 1977–2021, National Addiction & HIV Data Archive Program. Graph credit: American Institute for Boys and Men.

more ad revenue the platform generates. As the saying goes, "If you are not paying for the product, you *are* the product."

So, when you open your social media feed, what you see is not random. It is carefully curated based on what the algorithm predicts you will find interesting or engaging. This personalized content keeps you scrolling because it is tailored to your preferences, which can make it hard to resist spending more time on the platform. Moreover, these algorithms are designed to continuously learn and adapt, refining their understanding of your interests over time. This means the more you use social media, the better it gets at showing you content that grabs your attention, and the harder it is to control your own use.

Goals vs Effects

We start using social media with the best of intentions. We see it as a valuable tool for making new social connections, maintaining our existing relationships, learning about the latest trends or current events. We use platforms such as Instagram and TikTok for entertainment—a break from our work or means of decompressing at the end of the day. But the more time we spend on social media, the more susceptible we become to the social costs of increased technology use. Research points to worrying mental health effects associated with increasing levels of loneliness, feeling disconnected from family and friends, social comparison, body image issues and misinformation, all of which may accelerate with the advancing capabilities of generative AI.

In essence, we adopt new technologies to achieve specific and positive goals, but we often end up feeling lonely, misinformed, discouraged by social comparison or distracted from our work. And then we struggle to disentangle ourselves in the face of deeply engrained psychological and social factors. Our human craving for novelty is continually fed by the dopamine our brains release as we scroll through our feeds. We experience a fear of missing out, of losing our main source of social monitoring, of damaging the personal and professional networks we worked so hard to build. But the reality is that there are many ways to fulfill these needs that do not involve spending hours looking at social media on our phones.

If you take the time to articulate your core values and identify your most important commitments, you can identify the ways that technology helps and hinders you.

Strategies for Intentional Use

I am not advocating for complete avoidance of social media. I use Instagram to keep up with family and friends. I enjoy watching funny videos on YouTube with my children. But I strive to be intentional in my technology use and use guardrails to keep myself from mindlessly picking up the phone and scrolling. There are four strategies I have found to be helpful for those, like me, who want to use social media in a limited way.

Strategies to limit social media:

1. **Increasing friction:** With this strategy, you add more steps needed to check social media. It involves removing social media apps from your phone, using blockers to keep yourself away from the site during certain time periods and removing the auto-login or auto-fill password, so you must enter it each time you want to access the site. The greater mental effort required to access the site gives you more time to think about whether you are using technology with intention or just out of habit. Social media platforms are continually trying to reduce the amount of time it takes you to access their content, which is why they encourage you to "stay logged in," use their app instead of browser interfaces and enable push notifications. This strategy can help if you want to stop checking social media out of habit or avoid using your phone when you are around other people.

2. **Setting explicit boundaries for use:** This strategy includes unfollowing people or restricting your posts to certain topics, as well as maximizing the social media behaviors that have been found to generate more happiness and satisfaction, such as commenting on the posts of people we know and reminiscing by looking back through our own feeds. Some people only allow themselves to check social media feeds during certain times of the day. I personally avoid social media right after waking up, because I do not want it to set the tone for my day, and in the late evening, because I know it interferes with sleep. Many people have found success using the "phone foyer" method, where they place their phone in a specific and harder-to-access location in their home rather than carrying it around in their pocket or sleeping with the phone next to them. This strategy helps people who compulsively check social media because they have a fear of missing out on something important.

3. **Identifying & assessing the underlying need/ emotion:** This strategy involves asking yourself why you are checking social media and whether doing so will help you to satisfy the need or process the emotion you are experiencing. Most people—myself included—open a social media app because we are feeling lonely, bored or frustrated with something difficult we are trying to do. There are some types of interactions on social media that can alleviate boredom, but the negative emotions associated with passive consumption typically outweigh the novelty offered by our social media feeds, leaving us feeling like we have eaten a bunch of junk food. Asking yourself what you are feeling and what you need to address that feeling can move you toward more restorative activities that involve greater engagement with your body, your physical environment and the people who exist outside of your phone.

4. **Creating if-then scenarios:** This strategy focuses on the preemptive creation of alternatives to social media. It involves envisioning what you want (more intentional or less frequent social media use), brainstorming the most likely obstacles to achieving this goal and identifying a specific action you will take when you encounter those obstacles. That might look like: "If I find myself opening social media because I'm bored or waiting on something, then I will switch over to the Kindle app and read a novel;" or "If I am checking social media because I feel lonely, then I will message a friend;" or "If I am checking social media to avoid a task, then I will take a short walk around the office instead." This strategy helps you address underlying needs while adding higher-value activities back in your day.

Navigating the complexities of social media requires a thoughtful, intentional approach. As new technologies continue to emerge and social media platforms find new ways to capture our attention, it becomes increasingly important to reclaim control over our digital lives. Strategies such as those above help us foster a healthier relationship with social media. More and more people are choosing to opt out of social media all together. Whatever you choose, I encourage you to begin by reflecting on what truly matters to you, rebalancing the benefits of technology with the richness of offline experiences. Together, we can shape a future where our digital tools enhance rather than control our lives.

THE TIMES THEY ARE A-CHANGIN'

AI's Powerful Winds Sweeping Across Higher Education

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Higher education is often in a state of flux. Each year, teachers pour over their classroom materials reflecting on what transpired last year, spending countless hours considering the value and merit of the textbooks they used, the presentations they shared with their students, and the assessments they utilized to measure the students' absorption of their teachings. Administrators, too, are accustomed to change as teaching policies, strategies and resources persist in a constant state of flux. Yet, a more impactful and sudden change has swept across all schools—elementary to universities alike—that has abruptly disrupted pedagogical models and practices in unprecedented ways. The winds of artificial intelligence (AI), particularly generative AI, are quickly picking up intensity and show little signs of slowing down.

Generative AI refers to AI technology that is capable of creating original content, such as text images, video and sound from high-level instructions (referred to as prompts).[i] In short, AI isn't merely a tech tool that can help students; it's capable of taking the student's place in creating work-product with no supervision and minimal direction. It relies on complex machine-learning algorithms and large language models (LLMs) to provide powerful capabilities for content creation—all with a user-friendly interface. Although there are now many examples of generative AI platforms, one of the most popular, OpenAI's ChatGPT, launched in November 2022 and quickly became the "fastest-growing consumer application in history," as it took less than two months to reach 100 million users.[ii]

Having attended many conferences and panels focused on the AI storm in higher education, I've observed a spectrum of excitement, confidence and concern

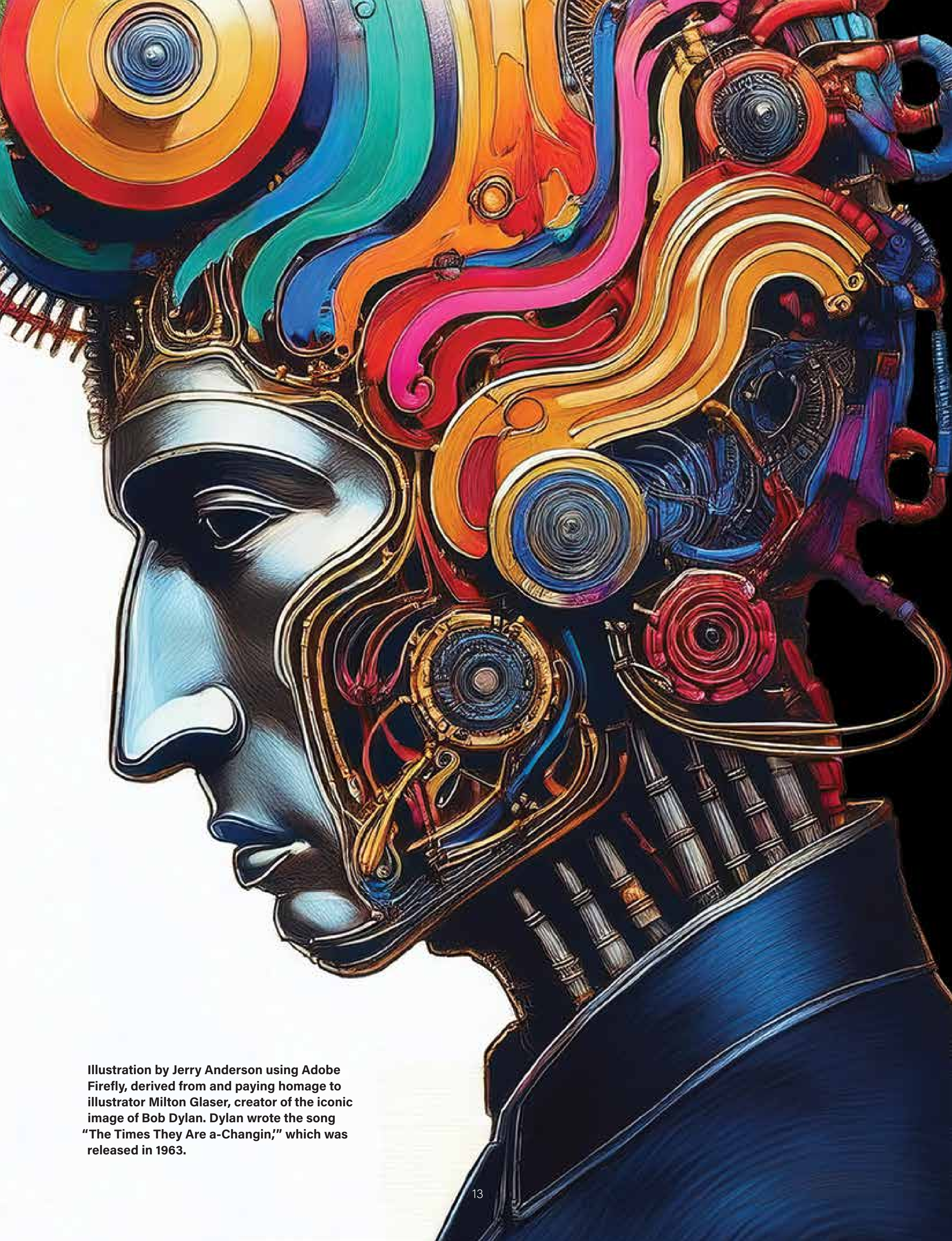


Illustration by Jerry Anderson using Adobe Firefly, derived from and paying homage to illustrator Milton Glaser, creator of the iconic image of Bob Dylan. Dylan wrote the song "The Times They Are a-Changin,'" which was released in 1963.

among faculty. A vigorous debate has emerged: If the goal is student learning, are these headwinds or tailwinds toward that destination? While the jury on that question is still out, few would deny the powerful capabilities and potential that AI has already demonstrated to transform the way in which students are taught. And as is true for all significant storms, ignoring them is unlikely to yield positive results. To the contrary, inaction all but guarantees catastrophic danger for both students and teachers.

Moreover, there can be little question that AI will have a significant role in shaping the future of higher education. Thus, the relevant question isn't whether AI should be part of higher-ed—the question is how. In my view, there will be three key aspects to harness the power of AI winds and bring higher education into the future: (1) attention, (2) adaptation and (3) implementation.

Attention

Every level of the education system has been uniquely impacted by generative AI. Early education teachers face different concerns and opportunities than high school teachers and higher-ed instructors. Similarly, in higher education, each discipline has been rewarded with its own advantages and plagued with its own challenges.

For instance, those teaching college writing courses have been asked to grow the knowledge and abilities of students who—with generative AI—possess the capability of generating a 10-page paper on any topic faster than it previously took a student to ready their typewriter or boot their computer.

> With a mere stretch of a few fingertips and some sinister motivation, every student can be tempted into ChatGPT's intuitive interface for nearly instantaneous work-product that can often outperform an average student.

This newfound capability surely provides students with increased potential for efficiency, but it also presents instructors with significant pedagogical challenges. When awarding a grade, how is a faculty member to know if the merit should go to the student or a well-trained algorithm?[iii] Similarly, university history professors have suddenly found themselves with a cadre of students who can submit an assignment summarizing or "reflecting" on a period of history with little assurance the knowledge put to paper was actually gained by working through the assigned material. Did the student create their work-product by laboring through the course materials or by the instant gratification provided through ChatGPT?

Those teaching language courses (ChatGPT is fluent in many languages),[iv] computer science courses (ChatGPT not only writes but also debugs code)[v] and math courses (ChatGPT gives you the right answer *and* shows its work)[vi] have also not been spared.

Law Schools & Generative AI

In my specific discipline, law schools are now directly facing the AI winds in ways very few could have predicted just a few years ago. In addition to being able to write faster than any human can possibly type, understand complex Latin phrases and instantly summarize long texts, generative AI programs have proven themselves capable of understanding logic, precedent and legal analysis.[vii] Thus, absent severing their students' internet connection, law school professors face many of the same challenges as peers across higher education.

Was a student's legal memo generated after long nights of reading dense legal material and writing and rewriting (then again revising) drafts? Or was it a product of a few well-executed prompts? Was the question just answered by a student in class the result of a well-prepared student or the craftiness of a quick-witted student who received a helpful generative whisper without ever talking to a single (human) classmate?

AI impacts not just the legal writing courses critical to a law student's transformation into a lawyer, but also the doctrinal courses without which students would have little value to offer a client—or even gain admission into a bar to share those skills with a client. Knowledge of substantive and procedural law—and the ability to effectively communicate that knowledge—are indispensable for any lawyer (and their clients) to find success. As of now, none of this can be "downloaded" to a student in the way fantasized in "The Matrix." Acquiring those skills and knowledge can be achieved only through immense effort and iterative practice. The chief concern, however, is that generative AI allows law students to produce the work-product without much of the effort (or learning) that happens during the process.

Of course, concerns of plagiarism are hardly new. For many years, students have been able to submit papers authored by someone else, look up answers to common or reused questions in online resources, translate large quantities of text with online tools or copy the computer code/legal analysis of students before them. But aside from the ethical barriers that stood between a student and ill-gained work-product, there were practical challenges that made those practices the exception rather than the rule. No centralized source or tool could accomplish all of these so successfully with such minimal investment, as does generative AI. With a mere stretch of a few fingertips and some sinister motivation, every student can be tempted into ChatGPT's intuitive interface for nearly instantaneous work-product that can often outperform an average student.

Refocusing on Process

Regardless of intentions or motivations, students who rely on generative AI can suffer significant negative impact on their learning. Course assessments are often based strictly on the final work-product submitted by the student, even though the learning value for almost all disciplines lies not in the work-product itself but the *process* of generating it. In many fields, generative AI has eliminated the requirement for that process to create the final work-product; the process can now be replaced by a student's short prompt and AI's near instantaneous creation. Yet, ChatGPT's perfectly written English paper, accurate accounting of an historical period or well-organized legal memorandum offer little value for a student looking to learn how to create high-quality works. A student can produce great work-product with generative AI, but ask them to explain the characteristics contributing to its quality or to explain why it embodies what they were learning, and you may be faced with a blank stare. So, students taking advantage of that process shortcut aren't just cheating their professor, they are cheating themselves from an opportunity to learn.

Nor should it be comforting to students that clients usually care most about the quality of the final work-product and that after graduation the student will be able to more freely rely on generative AI[viii]—because so will the student's future clients. For example, in some law firms, entry-level lawyers are now in competition with AI programs, as some of the tasks traditionally performed by junior lawyers have been outsourced to automated technologies—often at the request of clients looking to reduce costs from high billing rates. Vendors of these AI products are often quick to promote them without necessarily considering the full impact of implementation. Thus, the value a student can offer his or her future client will not be as an e-deliverer of AI-generated work-product—it will be in providing something more than what AI alone can generate. Likely that will derive in some form from the student's developed expertise of the underlying subject matter, as well as the appreciation and knowledge for how AI can positively contribute to the end-result, either through efficiency or quality.

With a deep focus on grades, however, the pedagogical value of the process is often lost on too many students during their learning. A focus for many students is achieving a good grade—not necessarily learning the material. As a result, a dangerous dichotomy begins to emerge: Faculty face growing challenges in assessing

A student can produce great work-product with generative AI, but ask them to explain the characteristics contributing to its quality or to explain why it embodies what they were learning, and you may be faced with a blank stare.

progress in student learning, while students (and employers) gain a false confidence in performance based on work-product no longer serving the needs or objectives of either participant.

Setting Expectations

Even more problematic than mere access to this disruptive technology is the lack of agreement and notice for what faculty view as welcome, suspect or prohibited use of AI in their courses. In the absence of a universal AI ethical code—and in many cases minimal guidance in a course syllabus—even those students looking to do the "right thing" have found difficulty understanding exactly where that threshold lies. Given the high stakes accompanying grades for many students' future career prospects, failing to utilize available tools that classmates (that is, fellow competitors for jobs) rely on to gain an advantage might prove too costly. To be sure, existing academic policies provide extensive remedies against students who bend the rules too far; after all, plagiarism isn't defined or limited by whether the author from whom the student plagiarized is human. Yet, despite the flexibility these policies provide, resorting to their after-the-fact penal nature (for the few who get caught) offers little satisfaction to students, teachers and administrators. Moreover, students who rely on generative AI to support their learning in the context of unclear boundaries and who are acting in good faith should hardly be faulted for their ingenuity and boldness.

In the end, the complicated questions, concerns and opportunities that have emerged through the AI storm are not for students to solve. Students have never been the ones expected to, or responsible for, leading the development of pedagogical models. That responsibility falls squarely on the faculty and administrators guiding them through their educational journey. Yet not all faculty have even taken notice of the challenges and opportunities directly before them. Those who have paid attention quickly discovered that the questions and issues evolved and gave rise to even more questions. None of this is reason to look away. And the shared goal to face the AI storm requires the same first step for every educator and administrator, in every discipline and every level of education: Give AI—and its impact on education—the attention it deserves.

Adaptation

With challenges come opportunities. For those who have been paying attention, the risks and challenges above paint a bleak picture. Indeed, despair is a common initial reaction. The sudden popularity of ChatGPT (or more broadly, generative AI) provided a significant shock to the system, with reactions such as: Students will never read any assigned material again; students will never submit anything originally drafted by them again; and, in short, students will never learn anything again. It wasn't just that the skies were falling; seemingly, the entire education world was crumbling.

Quickly, though, those educators (both faculty and administrators) who embraced the challenge at the outset and took on the work of better understanding what had changed and how we must adapt with it began to understand that the education world wasn't crumbling. It was merely changing—perhaps evolving. The change was sudden, significant and scary, so not many were familiar with, much less prepared for, it.

Yet, the change was likely necessary. It is clear by virtually any available projection that AI will impact the world in every industry and workforce sector. Whether we like it or not, whether we see it as good or bad, that is the world our students will walk into after graduation. Although we certainly do not know—nor can foresee—all the different ways AI will impact and change the world, little doubt exists that AI will be an incredibly important part of the future.

Thus, if educators must prepare students to be successful into that future, they can afford to ignore AI no more than they can afford to avoid electricity or the internet. Some future and current AI applications will surely have a negative effect on education, just as on society. It will be up to the participants in each discipline to establish the policies by which AI use will be governed and to guide the students through the application of those policies. That will take significant time and resources. Therefore, waiting until that work is fully completed is bound to be a poor decision with even more negative consequences.

No Time to Wait

While we wait for the "perfect" AI playbook, faculty must recognize and embrace the circumstances and challenges that have been brought upon the world of education and more purposefully build their pedagogical goals and strategies in light of the new realities, taking into account AI's capabilities and our students' increasing inclination to use them. The opportunity for student learning still exists in every classroom.

Of course, when necessary, faculty can always unplug the metaphorical cable and cut off a student's access to generative AI technologies. Many professors do so when it comes time for final course assessments. While this measure assures genuine authorship and provides more confident measures for student assessment, exclusive reliance on such "high stakes" assessment presents significant concerns that have been well-documented,[ix] particularly for students who do not thrive in such situations. Moreover, cutting off students entirely from AI is neither a prudent nor realistic path, given the world that awaits them.

In other words, education will need to rethink its assessments models: How can educators determine whether students are learning?

Although the impact and adaptation strategies will look different across disciplines, an emerging common theme is greater focus on the process of learning rather than the end work-product generated by students. One adaptation of this might be more formative assessments and less summative assessments. The renewed focus on process will be important for many disciplines because AI's work-product, essentially, creates a new baseline for quality. Every student is now capable of producing "adequate" work-product for many assignments—even if they do not understand the material—simply by having generative AI create it. This not only creates challenges for assessing student learning, it also shrinks the grading spectrum. If generative AI can instantly produce C+ work-product, the range of grades might not be A to F, it might be A to C. As such, in some assignments, the goal of educators might not be to help students reach the baseline (which can be accomplished by generative AI in seconds), it might be to teach them how to improve the baseline. For example, in teaching students to write, the focus might be on a student's progress of iterative drafts and exercises or editing an AI-generated draft rather than a final paper.[x]

There are many resources emerging to help educators looking to adapt their instruction with the advantages of AI.[xi] And even though the context for assessment in the age of AI might be different, the path faculty must follow is generally the same: Identify the course objectives, isolate the skills students are expected to gain and design a curriculum/assessment that works toward realizing/measuring those goals.

However, thinking about how to change things is not enough. Just as contemplating a plan of action for an impending storm won't accomplish much unless the strategy is implemented, faculty and administrators—even those who pay attention and contemplate how to adapt—will need to take concrete actions on their educational approaches.

Implementation

Given how suddenly the AI winds began to blow across academia, many institutions and faculty were caught flat-footed. In fairness, so was the rest of the world. Thus, those who fell behind (or have yet to start) can be forgiven. Rather than regret missed early opportunities, educators' focus now should be on moving forward. After paying attention and adapting learning methodologies to the new realities, faculty and administrators will need to implement those adaptations into still-evolving circumstances. To find an example of the successful transition from adaptation to implementation, one need not look further than our university system.

As one of the windiest states in the Union, North Dakota is used to dealing with powerful winds.[xii] So it shouldn't be a surprise that our higher-ed leaders have been at the forefront of implementing preparations for the AI storm since its early forecast. For example, in early 2023, the North Dakota University System (NDUS) created an AI Forum to explore AI's intersection with higher education.[xiii] Comprised of university presidents, state administrators and higher-ed faculty, the forum meets regularly to share ideas and advice relating to AI and education. Similarly, NDUS leadership and the State Board of Higher Education convened various study groups to formulate Envision 2035,[xiv] the state's strategic plan for the future of higher education with a focus on "major expansion of activity related to AI."[xv]

At the University of North Dakota (UND), there has been a conscious focus and effort since the start to learn about, grow with and put into action meaningful AI

initiatives. In 2023, numerous faculty panels were held to discuss AI's potential, risks and implementation. UND then published "Initial Guidelines for Using Generative AI Tools" before many schools formalized any stance on how AI should be used.[xvi] President Andrew Armacost even hosted Greg Brockman, co-founder of OpenAI (also, a former UND student and North Dakota native), for a conversation on AI's future,[xvii] followed by a panel discussion on the "Promise and Peril of AI in Higher Education."[xviii]

North Dakota State University (NDSU) and the other NDUS campuses have also been active in facing the AI winds and implementing strategies to harness their power, including by hosting AI discussions.[xix]

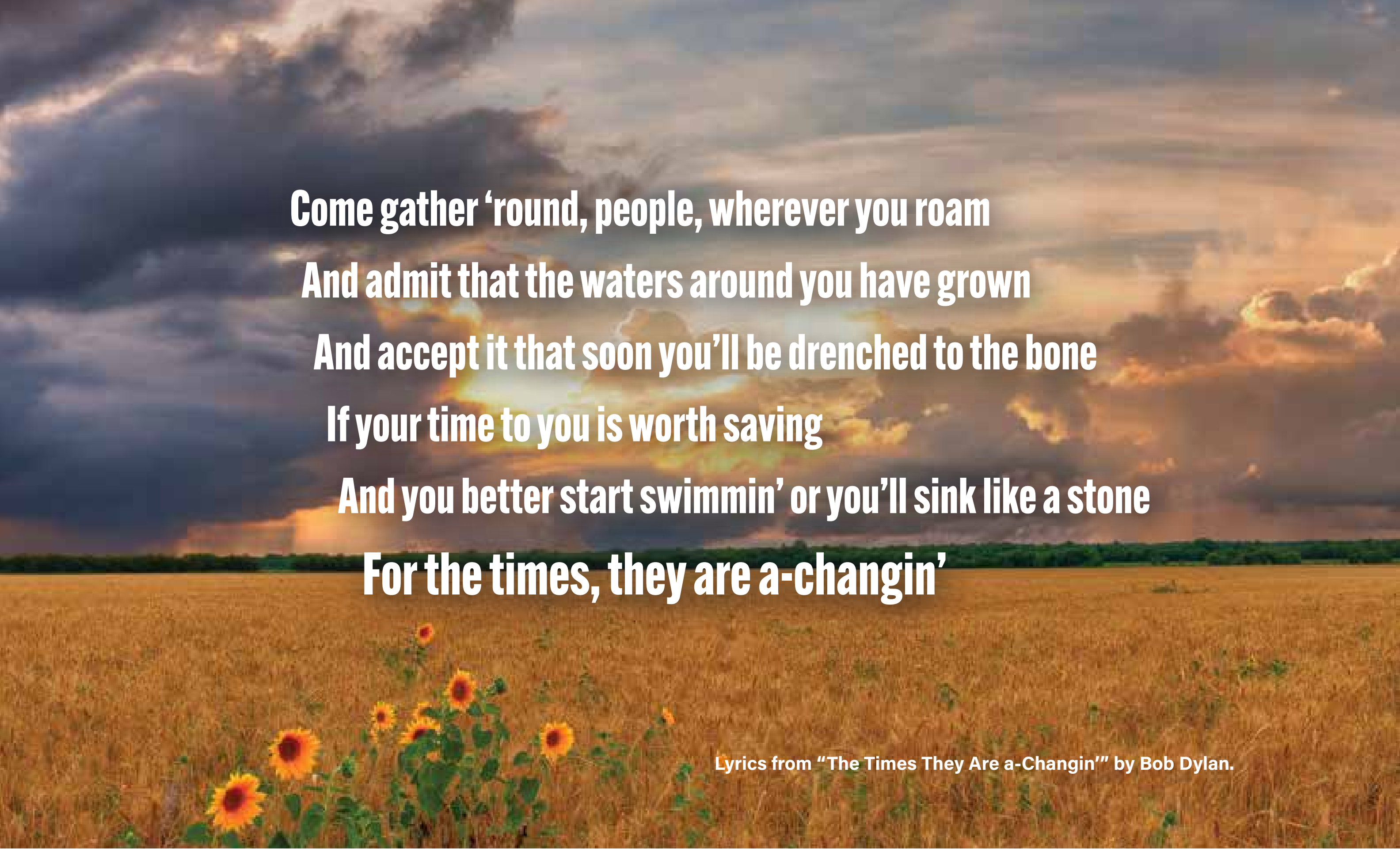
For our elementary and secondary schools, the North Dakota Department of Public Instruction published the "North Dakota K-12 AI Guidance Framework."[xx]

Across the state, NDUS faculty have been encouraged to participate in workshops designed to help move their courses and teaching into the AI age. The results have produced not only helpful interdisciplinary discourse but also tangible results. At UND, faculty members created and published more than 40 AI course exercises across many disciplines at the summer 2023 AI faculty workshop.[xxi] The summer 2024 AI workshop cohort featured an even larger number of faculty members and has published its work in the same repository. These efforts will surely be beneficial to colleagues at other campuses and, most of all, to our students.

Law Schools

Law schools nationwide have started to take notice, and a growing number of law faculty have begun to integrate AI into their coursework and teaching. To date, 258 professors have joined the AI Law Prof group, which is "organized to allow [the group] to collaborate and share [faculty] insights, best practices and resources."[xxii] Another law professor group, the Legal Writing and Generative AI Convo Group, which formed in May 2023 and has grown to more than 400 members, meets monthly to discuss all aspects of generative AI and how it impacts the teaching of legal writing and will be used in the legal field.[xxiii] Some professors have even argued that "*all* law professors have an inescapable AI mandate … [to] achieve competence in, and understand the challenges of, [generative AI]."[xxiv]

At most law faculty conferences I attend, AI dominates



Lyrics from "The Times They Are a-Changin'" by Bob Dylan.

the presentation topics, regarding its impact on teaching and also on substantive law. The same holds true for research, scholarship and publication, the growth of which is reaching a wider audience from different perspectives.

Evidence of adaptation and implementation is also evident in curricular changes. Until several years ago, AI was a meaningful part of the curriculum at few law schools. In the last year, however, more law school faculty have ventured into this brave new world to integrate AI, including generative AI, into their classes, not just for "AI and the Law" standalone courses but also skills and doctrinal courses. Often, the professors who choose to expand and integrate AI into their teaching discover that, while they are ahead of many colleagues, they are behind many students who didn't wait for an invitation, permission or direction. For those who have yet to become involved, the challenge will only increase.

In a recent informal study, the American Bar Association Task Force on Law and Artificial Intelligence reported that "AI is already having a significant impact on legal education and is likely to result in additional changes in the years ahead."[xxv] Not surprisingly, the survey found that "law schools are increasingly incorporating AI into their curricula."[xxvi] Specifically, more than half of the responding law schools (albeit a small percentage of law schools overall) indicated they offer courses primarily focused on teaching students about AI[xxvii] and "nearly all (93 percent) of the responding law schools are considering changes to their curriculum in light of the profession's increasing use of AI."[xxviii] A majority (62 percent) of responding schools offer students an opportunity to learn about AI in the first-year curriculum.[xxix] Given the low number of law schools that participated in the survey, some have questioned the underlying numbers.[xxx] However, the key takeaways from the study are on firm footing and supported elsewhere: Law schools are aggressively exploring AI's impact in legal education, and the number of law schools with AI courses is growing quickly.[xxxi]

Overall, while the study found that "legal education is evolving to meet the demands of a profession" into "AI literacy," it also cautioned that "law schools are at different stages of readiness and enthusiasm for adopting AI-related changes."[xxxii] For those schools striving to harness AI winds and transform them into tailwinds for their teaching methodologies, the focus has been on "new concentrations and courses," "integrating AI tools and concepts throughout the curriculum," "encouraging the use of AI in experiential classes," and "reevaluating their methods of assessment to adapt to AI's capabilities."[xxxiii]

My impression of the state of AI implementation from talking to colleagues at law schools around the country is that many schools have taken the initiative to create committees to evaluate the impact of AI on their programs, but that it is a challenge to reach a wider audience of professors at each school.

The UND School of Law, like its main campus, has eagerly embraced AI's transformative power. In 2023, our law students began working with AI in their first-year studies to gain exposure on how AI is changing the profession. Numerous professors have implemented AI-based assessments and exercises into first-year and upper-level courses to introduce students to the capabilities and risks of AI, as well as its impact on the practice of law and different substantive legal areas.[xxxiv]

Additionally, the law school recently approved a newly designed "AI and the Law" course, which I will begin teaching in the spring semester. The course will focus on teaching students about the many complex issues and unresolved questions at the intersection of AI and the law, including tort liability, free speech, privacy, intellectual property, ethics and bias. During the course, students will gain the skills necessary to identify key legal issues and concerns regarding AI use in various factual situations and legal substantive areas. Through this "survey" AI law course, students will be able to build on their foundational knowledge of AI in the specific substantive areas that interest them (or their clients) most. In short, UND's law graduates will have the opportunity to enter the profession with "AI literacy."

Beyond the classroom, UND Law's commitment of resources and support to foster a community of AI expertise in a diversity of legal areas has led to substantial successes. In the past two years, five of UND's 18 full-time law professors have published numerous articles[xxxv] and made dozens of presentations locally, nationally and internationally[xxxvi] on the impacts of AI on the law. This broad AI expertise further benefits students directly. With 28 percent of our faculty having AI expertise, UND Law is ahead of many peer institutions still trying to build an AI footprint. The law school is now positioned to implement AI throughout the entirety of its curriculum. Aware of the future challenges the AI winds will bring and the major changes accompanying the NextGen bar exam, UND Law is in the process of intensely reviewing its curriculum to ensure it can best equip students to meet the emerging challenges for the practice of law in the AI age.

Sailing with the Wind

Regardless of whether university faculty embrace or resist the powerful AI winds sweeping across higher education, it's clear that a growing number of students have already joined the AI experiment. If educators want to continue utilizing pedagogical strategies with intentionality, impact and results, they must face (and embrace) the AI winds that continue to intensify by: (1) paying attention to the changes trailing AI, (2) consciously reflecting on adapting to the AI revolution, and (3) implementing pedagogical approaches that take into account AI's transformative power.

Without adhering to these critical steps, the growing divide between student expectations and faculty expertise (or lack thereof) will only further strain the opportunity for meaningful student learning in every discipline. Many institutions, including UND and others statewide, as well as a growing number of law schools, have responded with determination not just to weather the AI storm but to turn the AI winds into a tailwind for pedagogical objectives. Yet, with so much uncertainty in how exactly AI will transform higher education (and society), plenty of work remains to be done. ▣

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[xxii] "AI & Law-Related Course Professor List," https://www.ailawprof.com/ (last visited July 20, 2024).

[xxiii] Anyone interested in joining or learning about the group can contact its founders: Professor Carolyn Williams (carolyn.williams.2@und.edu) or Professor Kirstin Davis (kkdavis@law.stetson.edu).

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[xxxiii] *Id.* at 12.

[xxxiv] *See, e.g.*, Nikola L. Datzov, "Using ChatGPT to Enhance Law School Assessments (2023)," UND AI Assignment Library, *available at* https://commons.und.edu/ai-assignment-library/39/ (last visited July 19, 2024); Carolyn Williams, "Checking ChatGPT for Accuracy (2023)," UND AI Assignment Library, *available at* https://commons.und.edu/ai-assignment-library/36/ (last visited July 19, 2024).

[xxxv] *See, e.g.*, Nikola L. Datzov, "Artificial Intelligence is Transforming Our World—Are We Ready?," Dakota Digital Review (September 2022), *available at* https://ssrn.com/abstract=4378970; Nikola L. Datzov, "The Role of Patent (In)eligibility in Promoting Artificial Intelligence Innovation," 92 UMKC L. REV. 1 (2023) *available at* https://ssrn.com/abstract=4380405; Nikola L. Datzov, "Toward Automated Justice" (work-in-progress); Denitsa Mavrova Heinrich and Jennifer Cook, "AI-Ready Attorneys: Ethical Obligations and Privacy Considerations in the Age of Artificial Intelligence," 72 U. Kan. L. Rev. 313 (2024), *available at* https://ssrn.com/abstract=4876134; Denitsa Mavrova Heinrich and Erika Pont, "Who You Gonna Call: The Role of Expert Witnesses in Authenticating AI-Generated Evidence," (work-in-progress), *available at* https://ssrn.com/abstract=487621; Carolyn V. Williams, "Bracing for Impact: Revising Legal Writing Assessments Ahead of the Collision of Generative AI and the NextGen Bar Exam," 28 Legal Writing 1 (2024) *available at* https://ssrn.com/abstract=4509603.

[xxxvi] *See, e.g.*, Nikola L. Datzov, "Patents, Ethics and AI," Panel Chair at the 42nd ATRIP Congress, Rome, Italy, July 2024; Denitsa Mavrova Heinrich and Jennifer Cook, "Global Lawyers: A Comparative Approach to the Ethical Use of AI in the EU and the U.S.," Presenter at the 16th Global Legal Skills Conference, Bari, Italy; Blake A. Klinkner, "Generative AI: The Future is Here. Ethically Navigating This Brave New World," Presenter at the 2024 South Dakota State Bar Convention, Pierre, South Dakota, June 2024; Carolyn V. Williams, "Generative Artificial Intelligence: The Possibilities for Imagining a New Paradigm for Legal Writing," Panelist at the Legal Writing Institute 2024 Biennial Conference, Indianapolis, IN, July 2024; *see also* Joseph Vacek (Courtesy Appointment, School of Law), "How AI works," Presenter at the Aviation Lawyers Association 2023 Conference, Washington, D.C.

Cybersecurity & INSURANCE LAW

Warlike-Action Exclusion & the Merck Case

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June 27, 2017, marks the day of the most aggressive cyberattack in history. The NotPetya malware attack, instigated by Russian military hackers, ripped through business organizations in more than 60 countries, causing billions of dollars of damage in mere hours. Major multinational corporations, including American pharmaceutical giant Merck & Co. and the Russian state-owned oil producer Rosneft, were brought to their knees by the malware, resulting in massive monetary losses and worldwide operational paralysis.

The impact of the NotPetya attack began a new era for business owners, insurers and the cybersecurity industry, as these sectors began to grapple with the new reality of modern cyberwarfare, in addition to the complexities of recovering (financially and otherwise) after an attack. The contentious legal battle brought by Merck & Co. to recover insurance payouts for its $1.4 billion in losses introduced the question of whether insurers even have to cover this class of cyberattacks.

THE CYBERATTACK

It all began in Ukraine. On the western side of Kiev, the family-run software business Linkos Group was responsible for developing a key player in this story: an accounting software named M.E. Doc. Russian military hackers, intending to target Ukraine with cyberwar tactics, gained access to M.E. Doc's software updates, allowing them to access customer computer systems. The hackers were thereafter capable of executing code on the customers' networks without detection, enabling them to leave the computers inoperable.

At the time, Merck was using M.E. Doc to transmit invoice and financial data to the Ukrainian government. On June 27, 2017, NotPetya infiltrated Merck's computer systems through M.E. Doc. Within 90 seconds of the initial infection, around 10,000 Merck machines were infected; within five minutes, about 20,000 machines were infected. Ultimately, more than 40,000 of Merck's computers were infected with the malware. This caused production facilities to go offline and created large disruptions to Merck's operations, including manufacturing, research and development, and sales. Merck alone claimed $1.4 billion in losses from the attack.

Merck was not the only company impacted by attack. The NotPetya malware spread through more than 64 countries and affected other major multinational corporations. American food company Mondelez International Inc. lost a purported $100 billion from the attack. Danish shipping titan Maersk, a company that is responsible for more than one-fifth of global trade, lost between $250 and $300 million. Computers at a Pennsylvania hospital were infected. FedEx's European subsidiary, TNT Express, lost $400 million. Computer systems that monitor radiation at the Chernobyl Nuclear Power Plant went down.

To top it off, the malware spread *back* into Russia, hitting Rosneft, a government-backed oil producer, and Home Credit Bank, one of the country's top lenders.

The total damage from NotPetya is estimated at a staggering $10 billion globally.

THE LITIGATION

After all was said and done, the real battle began for business entities: getting insurance payouts to recoup losses. As the cost of cybercrime escalates, with a projected estimate of $10.5 trillion annually by 2025, insurance battles over cybercrime will likely become a key focus in the insurance and litigation worlds.

N.J. District Court

In the case of Merck and its attempts to recoup from the NotPetya attack, the lawsuit turned on the application of a common insurance provision—a "warlike-action" exclusion—first seen in insurance policies in the 1800s[i].

A war exclusion, used in both cyber policies and property or liability policies, excludes losses caused by "warlike" action. Initially, war exclusions were introduced by Lloyd's of London market insurers to exclude war risks from marine coverage policies in the shipping business. Today, the exclusions turn on two questions: "First, is the loss-causing conduct attributable to a sovereign state? Second, is the loss-causing conduct properly characterizable as 'warlike'?"[ii]

These questions create considerable uncertainty in the context of cyber operations. The focus on the warlike-action exclusion in Merck's lawsuit precipitated heavy scrutiny by the insurance and cybersecurity industries. The rising prevalence of nation-state and criminal ransomware cases linked to world conflicts, such as in the Israel-Hamas War and the Russian invasion of Ukraine, meant the outcome could dramatically transform future cyber-insurance coverage.

Before the attack, Merck purchased a $1.75 billion "all risks" property insurance policy that was intended to protect against just the type of damage that NotPetya caused: loss resulting from destruction or corruption of computer data and software. Therefore, Merck, believing it was entitled to a payout, submitted a notice of loss to its insurers in July 2017. The insurers, however, were adamant that the "all risks" policy contained a warlike-action exclusion that allowed them to avoid paying for the damage. The insurers claimed the exclusion applied due to the attack originating from the Russian Federation and, in a 'warlike' manner,

As the cost of cybercrime escalates, with a projected estimate of $10.5 trillion annually by 2025, insurance battles over cybercrime will likely become a key focus in the insurance and litigation worlds.

targeting Ukraine. Merck, understandably eager to secure the insurance funds, brought a lawsuit in New Jersey district court in 2018 to litigate the issue. Merck initially brought suit against over 30 insurance companies, many of which decided to settle their claims rather than litigate against Merck.

On January 22, 2022, after numerous oral arguments on the application (or non-application) of the warlike-action exclusion on Merck's claim, the district court granted summary judgment in Merck's favor. In doing so, the court found that no reasonable fact finder could conclude that the warlike-action exclusion applied in Merck's case, even after viewing the evidence in the light most favorable to the insurance companies. The court noted that no other court in history had applied a warlike-acts exclusion to any case "remotely close to the facts"[iii] present in Merck's lawsuit.

The court also stressed that the insurance company's policy language had been the same for *many* years, something that the court found interesting given the ever-increasing rise of cyberattacks. This presented an opportunity for the insurance company to update their exemptions in order to put Merck on notice that cyberattacks were not covered—an opportunity that the insurance company failed to take. In the words of the court, "Merck had every right to anticipate that the exclusion applied only to traditional forms of warfare."[iv] This meant a big win for Merck, and a big scare for insurance companies worldwide using antiquated warlike-action exclusions.

N.J. Appellate Court

As was highly foreseeable by those within the relevant industries, Ace American and the remaining insurance companies who failed to come to a settlement with Merck appealed the district court's decision to the New Jersey Appellate Court. A flood of opinions from *amicus curiae* (organizations permitted to assist courts in a particular case) urged the appellate court to affirm or deny the district court's decision. American Property Casualty Insurance Association, a national trade association for insurers, contended that Merck's damage fell squarely within the meaning of a warlike-action exclusion.

On the other side, the New Jersey Association of Counties, United Policyholders, various insurance law scholars, and more, contended that the district court's findings were correct and that the appellate court should affirm the case in favor of Merck. Another group of well-versed international law professors and former government lawyers, argued "[t]he terms 'war' and 'hostilities' are terms of art that have long been understood as describing the use of armed force between rival states"[v] and that the U.S. government "has been careful not to broaden the legal definitions of these categories, despite the advent of various types of malicious cyber activity."[vi]

On May 1, 2023, the appellate court concluded that the insurers simply had not been able to demonstrate that the warlike-action exclusion applied under the circumstances of Merck's case. The court found that similar exclusions had never been applied in a situation that was not clearly war or military action. Merck had risen victorious once again, with the court finding it was entitled to about $700 million in claims.

N.J. Supreme Court

The insurance companies were not done fighting, however. Their appeal to the New Jersey Supreme Court was granted on July 19, 2023. The appeal focused on the same warlike-action issue as in Merck's case. But, in early January 2024, days before the supreme court was scheduled to hear oral arguments, Merck filed documents with the Court indicating that it reached a settlement with the insurers. The terms and amount of the settlement have not been disclosed, but the settlement meant an end to the six-year legal battle.

The settlement allowed the insurance companies to avoid having an unfavorable state supreme court opinion as precedent. But, the lower New Jersey court rulings provided incentive enough for insurers to both wrap up their issues with other insured companies claiming damage from NotPetya and to quickly fine-tune their policies to avoid future payouts. For example, after the New Jersey district court ruling for Merck in 2022, Mondelez International settled its lawsuit against Zurich American Insurance over its $100 million NotPetya claim. Additionally, in 2022, Lloyd's announced that losses from cyberattacks "have the potential to greatly exceed what the insurance market is able to absorb," and that they are requiring "all stand-alone cyberattack policies … must include … a suitable clause excluding liability for losses arising from any state-backed cyberattack."[vii]

LOOKING FORWARD

Insurance companies, although adverse to major risk, need some risk appetite to bring in premiums. Beyond a certain point of risk, however, they simply cannot afford to pay.

"Systemic risk is an ongoing concern. Property catastrophes typically affect a limited geographic area, but a cyber catastrophe, as we saw with NotPetya, can go worldwide," said Fred Eslami,[viii] an associate director at AM Best, a credit-rating agency specializing in the insurance industry.

On top of this, as with NotPetya, cyber incidents can be perpetrated by foreign governments or quasi-state actors, even though it can be very difficult to identify hackers and determine whether they are truly backed by a government. According to McGuireWoods, a Chicago-based governmental affairs law and consulting firm, policyholders "should not assume that traditional 'war' exclusions drafted during the Cold War necessarily bar coverage for 21st century attacks in cyberspace."[ix]

The answer to this cyber uncertainty seems clear, at least, for some insurance providers. The Merck litigation and other disputes stemming from NotPetya gave the insurance industry time to limit their exposure by adding new exclusions for cyberattacks caused by state actors or in connection with warlike conduct. Insurance Law Scholars, one of the amicus advisers from the Merck case, stated simply that the insurance companies deserved to lose because they "failed to use *readily available* insurance policy provisions that would have excluded or limited the coverage provided for cyber-related events."[x] (italics added by author)

Global law firm Latham & Watkins LLP is advising clients that policyholders have several options in the face of the new war-exclusion developments: First, the new—and narrowed—terms of war exclusions in policies may be negotiable; second, policyholders can place coverage with insurers that are not narrowing their exclusion language; or third, policyholders can simply find alternative insurance products with more favorable terms. But, as with any language changes in policies, every additional contractual word included or excluded could be a breeding ground for future litigation.

"Hardly a day goes by without a news story about some type of cyberattack," said Alan Rutkin and Rob Tugander, law partners at Rivkin Radler LLP.[xi]

Although NotPetya is not a current threat, its perpetrators are still operating. Hacker groups supported by hostile governments are constantly evolving malware and ransomware created for financial gain or widespread destruction or both. With cyber conflicts rising exponentially, Rutkin and Tugander said, "Merck will not be the last decision on this issue. More will come."[xii]

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i https://casetext.com/case/merck-co-v-ace-am-ins-co-1

ii https://www.marshmclennan.com/insights/publications/2023/january/asking-the-right-questions-about-war-exclusions-in-the-context-of-cyber-operations.html

iii https://casetext.com/case/merck-co-v-ace-am-ins-co-1

iv https://casetext.com/case/merck-co-v-ace-am-ins-co-1

v https://casetext.com/case/merck-co-v-ace-am-ins-co-1

vi https://casetext.com/case/merck-co-v-ace-am-ins-co-1

vii https://www.insurancejournal.com/news/international/2022/08/19/681274.htm

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ix https://www.jdsupra.com/legalnews/merck-settlement-of-1-4-billion-1936983/#:~:text=Cyber%20incidents%20are%20sometimes%20perpetrated,first%20century%20attacks%20in%20cyberspace.

x https://casetext.com/case/merck-co-v-ace-am-ins-co-1

xi https://bestsreview.ambest.com/edition/2023/september/Regulatory-Law-NotPetya-and-War-Exclusions.html?_gl=1*qlbg6l*_ga*MjExMjQ3NzYyOC4xNzIwNjMxNjE3*_ga_VNWYD5N5NL*MTcyMDYzMTYxNy4xLjEuMTcyMDYzMzMwMy4wLjAuMA.

xii https://bestsreview.ambest.com/edition/2023/september/Regulatory-Law-NotPetya-and-War-Exclusions.html?_gl=1*qlbg6l*ga*MjExMjQ3NzYyOC4xNzIwNjMxNjE3*_ga_VNWYD5N5NL*MTcyMDYzMTYxNy4xLjEuMTcyMDYzMzMwMy4wLjAuMA.

Terri Zimmerman, CEO of Packet Digital and Botlink, speaking at Grand Farm's Autonomous Nation, an annual conference that convenes stakeholders, entrepreneurs and innovators to advance autonomous technology in agriculture.

The Fourth Agricultural Revolution

Unleashing AI & Community Innovation

WILLIAM ADERHOLDT, PHD
Director of Grand Farm

During the past 100 years, a global revolution was waged and won. The Third Agricultural Revolution led to the increase in the global population by six billion people. Often, innovators are specifically mentioned in this feat; however, it was entire innovation communities that ultimately led to this accomplishment. This is not to belittle agricultural innovators, such as Nobel laureate Norman Borlaug, who dedicated his life to feeding the world—spending decades dedicated to innovating disease resistance and higher yield wheat varieties. Instead, the view that innovation communities worked together to solve the challenges and demands of food production sheds light on the bigger picture—how people from around the world collaborated, competed and collided to solve some of the largest challenges facing society at the time.

These innovation communities provided infrastructure, funding and knowledge-sharing platforms. They facilitated field trials, scaled up successful models and trained farmers in new techniques. They collaborated across international borders, sharing their findings and refining their methods. As a result of this monumental effort, countries and regions on the brink of famine had the tools to become self-sufficient in food production.

Innovation communities showed that when diverse, multidisciplinary groups come together with a central goal, the seemingly impossible can be achieved.

Fourth Agricultural Revolution

The Third Agricultural Revolution introduced advanced technologies, including high-yield crop varieties, chemical fertilizers and irrigation systems. This revolution significantly increased global food production, particularly in developing countries, and also raised concerns about environmental degradation and unequal access to resources.

Today, we stand at the beginning of the Fourth Agricultural Revolution. In agriculture, we are no longer fighting to prevent regional or global famine.

Julien Laffont (left), Director of Strategy & Business, Naïo Technologies (France), with coworker Thomas Chartier (center), who is explaining how one of their precision ag robots functions.

A group of NDSU graduate students from Professor Rex Sun's lab showcasing their work with the Husky Unmanned Ground Vehicle from Clearpath Robotics from Kitchener, Ontario.

However, current and future challenges are more complex than in the past.

The Fourth Agricultural Revolution is and will continue to build on the immense work of its predecessor with new technologies, including robotics, biotechnology, sensors and artificial intelligence (AI).

AI will aid greatly with autonomous agriculture. Understandably, many people focus narrowly on autonomous tractors as the keystone invention in the future of agriculture. Driving a tractor is a very human activity, which many people, including myself, have done or see themselves doing when thinking about farming production.

However, AI's far greater impact will occur in the rapid increase in both the quality and quantity of decisions that can be made and operated on in agriculture production. In the Third Agricultural Revolution, producers became very proficient at making quality decisions at the field level, such as how much nitrogen to apply or when to harvest. These critical decisions are made throughout the growing season or during the lifespan of livestock. Typically, one good decision is made per event, per field, for example, when and how much fertilizer to apply.

Now producers make many more such decisions as precision agriculture tools become available and are implemented. The Fourth Agricultural Revolution, especially regarding AI, is like giving someone glasses, which bestow immense resolution and clarity. Farmers can greatly increase the number of quality decisions they make on their fields. As decision-making resolution increases, farmers will produce more food, fuel and fiber with less resources.

This phenomenon will be experienced not only in row-crop agriculture but also throughout food production. Imagine having the information and tools to provide each cow with its own unique diet, customized to maximize both return on investment and quality of life. And this is just one decision, where perhaps hundreds or thousands of similar decisions can be made for that individual animal. All of this will transpire without needing to increase costs or effort.

These tools will enable farmers to go from one decision per field to 100 and then 1,000. Eventually, when the farmer is enabled to make one decision per plant, we will be in the middle of the Fourth Agricultural Revolution.

Imagine, then, if every seed is planted into the ground with the perfect orientation, the perfect amount of water and the perfect amount of nutrients—repeated millions of times across an entire field.

That is just the beginning. Once the achievement of one decision per plant is reached, we will quickly go to ten, then 100, then 1,000 and so on, maximizing everything from yield to micronutrients to moisture.

Effects on Engagement with Food

Similar to how technology, such as AI, is rapidly changing the rest of society, the Fourth Agricultural Revolution will dramatically change the landscape of how people around the world engage with their food.

As the percentage of the population with no connection to agricultural production increased greatly, the disconnection between consumers and the food they eat has also grown, along with a disconnection with what it takes to produce the world's food, feed, fuel and fiber (the 4 Fs of agriculture). The Fourth Agricultural Revolution will reconnect people with food quality, as well as food and clothing production, by providing increasing information about consumer choices.

This will bring about resource conservation and optimization; a greater emphasis on food quality, not just quantity; and increasing the connection between people and the food they eat.

These are just three examples of hundreds of benefits that the Fourth Agricultural Revolution will create. To achieve this will take a momentous effort similar to that seen in the last 100 years, requiring an interlock of innovation versus the siloed approach of the past.

Five Critical Technology Families

There are five critical families of technologies needed for this future to exist: connectivity infrastructure, data collection tools, data analysis tools, decision-making tools and finally equipment that can operate at the appropriate decision-making resolution.

Once these interconnected technologies reach the capability to operate at the level of one decision per plant, the decision-making resolution will be at the degree of millions and perhaps billions of decisions per field.

Hollie Mackey, PhD, serving as an emcee at Autonomous Nation 2024. Mackey is CEO of the North Dakota Advanced Agriculture Technology Engine, supported by the U.S. National Science Foundation, award #2315313.

Innovation Communities

To achieve this, agricultural innovation communities, such as Grand Farm, are needed to bring the existing agriculture community together with innovators from around the world representing startups, corporations, researchers, government and investors. This convening will facilitate a global engine set on solving the problems of each unique agricultural region. Innovation communities are built on trust, relationships and resources, and they thrive on the exchange of ideas.

By bringing together the existing agriculture communities, such as in the Upper Midwest—representing unique soil conditions, cropping practices and regional cultures—with this global innovation engine, the Fourth Agricultural Revolution can be achieved more quickly. Agricultural communities worldwide will guide innovators to this future through exposure to challenges and opportunities—and knowledge about how these are currently tackled.

Agricultural communities are regional in nature. With different growing seasons, cropping rotations, soil types and cultures, these communities encounter problems requiring specific and perhaps unique solutions. In response, innovation communities will need to be guided by local farmers and ranchers who can inform them about their specific challenges and opportunities. This will help innovators best decide what innovations are worth pursuing.

Often regional challenges are also national, which can drive greater investment since the resulting innovations will serve a greater portion of the agriculture industry, which in turn would drive the need for an innovation to be developed sooner rather than later.

Intentional Actions to Accelerate Innovation

These innovation communities have self-organized in the past. We've seen passive innovation communities, such as Silicon Valley, emerge to rapidly grow specific segments of innovation. However, the passive innovation community model can be strengthened and accelerated by facilitating four intentional actions (the 4 Cs). By both guiding the innovation communities and intentional utilization of the 4 Cs, the need

Jonathan Gehrke (far right), Director of Development at the John D. Odegard School of Aerospace Sciences, UND, moderating a panel discussion, titled "AI & Autonomy's Role in Weed Detection and Destruction," at Autonomous Nation 2024. Panelists (left to right): Greta Silewski, Project Consultant, Thales; Jeremy Amundson Project Manager, Northern Plains UAS Test Site; and Xin (Rex) Sun,PhD, Associate Professor of Precision Agriculture and Uncrewed Autonomous Systems, NDSU.

for interlocked innovation, as seen in the Fourth Agricultural Revolution, can be met:

Collision: When people from different backgrounds, disciplines and experiences collide, unexpected and powerful ideas emerge. Every interaction between two people is a collision, and the frequency and number of these lead to positive impacts across the innovation community. Informal interactions, such as hallway conversations or coffee breaks, can lead to moments of inspiration. These spontaneous discussions often result in the cross-pollination of ideas that formal meetings might not generate. For example, a chance conversation between a startup founder, who is developing AI-driven crop monitoring tools, and an executive from a major agriculture company at an industry conference sparked a partnership to pilot the technology on large-scale farms. (This and the other examples below occurred, but the names of the individuals and companies have been withheld).

Collaboration: By forming teams with members from different fields, innovation communities can tackle complex problems from multiple angles. Collaborators share goals, resources and risks. Regular interactions and feedback sessions help refine ideas quickly. For example, a university researcher specializing in sustainable farming practices teamed up with a leading agriculture company to co-develop fertilizers that enhance crop yields.

Competition: Competitors drive each other to excel and innovate. The presence of multiple players working on similar problems fosters a healthy competitive spirit, pushing everyone to improve and innovate continuously. For example, two agriculture equipment companies, both developing precision irrigation systems, spurred each other to innovate

Innovation communities showed that when diverse, multidisciplinary groups come together with a central goal, the seemingly impossible can be achieved.

An NDSU graduate student demonstrating the Amiga Robot, an all-electric micro-tractor. This work is led by James Kim, PhD, a research scientist at USDA Agricultural Research Service in Fargo and an Adjunct Professor at NDSU's Agricultural & Biosystems Engineering. Prof. Kim uses the robot for research on engineering solutions for crop protection with UAS-based field mapping for AI-based target identification and a robotic platform for field scouting and treatment.

more efficient water-saving technologies, ultimately benefiting farmers with improved crop yields and reduced resource consumption.

Convening: Finally, the act of bringing together the innovation community, especially in neutral spaces multiplies the impact of the rest of these actions. Convening provides the presence, intentionality and energy to discuss and share big ideas and move innovation forward. The rhythm of these engagements builds both momentum and focus. For example, a regular set of roundtables was developed to bring together members of regional agriculture communities and the global innovation community to discuss the need for herbicide resistant technologies, resulting in the co-creation of a new innovation.

To accelerate the Fourth Agriculture Revolution, innovation communities must engage in collisions that spark new ideas, collaborate across disciplines to solve complex problems, compete to drive each other towards excellence and multiply impact by gathering regularly.

More importantly, by combining these actions and bringing together both the regional agricultural communities with the innovation community, a new type of innovation community emerges: a guided innovation community. This is the approach Grand Farm takes in facilitating a global innovation community to solve the challenges and opportunities of regional agricultural ecosystems. The agricultural community guides and leads the innovation community into the future, saving both time and resources. This is stronger than the passive innovation communities like Silicon Valley because it provides a framework for "what's next."

Need for Campus Climates Fueling Innovation

JOHN D. BITZAN, PHD
Menard Family Director, Challey Institute, NDSU

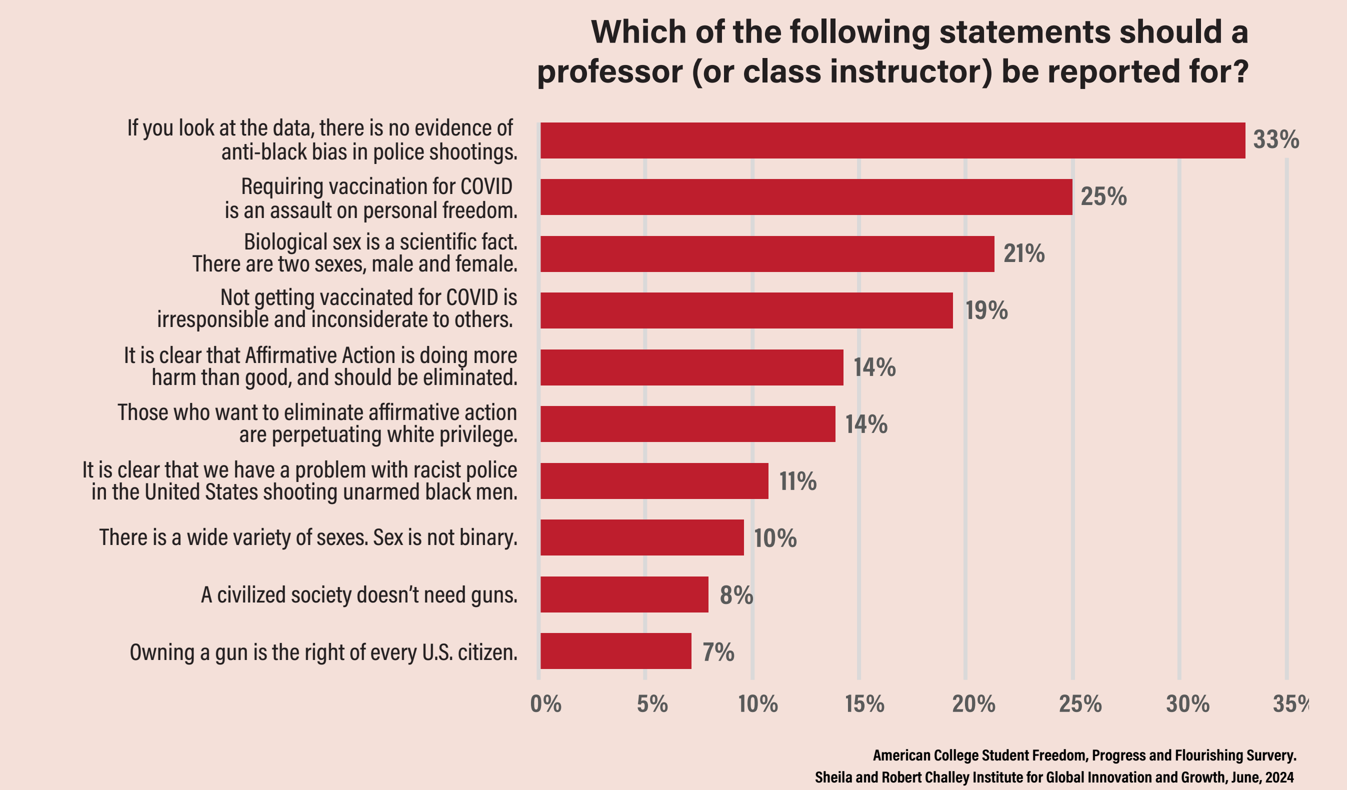
The unprecedented global prosperity over the past 200 years has been termed "The Great Enrichment" by Diedre N. McCloskey, Distinguished Professor Emerita of Economics and History at the University of Illinois at Chicago. Other economists have described it as the "Hockey Stick of Human Prosperity." As a result of this economic surge, real per-capita income worldwide has increased by more than 1,500 percent since 1800, by more than 2,000 percent in the U.S. and by an astounding 4,900 percent in Japan.

Prof. McCloskey attributes this to "innovism," the notion that ideas and creativity lead to prosperity more than the mere accumulation of capital. This resulted from a rise in liberalism, which increases freedom worldwide. Allowing people to pursue their own interests and to test their own ideas in the marketplace enabled the huge proliferation of ideas and the resulting innovations that have allowed us to live better.

Recently, the link between liberalism and innovation has been recognized in academic and business literature, particularly concerning the benefits of viewpoint diversity. Academic studies highlight the benefits of viewpoint diversity in driving innovation resulting from information exchange and elaboration among team members with different ideas. As noted by Entrepreneur Magazine, disagreement and differences of opinion lead to better ideas and innovation.

In discussing the benefits of diverse thinking, UC Berkeley ExecEd (Executive Education at the University of California Berkeley) notes that the 2012 Mars rover landing was facilitated by a team at the National Aeronautics and Space Administration (NASA) with a wide variety of viewpoints that blended traditional and novel ideas to achieve a groundbreaking solution.

> [O]ver the four years of our survey, large percentages of students have consistently said they favor illiberal actions regarding speech.



This liberal environment in the U.S. has made it a global leader in innovation, ranking third in the world on the Global Innovation Index—the measure of innovation capability and success developed by the World Intellectual Property Organization (WIPO).

However, this liberal environment is under attack, with calls for regulating or censoring social media from the left and the right, as well as growing illiberalism on most campuses.

Challey Institute & College Pulse Survey

To gain a better understanding of the degree of liberalism or illiberalism on college campuses, the Sheila and Robert Challey Institute for Global Innovation and Growth at NDSU, in collaboration with College Pulse (an online survey research and analytics company focused on U.S. college students), has conducted a survey of university students nationwide since 2021 on issues related to viewpoint diversity and campus freedom.

The survey explores the classroom climate, students' comfort level in sharing opinions, their attitudes toward unpopular or controversial points of view or speakers, and their willingness to report others who offend them.

On the surface, the survey results from the past four years suggest a campus environment that welcomes diverse views and allows students to express their opinions on controversial and sensitive topics. From 2021 through 2023, more than 75 percent of students reported a classroom climate that allowed diverse points of view and where professors encouraged a wide variety of viewpoints, and more than 63 percent reported a classroom climate in which people with unpopular views would feel comfortable sharing their opinions.

Although our 2024 survey didn't ask the same questions, it shows that 70 percent of students feel at least somewhat comfortable sharing their opinions on controversial or sensitive topics in class. These results suggest an environment of free inquiry and contestation of ideas that enables universities to fulfill their missions of advancing scientific knowledge and training students in critical thinking.

Openness Illusion

However, a closer look reveals that this apparent openness is an illusion. When students who say they are comfortable sharing their opinions on controversial or sensitive topics in class are asked why, more than 40 percent say they are comfortable because they believe their views align with most other students and professors. Moreover, over the four years of our survey, large percentages of students have consistently said they favor illiberal actions regarding speech. This includes one-third saying that speakers with unpopular views should have university invitations withdrawn, and more than one-third saying readings that make students uncomfortable should be dropped from class requirements. More than one-quarter say class discussion topics that make students uncomfortable should stop being discussed.

The most telling evidence of a restrictive campus environment comes from student answers on whether their professors and fellow students should be punished for saying things they disagree with. When students were asked whether professors who say something that students find offensive should be reported to the university, more than 68 percent of students said 'Yes' in every year of the survey. When asked whether fellow students should be reported for saying something that is deemed offensive, more than 56 percent said 'Yes' every year.

To verify that these answers suggest an intolerance of different points of view and not a concern over racial slurs, sexual harassment and personal attacks, we asked students to identify whether professors should be reported to the university for making various statements related to affirmative action, policing, guns, sex/gender and vaccines (opposite). In the two years that we asked this question (2023 and 2024) more than 62 percent of students said that professors should be reported for making one or more of these statements of fact or opinion. For students who report being liberal or liberal-leaning, three-quarters say professors should be reported for making one or more of these statements.

Further analysis supports the idea that the campus climate is not as open to diverse viewpoints as surface-level questions suggest. After controlling for political ideology, socioeconomic status and gender, we found that students who believe their campus is open to diverse and unpopular views are also more likely to support actions that prevent others from speaking—such as disinviting speakers, dropping controversial readings, and reporting students and professors who express offensive views. This points to an environment where certain viewpoints are accepted, but others are not.

These results are concerning given the central role that U.S. universities play in innovation and in training future leaders who will spur innovation in private industry. Moreover, calls for censorship of social media that started during the Covid-19 pandemic and efforts to suppress dissenting scientific views should raise concerns about the future of American innovation.[i] Not only does this type of censoring or suppression prevent new ideas from emerging, it also makes people less trusting of the academic, governmental and media institutions that help to convey current knowledge.

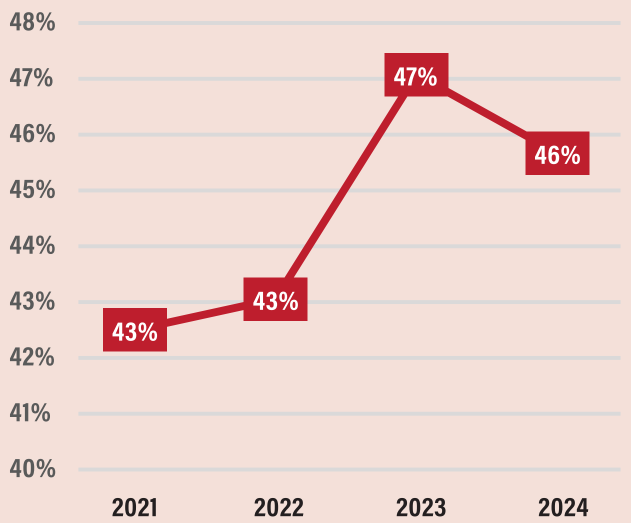
IAN ROWE, author and cofounder of Vertex Partnership Academies, a network of character-based International Baccalaureate high schools in the Bronx, NY, presented "A Conversation on Agency, Education and Upward Mobility" on November 14, 2023, at the Challey Institute's Distinguished Speaker Series.

TAMI RELLER, who began her career at Great Plains Software in Fargo and served as CEO of Duly Health and Care, spoke about her experiences as a woman entrepreneur and executive on February 28, 2024, at the Challey Institute's Distinguished Speaker Series.

GREG LUKIANOFF, best-selling author and President and CEO of the Foundation for Individual Rights and Expression (FIRE), spoke about "Free Speech in Free Fall: The Academic Freedom Crisis on Campus" on October 8, 2024, at the Challey Institute's Distinguished Speaker Series.

Based on what you have learned in college so far, do you think that the world has generally been getting better or worse over the last 50 years (considering issues such as extreme poverty, life expectancy, hunger and literacy)?

Percent answering better



American College Student Freedom, Progress and Flourishing Survery.
Sheila and Robert Challey Institute for Global Innovation and Growth, June, 2024

Tribalism

As highlighted by a recent piece from Ben Klutsey, this lack of trust in "the reality-based community" makes people resort to epistemic tribalism.[ii] Instead of looking at the evidence from a variety of perspectives and with full information, they resort to incomplete information and speculation from within their own communities. This separation of idea exchange into individual communities further diminishes the broad exchange of ideas that leads to innovation.

Unaware of Progress

Our survey results also show that many students lack awareness of the tremendous progress made globally and in the U.S. over time, in areas such as extreme poverty, life expectancy and literacy.[iii] In any of the four years of our survey, when students were asked whether the world has been getting better or worse over the last 50 years in terms of extreme poverty, life expectancy, hunger and literacy, less than half of students have said it has improved (Figure 2). Similarly, just over 40 percent of students think the U.S. has improved over the last 50 years in terms of life expectancy, per capita income and education level.

Not surprisingly, this fuels a lack of optimism among students about the future of the world (less than 30 percent optimistic in any year of the survey), the future of the U.S. (about a quarter of students in any year) and their own futures (just over half in any year). This optimism often motivates individuals to take actions (including those leading to innovations) that further human progress.[iv]

Misunderstanding Capitalism

Survey results also show a widespread misunderstanding of capitalism among students. While more than half of students define capitalism as free market capitalism in our most recent survey, about 40 percent of students confuse capitalism with cronyism. This leads to skepticism about capitalism, with only 27 percent having a positive view in our most recent survey. This type of confusion is likely to lead to a destructive spiral in which people attribute problems resulting from cronyism to capitalism and call for policies that require more government intervention in the economy.[v] This leads to more opportunities and incentives for firms to engage in cronyism, resulting in additional distrust of capitalism.

To illustrate this kind of unvirtuous destructive spiral, consider the supply chain disruptions during and after the Covid-19 pandemic. Some blamed capitalism for the problems[vi] when much of the problem was rooted in cronyism. U.S. companies experienced delays in receiving imported products to meet consumer demand and experienced rising shipping costs, while exporters were unable to get containers to ship their products elsewhere.

While port congestion and delays in 2021 and 2022 were certainly much the result of a spike in imports due to pandemic recovery, cronyism also played a major role in the problems experienced at U.S. ports. Scott Lincicome, JD, a policy scholar at the Cato Institute, highlights factors catering to special interests that were major contributors to the problems.[vii] First, provisions in labor union contracts made U.S. ports less efficient, including limiting hours of work, inflating labor costs and fighting automation. In fact, in 2021, when these delays were at a peak, the two largest container ports in the U.S.—Los Angeles and Long Beach—ranked last and second to last in the World Bank's Container Port Performance Index.[viii]

Second, the Jones Act and the Foreign Dredge Act, two U.S. maritime laws, which are also heavily supported by union lobbying, reduced the ability of ships to travel between U.S. ports and made it expensive to dredge ports to accommodate larger ships. The Jones Act prevents non-U.S. owned, built and crewed ships from transporting products between U.S. waterway ports, while the Foreign Dredge Act applies the same rules to dredging material. These restrictions led to increased congestion on in-land modes of transportation.

Lastly, trade-remedy import tariffs on truck chassis contributed to large price increases on truck chassis and limited the ability of U.S. freight carriers to get them. These trade-remedy import tariffs, which were the result of an investigation done at the request of U.S. chassis manufacturers, also contributed to limited transportation capacity.

As a result of the disruptions, many called for reshoring supply chains by imposing trade tariffs and other incentives. Not only does this harm consumers and taxpayers, but it also incentivizes firms to lobby to influence the products that are charged tariffs and receive subsidies. This misplaced energy on lobbying directly harms innovation by consuming resources that would otherwise be used for innovation. In addition, fostering further mistrust of capitalism leads to more policies that dull incentives for innovation.

Role of Universities

These survey results suggest that if universities are to fulfill their roles in enabling innovation and training future innovators, they need to change. Students need to be exposed to alternative viewpoints to engage in critical thinking. Moreover, they need an appreciation for the positive role of viewpoint diversity in innovation and an ability to interact with others who see things differently. As well, they need to understand the world's progress and the role that free market capitalism has played in fueling that progress. Not only will this enable them to appreciate and advocate for policies that will allow progress to continue, but this will also help them envision future progress and the role they can play in advancing it.

The types of student programs that can help universities improve are being implemented at the Challey Institute. We offer reading groups that challenge students to explore important questions from various perspectives while engaging in constructive dialog with students who may or may not agree with them. Similarly, our pluralist lab allows students with different political views to discuss controversial topics. We offer a workshop where students learn about human progress and its causes, and where students gain insights from internationally-renowned scholars on solutions and policies that contribute to opportunity, innovation, and individual and societal flourishing. We offer a course that teaches students about different types of economic systems, including capitalism and socialism, and their implications. Our Menard Family Distinguished Speaker Series provides a venue for students, faculty and the public to learn from world thought leaders on ways to improve the human condition and create economic opportunity.

Although other university centers and institutes are doing similar things, this effort needs to be extended more broadly across higher education and to more students within universities. Universities play an important role in our nation's future prosperity and culture of innovation. Higher education needs to take the lead in fostering an appreciation for the value of viewpoint diversity, the progress we have made and the important role of freedom in this progress. By doing so, universities can help ensure that America will remain a leader in innovation.

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[i] Editorial Board. "How Fauci and Collins Shut Down Covid Debate," The Wall Street Journal, December 21, 2021.

[ii] Klutsey, Ben. "To Conquer Our Biases and Improve Our Knowledge, We Need Epistemic Liberalism," Discourse, September 23, 2021.

[iii] Data on human progress in these and other areas can be found here: https://humanprogress.org/datasets/

[iv] Bitzan, John and Clay Routledge. "Is there a relationship between knowledge of human progress and student optimism? Challey Institute Research Brief, November 2021. https://www.ndsu.edu/fileadmin/challeyinstitute/Research_Briefs/Research_Brief_2021.02.pdf

[v] Klein, Peter G., Michael R. Holmes, Jr., Nicolai Foss, Siri Terjesen, and Justin Pepe. "Capitalism, Cronyism, and Management Scholarship: A Call for Clarity," Academy of Management Perspectives, 36(1), 2022.

[vi] Selwyn, Benjamin. "Limits to Supply Chain Resilience: A Monopoly Capital Critique," Monthly Review: An Independent Socialist Magazine, March 1, 2023.

[vii] Lincicome, Scott. "America's Ports Problem is Decades in the Making," Cato Institute, September 22, 2021. https://www.cato.org/commentary/americas-ports-problem-decades-making#

[viii] The World Bank, "The Container Port Performance Index 2021: A Comparable Assessment of Container Port Performance," World Bank, Washington, D.C., 2022.

Securing Elections with Blockchain?

Back to the Future with Paper Ballots

MARCUS FRIES, PHD

Assistant Dean of Cybersecurity
Bismarck State College

In recent years, contested elections have motivated political pundits, think tanks and technology experts to propose blockchain as a means to secure our elections.Given the political mess that followed the presidential elections in 2000, 2016 and 2020, finding a way to make elections immune to hacking and other forms of manipulation—both real and perceived—is crucial to national security and the maintenance of our republican system.

Could blockchain be used to secure elections?

What is Blockchain?

According to IBM, a blockchain is "a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network."[i] At its core, a blockchain is primarily a digital ledger, which is a document recording information, usually but not only financial. Bitcoin uses blockchain to track all transactions on the Bitcoin network.

Blockchain could be used to track contracts and scientific discoveries.

"Immutable" means that blockchain is unchanging, in that once a transaction, such as with Bitcoin, is processed, it is added to the blockchain and can never be removed.

"Shared" means that all users on that blockchain network can see every element on the ledger, meaning there is no hidden information. Regarding Bitcoin, anyone can download the ledger and see every transaction that has ever been processed.

If anyone can download the Bitcoin ledger, how can it remain private? This is because the ledger only contains account numbers, balances and public keys. There is no information about the actual users.

The last and most interesting feature of a blockchain is that it consists of blocks of data that are linked, one to the next, through a cryptographic process. This means a previous block cannot be faked except by faking all past blocks to the present. So, if something is in the blockchain a long time ago, it is nearly impossible to fake the age of the item.

Hash Functions

Part of what makes blockchain useful is that it can store an image of data, compressed into a smaller format

[M]any proponents claim that blockchain can secure our elections. I was in this camp when I began to write this article. But after considerable research, I changed my mind. **Blockchain cannot secure our elections.**

that is completely dependent on the original. The most common method for this is a hash function, which takes an input object (document, picture, etc.) and produces a string of 0s and 1s, usually 256 digits (1s and 0s) in length.

The three main properties of hash functions are:

First, hashes must be fast to compute. For a hash to be effective, a computer must be able to compute the hash within a fraction of a second. Bitcoin blocks in the blockchain are created by hashing in a particular way (see below), and the computers capable doing this run up to one quadrillion (1,000,000,000,000,000) hashes per second, which is extremely fast.

Second, hashes need to have pre-image resistance, which means that no one can meaningfully control the output—that is, make the output be whatever one wants. Hashes are designed such that changing one character in a document or a pixel in an image gives a 50/50 chance that each of the 256 bits (0,1) in the output can change. So, a tiny change in a document results in a drastic change in a hash, since the odds that all 256 bits would not reflect a change in output is 1 in 2^{256} (on par with finding one particular atom in the universe).

Third, hashes need to be collision resistant, which means that it is very difficult to find two meaningful documents that have the same hash value.

How Can Blockchain Be Used?

Blockchain solves the problem where people want to secure some piece of information or validate ownership. An ag tech inventor named Pete, for example, has created new technology but is not ready to go public.

He wants to prove he had the discovery first, so that no one can steal his work. To do so, he needs to show that he developed the technology on a particular date in the past.

To prove this, Pete can perform a hash of the document and submit it to the blockchain. Then he can prove to anyone that he had this document in his possession at the time it was submitted to the blockchain, since it is impossible (as discussed above) to fake a hash because any minor change will result in a different hash. As well, this hash was stored in the blockchain and is now fixed in time. At any future date time, Pete can present the document and its hash in the blockchain proving that he had the document at that point in the past.

In another example, imagine that Rob and Jenny have a legal contract for business partnership they want to keep private for the next three months. However, they both want to be able to prove this contract was signed today. Rob and Jenny can create and digitally sign their contract. They can then encrypt and hash the contract and then submit the hash to the blockchain. Now, they are able to prove that the contract existed at a particular time even without a third party knowing the details.

Bitcoin Blockchain

In a third example, imagine Kevin wants to accept Bitcoin as payment but also wants to be sure that this is a valid transaction. Since Bitcoin transactions are kept in the blockchain, Kevin can check the Bitcoin blockchain to see that his transaction has been validated and is now part of the blockchain. This shows that the payment was received, and the currency is securely in his possession.

The Bitcoin blockchain was the first blockchain to exist. It was invented by an unknown person using the pseudonym Satashi Nakamoto. The Bitcoin blockchain makes blocks and then links them one to the next. All Bitcoin transactions since the last block was formed are collected and verified cryptographically (see my article in the Fall-Winter 2022-23 issue of Dakota Digital Review, "The Unencrypted History of Cryptography"). The transactions are then plugged into a hash with the hash of the previous block.

Then a search is done for a number so that when it is included in the hash, it results in a hash output with a specific number of leading zeroes, (76 at the time this article was written, but this changes every few months) There are 2^{256} hash values, and we are looking for one out of 2^{180}, so the probability of finding one on the first try is $2^{(-76)}$ (that is, 2^{180} divided by 2^{256}), which approximates 0.000000000000000000000013. To put this in perspective, your chances of winning the Powerball are 0.0000000034, which is ten quadrillion times better.

The amazing part now is that the computers on the network adjust values until a satisfactory number has been found. There is no method to this; the computers simply try values until they find one that works. From this, the bitcoin network takes significant computational power. The network parameters are adjusted so that this search takes about 10 minutes on average.

Why Blockchain Cannot Secure Elections

Because of the above, many proponents claim that blockchain can secure our elections. I was in this camp when I began to write this article. But after considerable research, I changed my mind. Blockchain, cannot secure our elections.

The following ideas are based on a paper by four MIT professors, entitled "Going from Bad to Worse: From Internet Voting to Blockchain Voting."[ii]

Advocates for blockchain voting claim we can use modern cryptography, electronics and blockchain to secure elections. They argue that voters can use either an electronic voting machine or cell phone with modern cryptography to vote and tally votes securely.

To assess this argument, we must consider the five properties that a secure election system needs to possess:

> ***1. Evidence-based:*** To be secure, election systems need to be evidence-based, meaning that "election officials should find the true winner(s) but also provide the electorate convincing evidence that they did."[iii] As we see every day in the news, all electronic systems can be hacked. Obviously, American elections would be high-value targets for malicious attackers. Thus, security concerns are vastly greater than a simple shopping website. Online shopping and banking can tolerate a certain amount of fraud. Credit card companies use their money from interest

to absorb some of this fraud, and if the fraud is large enough, the government might step in for recourse. Elections try to maintain zero fraud, since a single vote can determine the outcome. So, the security needs of a digital election could easily be too cumbersome (too time-consuming and complicated to use very secure passwords and a very secure voting device, both of which are orders of magnitudes more secure than what's currently in use, such as a cell phone or home computer) for the average person.

2. Secret ballots**:** Elections in democratic countries must guarantee that all voter ballots are secret. However, to create a computer-based cryptographic system in which we know exactly who voted but not who they voted for is a large task. Again, the security concerns are huge compared to modern computing infrastructure.

3. Voter-verifiable votes**:** The above security concerns are compounded by the fact that votes must be voter verifiable. Voters must be able to verify, before votes are cast, that their ballots reflect their true intentions. This would require secret keys for every individual voter, which are simple enough to cast and verify a ballot but secure against all outside influences.

4. Contestability: If a voter or an election official recognizes an error, he or she must be able to convince others that an error has occurred. Then election officials must be able to correct that error.

5. Auditable**:** Is there an evidence trail that can be checked to verify that the system is indeed functioning correctly? Without auditability, there is no surety that the vote tally is correct or that the correct people voted. Nor would recounts be possible. When the system is audited, we have evidence that the election was correctly done.

The best cryptographers in the world have worked to address these issues. We know from the hacking we see daily in the news that insecure passwords and insufficient security abound. With this in mind, the security needed for an election to satisfy the above properties would be so cumbersome that, in the opinion of many experts, voting participation would drop dramatically. Just imagine that online shopping was made significantly more difficult to improve security. There would be a large number of people who would give up shopping online. To make elections secure would require much more difficulty than this for the average user, thus discouraging many from doing it.

Paper to the Rescue

So, what can be done? Paper ballots with electronic counting satisfy all of the above criteria:

1. Evidence-based**:** There is a physical object that exists showing the individual's vote. In North Dakota, these ballots are also marked by an election official, so that falsifying a large group of ballots is infeasible. Also, the individual's ID is checked against a database, thus verifying that he or she is eligible to vote.

2. Secret ballots: The voter is given a ballot and then goes to a voting booth where his or her vote cannot be seen by another voter or official.

3. Voter-verifiable votes: The voter sees exactly how he or she marked the ballot, and thus is able to verify for whom and what he or she voted.

4. Contestability: If the counting machine is believed to be in error, a recount with a different verified machine can be conducted.

5. Auditability: The voter list can be verified against other data, thus ensuring only eligible voters voted. Further, the physical paper ballots allow for a variety of recount methods. Lastly, as the ballots are marked by an official, false ballots are difficult to introduce into the system.

North Dakota does all of these and does them well. Thus the North Dakota paper ballot system is very secure, well designed, easy to use and satisfies the properties of a good voting system. The author would encourage all states to copy the North Dakota paper ballot system. ▣

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[i] https://www.ibm.com/topics/blockchain

[ii] Sunoo Park, Michael Specter, Neha Narula, Ronald L Rivest, "Going from Bad to Worse: From Internet Voting to blockchain Voting," Journal of Cybersecurity, Volume 7, Issue 1, 2021, tyaa025, https://doi.org/10.1093/cybsec/tyaa025

[iii] Ibid.

Noel Anderson, PhD, inventor and educator, speaking at Grand Farm's Autonomous Nation 2024.

Will AI Replace Inventors?

Computing vs Seeing

NOEL W. ANDERSON, PHD

Does generative artificial intelligence (AI), including Large Language Models (LLMs), signal the end of the road for inventors such as me? Or will generative AI accelerate and enhance the quality of my work? I hold 204 issued and 54 pending U.S. patents, putting me in the upper 0.1 percent of inventors with at least one U.S. patent and at the top of inventors in the agricultural equipment industry, in which I spent most of my career. Besides concerns for my future, how do I mentor novice inventors so they can catch the wave of AI-assisted invention? Or will that wave permanently submerge them?

What is an Invention?

An invention starts with seeing a need and then addressing that need. For this article, I add the U.S. patent law requirements for an invention: (1) patentable subject matter, including a device, system, composition of matter or method; (2) novelty or not being an exact copy of something already in existence; and (3) non-obviousness in the eyes of a hypothetical person who has "ordinary skill in the art" and access to all public information in the world. In Europe, non-obviousness requires an "inventive step" beyond common problem-solving.[ii]

It should also be noted that with the exception of South Africa,[ii] global patent law requires inventors to be "natural persons."[iii] AI software as an inventor is a topic of much current debate including court cases[iv] and introduced legislation.[v] On the one hand, companies using AI software to develop patentable inventions want legal protection for those inventions. On the other hand, there is interest in protecting the legal rights of humans participating in invention through AI software.[vi]

Inventive Process

As an example of my human inventive process, consider thoughts during my drive home from a medical appointment.

What if we had digital twins, high-definition digital models of our bodies, to mitigate unpleasant and risky medical procedures?

For example, if a patient had a digital twin of their colon generated from the first physical colonoscopy, a medical procedure with a quite unpleasant preparation process. These procedures are first given when people turn 50 years of age and then are repeated every five to 10 years. Perhaps the digital twin could be used to "finish" the sequence of colonoscopies started by the human? In moving this concept to commercialization, there would be a many patentable details left to work out. At this point, there is early research on creating digital twins of human colons. There are questions that need to be answered such as what data should be collected in the initial colonoscopy and then what data needs to be provided to update the twin. While later colonoscopies might be eliminated, it is more likely that the common fixed five or 10 year retest intervals would be modified to longer, variable intervals, still resulting in cost and comfort benefits.

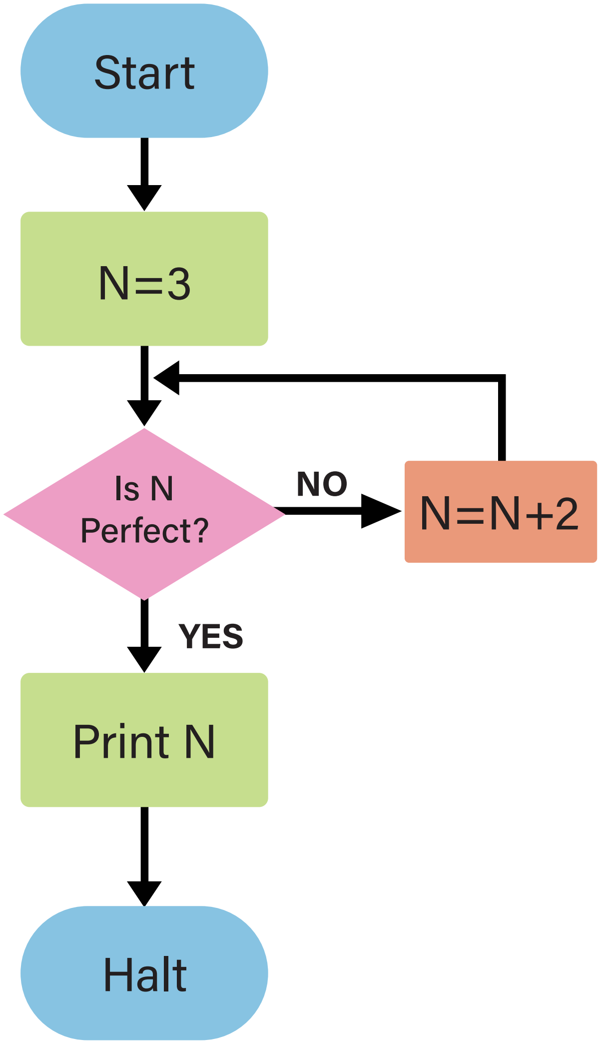
In a later coffee-shop conversation, an idea emerged regarding continuous blood-glucose monitoring, which would eliminate the need for a blood draw or wearing a patch, as an analogous application for a digital twin that could "complete" a series of invasive medical data collections. Currently, glucose monitoring is evolving towards wearable devices, such as smart watches, that

JOHANN GUTENBERG
Printing press

ROBERT HALL
Semiconductor Laser

BARTOLOMEO CRISTOFORI
Piano

CHARLES BEST
Insulin



will measure blood glucose using infrared or terahertz electromagnetic signals. The digital twin could then be used to predict the individualized effect of eating certain foods on blood glucose for managing diabetes or weight.

AI's Computational Limits

Solutions, whether from computers or humans, need to be delivered in a timely fashion. Tomorrow's weather forecast is of no value if it is delivered the day after tomorrow. Similarly, inventions by AI need to be delivered while still relevant to individual, business or societal needs.

In the early- to mid-20th century, work by mathematicians and early computer scientists explored the bounds of what could be computed or solved. The research identified a number of generic problem categories and, for each category, whether a solution could be calculated and the program end or halt. If the program does halt, how much computing time is required as the size of the problem increases? The fastest computing time is limited by the problem size, the ability of software algorithms to handle growth of problem size beyond a handful of inputs, and the physical limits of the computer These limits will now be considered in more detail.

Halting Problem

One such category is the Halting Problem, which seeks a general algorithm that, given a program and inputs to the program, determines if the program will eventually halt—that is, complete its execution or go into an infinite loop. Alan Turing,[vii] a mid-20th century mathematician known for his work in breaking German codes during WWII, proved that there is no solution for the general case even though specific cases may be decidable.

For example, the following one-line program always halts after sending the phrase—"This program halts."—to a printer or display device:

```
PRINT ("This program halts.")
```

And this two-line program (below) never halts because the WHILE statement is an infinite loop that never exits. The PRINT statement is never reached in the execution of the program. Infinite loops are often experienced on consumer devices by a progress indicator that continuously spins or scans on a display, never advancing to the next step of program execution:

```
WHILE (TRUE) ENDWHILE

PRINT ("This line never gets printed.")
```

Programs that can't be decided typically involve calculations of numbers in sets for which the existence of a particular member or the largest member are not known. As an example, it is not known if there are any odd "perfect numbers," or if the number of perfect numbers is finite.[viii] A perfect number is an integer that is equal to the sum of its positive proper divisors, for example, 6 has proper divisors of 1, 2, and 3 and 6=1+2+3; 28=1+2+4+7+14; etc.) Consequently, it is not known if a program to find an odd perfect number, such as the one above left, will halt. 'N' is set to the odd number 3. 'N' is tested and if found to be a perfect number, it is printed and the program halts. Otherwise, the next odd number is generated by adding 2 to N, and then program execution returns to the testing step and, as necessary, trying the next odd number.

While the Halting Problem is typically considered in the context of finding solutions to mathematical problems, by analogy it can be applied to general inventive problems. Would an AI problem-solver be able to find a way to travel faster than the speed of light? Using all current physics knowledge, the answer is "no." Could it discover new enabling physics? It is unknown if such physics exists and then if AI could discover it and halt. Thus AI problem-solvers could be turned loose on some problems without knowing at the start if they will ever return a solution; they could run indefinitely.

Growth Function

In addition to identifying if an algorithm will come to a solution and halt, another consideration is the growth function of algorithm-execution time as the number of inputs increases. This is typically expressed as a mathematical function using "big-O" notation.[ix] One place computational time growth is observed is software for, say, an online store-product database. When a vendor demonstration is conducted with several dozen products in the database, the speed seems instantaneous. When the system is purchased and installed with data for tens of thousands of products, it runs painfully slow. Potential customers get tired of waiting and leave the online store before search results are delivered. People can also get tired of waiting for inventive problem solutions or find them of no value if they are delivered too late. The table below shows some examples of common growth functions for a baseline set of data, the 1x-column, which can be processed on average in one second. Later columns show typical execution times for datasets of some multiple (2, 4 and 8) of the original dataset.

Because of the intractable execution times needed to exhaustively process some large datasets, heuristic (rule-of-thumb) algorithms[x] have been developed that can execute much more quickly but do not guarantee the very best result to a given problem. Shoppers often apply heuristic algorithms as they approach the checkout line to minimize wait time. Rather than do a detailed calculation to determine which line gets them through check-out as quickly as possible, shoppers

Algorithmic Growth Functions

Growth Function	Example Application	Datasite Size 1x	2x	4x	8x
O(n) (Linear)	Finding an item in an unsorted list	1s	2s	4s	8s
$O(\log_2)$ (Base 2 logarithm)	Finding an item in a sorted list (e.g., phonebook look-up by name)	0s+ε	1s	2s	3s
$O(n^2)$ (Square)	Sorting a list by value (e.g., alphabetizing)	1s	4s	16s	64s
O(n!) (Factorial)	Finding by brute force the shortest route to visit X number of cities	1s	2s	24s	40,320s

The sad thing about artificial intelligence is that it lacks artifice and therefore intelligence.

Jean Baudrillard

often select the shortest line based on number of people currently waiting or the shortest line based on the total number of items to be scanned, or simply join the closest line open for checkout.

Combinatorial Optimization Problems

Heuristics are often applied to combinatorial optimization problems, such as the O(n!) example in the table on page 47. Combinatorial problems typically involve finding an optimal or best-fit solution from a finite set of possible solutions. The Traveling Salesperson Problem (TSP) is a common example. The basic problem is to travel to each of X number of cities, covering the least amount of distance and never visiting a city twice. The brute force approach of evaluating all possible routes to find the shortest one grows factorially, (X-1)!. For example, there are (8-1)! or 5040 possible sequences to visit eight cities. Numerous heuristic algorithms have been developed to provide good routes in a tolerable amount of time. Some have been animated, available on YouTube, to illustrate the approaches.[xi]

Some inventions are carried out as search problems. Consider Thomas Edison's invention of the incandescent light bulb. It was known that passing electricity through a material could cause it to heat up and glow. The problem was getting the material hot enough to provide a useful amount of light without quickly burning out. Edison's approach was largely trial and error. He and his staff evaluated somewhere between 1,600 and 6,000 filament materials (reports on the number vary) until, in 1879, they settled on a carbon filament made from charred bamboo. It wasn't until 1904 that tungsten was identified as a superior filament material, and then later the tungsten filament was wound to reduce the space it occupied, reducing the size of light bulbs producing a given amount of light. Putting the filament in a vacuum and later a neutral gas to extend its life was another dimension of light-bulb evolution.

The process was largely searching through a finite number of filament materials, dimensions, geometries and enclosures. The combinatorial space was large but could be reduced by pruning the search space based on empirical rules (heuristics), such as finer conductors will glow with less current and organic material tends to burn when heated in an oxygen environment but not in other environments. Yet there was the initial inventive step/observation that the problem of generating light with electricity might be solved (better) by running a current through a material, causing it to glow brightly. While carbon arc lamps were first demonstrated in the early 1800s, as was electrical incandescence, Edison iteratively mitigated deficiencies of the initial concepts, resulting in a commercial product.

Computer-aided identify-and-test is in use today, particularly with drug and material discovery.[xii] The molecular shape of, say, a biological receptor is identified. Candidate molecules to fit the receptor are generated by software and tested to see if they fit and have the desired patient benefit. Chemicals passing that test are then evaluated for potential side effects on humans. Combinatorial growth in computation occurs based on molecular complexity, the number of candidates and number of evaluation dimensions.

Physical Limits

Besides AI's algorithmic limits, related to the halting question and to processing growth functions, there are physical limits on computational devices that execute AI algorithms. For the last 60 years, computing devices have been dominated by semiconductor electronics that have steadily improved in performance. Silicon circuit features are approaching size limits where instead of following circuit paths, electrons tunnel between paths and the technology no longer works. Also notable is the speed of light, limiting the transmission of data within and between circuit elements to approximately one foot per nanosecond in a vacuum. In media other than a vacuum, the signal velocity is reduced.

Quantum computers have demonstrated superior processing capability for problem domains, such as encryption and optimization. These are still in the experimental stage with some challenges to overcome, including error rates; computer-size scalability; costs, such as the need for cryogenic cooling; and the development of programming environments and algorithm libraries. Some aspects of invention might be radically impacted by quantum computers, but it is difficult at this time to predict the full extent.

Philosophical Limits of AI

Beyond the mathematical and physical constraints on AI invention, there is a set of limitations presented here as philosophical since they are related to assumptions, values and beliefs.

The first two limitations are brain/mind vs computer/program and the role of lived human experience in invention. As described above, some inventions can be handled by exhaustive generate-and-test, but that approach is limited by existing knowledge and by the combinatorial explosion of processing required for trial-and-error approaches. If the solution search-space can be trimmed, then computation requirements may be reduced. Also as noted earlier, invention involves identifying and applying new knowledge or perspective, sometimes called "thinking outside the box" or "taking the inventive step."

One assumption in the belief that computers may at some point equal or exceed human capabilities in taking inventive steps is that computers can mimic the human brain/mind: that algorithms executed on silicon, quantum or other artificial structures can replicate the essential thinking of a human inventor. "Replicate" can mean that inorganic circuits and software could be designed to mimic or simulate the biochemical processes of the human brain with its labyrinth of ~100 billion neurons and ~100 trillion synaptic connections. "Replicate" can also mean that any problem solvable by the human brain/mind could also be solved by a computer, possibly by a different approach. An example of this is chess, in which human grandmasters rely on patterns and looking ahead several moves, while computers rely on a different approach, looking at exact board configurations and game outcomes many moves into the future.

Lived Human Experience

Much invention is directed to improving human living, and how lived human experience plays into identifying those opportunities. Can this lived experiential knowledge be replicated by AI? Consider an example in which a robot checks into a hotel and walks into its room, which has a temperature of 87° F, well within its own and human operating limits. End of story.

Now consider the same story, but a human walks into the room and is uncomfortable until the air conditioner cools the room to 72° F (Where is the thermostat? How is it operated? Now I will be sweaty for my dinner meeting … .)

The human, who is an inventor, recognizes that having the thermostat set high reduces air-conditioner use and consequently reduces hotel energy costs and greenhouse-gas footprint. Yet these benefits are offset by customer discomfort when the room is initially occupied. How can the customer be comfortable when in the room while saving energy when absent? One solution is to control the thermostat based on a

STEPHANIE KWOLEK
Kevlar

ALEXANDER FLEMING
Penicillin

ISAAC SINGER
Sewing machine

RANSOM ELI OLDS
Assembly line

check-in time captured from the customer when the reservation is made or by using GPS and estimating time of arrival from a phone app.

This problem can easily be identified by a human, especially one who finds 87° F excessively warm and who can initiate an inventive solution.

How would a computer observe the problem and initiate a search for a solution? Big data and data analytics are possibilities. Guest comments that say, "Room was too warm," are not as helpful as comments saying, "Room was too warm *on arrival.*" Then there is the need to collect thermostat data to quantify the phrase "too warm." This may be difficult if the customer comments are anonymized for privacy, or if the thermostat can't communicate with the customer-feedback software.

To solve the problem, a contradiction may be formulated along the lines of, "The room must be hot to save air-conditioning costs, AND the room must be cool for customer comfort." Contradictions are often resolved through optimization, say, finding a room temperature of 76° F that balances energy costs and unhappy customer costs. In other approaches, the contradiction is resolved by recognizing that hot and cool can be time-shifted based on occupancy, leading to the solution of having the room warm when unoccupied and cool when occupied with a cool down occurring before the guest arrives.

Unspoken Needs

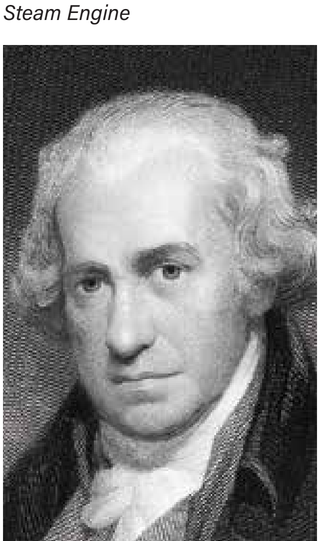
The hotel room example addresses spoken needs, but many needs go unspoken. Sometimes this is because data isn't collected. Other times, people aren't aware of the need, often because a suboptimal situation is accepted as the way things are. It's not clear that computers can generally identify unspoken human needs and follow up with solutions requiring an inventive step. As Henry Ford is attributed to saying, "If I had asked people what they wanted, they would have said faster horses." Horse riding or pulling a carriage set the standard for human transportation for millennia and so was seen as a fixed element. A horseless carriage didn't make sense because it wouldn't move. In the 19th century, steam engines propelled trains over fixed tracks, but off-track steam-traction engines were unwieldy and struggled on hills. They also required two people to operate: one steering and the other stoking the boiler. The opportunity to have personal transportation with something other than horses wasn't seen until inventors subtracted horses and replaced them with steam and then petroleum engines.

Cultural, Social & Legal Limits

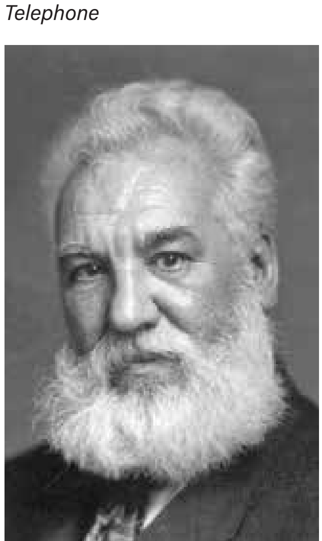
Another set of philosophical limits are cultural, social and legal. These limits are highly dynamic as AI technology evolution races faster than cultural and legal systems. To be viable, trained AI systems, such as LLMs, require large amounts of low-cost data.

However, businesses, including news organizations and book publishers, are pushing back on the uncompensated use of their copyrighted text and images. Lawsuits have been filed against generative AI companies regarding use of copyrighted material as training data without notification, compensation and consent.[xiii] Individuals have privacy concerns about the use of their social-media posts, as well as concerns over defamation and other damages that can occur when generative-AI systems provide information or guidance, which is false and/or defaming[xiv] or biased.[xv] Restrictions

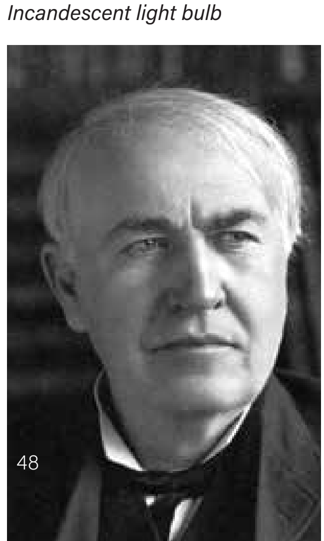
JAMES WATT
Steam Engine



ALEXANDER GRAHAM BELL
Telephone



THOMAS ALVA EDISON
Incandescent light bulb



HEDY LAMARR
Spread spectrum radio

on free training data will impact the capabilities and costs of AI systems used for invention. The U.S. Congress—as well as European lawmakers[xvi]—is starting to consider legislation that promotes technical and commercial advancement of generative AI, while protecting the economic and privacy interests of data sources and those impacted by false outputs.

Society also faces the potential displacement of at least some humans involved in invention, as well as other jobs, by AI systems. A significant rise in unemployment from AI may result in deployment restrictions, service taxes, consumer boycotts or other actions, limiting the use of AI for invention. These actions are hard to predict, especially since the type and magnitude of pushback might depend on a catastrophic gray or black swan event (that is, a significant partially or fully unforeseen event) involving AI.

Other philosophical limits result from realities beyond current science and mathematics. New knowledge about the natural world through scientific or mathematical research could play significant roles. A better understanding of how the human brain/mind invents is a major subcategory. Advances in computer hardware and algorithms are others. Some philosophical limits might lie beyond the physical electrochemical activity of the brain/mind—for example, engaging a human soul. Unique creative abilities of humans are seen emerging from within and rising beyond cellular biology and electrochemical activity. Others posit unique creativity coming from a source external to humans and even to the natural world. Such inventive sources, if valid, are unlikely to be reproduced by computers. Assuming such elements exist, it is unclear what problems would have solutions reachable by humans and unreachable by computers.

AI-Assisted invention

Coming back to the original question—'Will AI replace inventors?'—my current answer is that, in general, it will not happen in the immediate future. There are some specific areas, such as material and drug discovery, where generate-and-test algorithms in constrained problem/solution spaces will outperform human inventors sooner rather than later. For the rest, I see AI-assisted invention as the norm for the foreseeable future, say, at least five to 10 years.

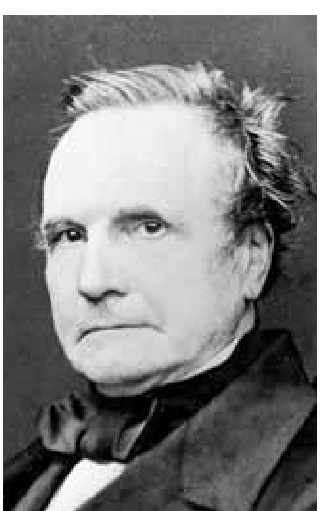
For patentable inventions, the inventive process includes:

1. Problem identification
2. Solution identification
3. Technical development of the solution[xviii]
4. Invention documentation write-up
5. Patent application write-up and filing
6. Patent examination

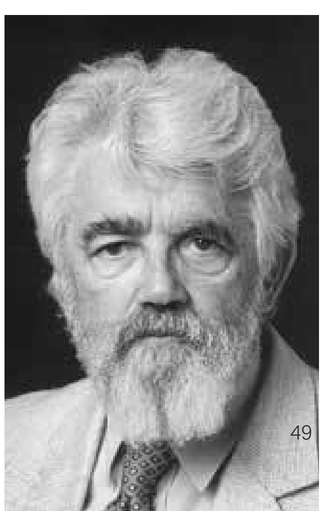
As noted earlier, the inventive step of identifying a novel and non-obvious solution (step 2, above) to a problem (step 1) may be difficult if not impossible for AI in the general case. Brute force approaches, such as trial-and-error, face the combinatorial explosion of computation and the physical limitations of computers. It is not clear how a computer could be programmed to take inventive steps given structural and lived experience differences between the human brain/mind/soul and semiconductor or quantum computers.

However, AI can accelerate all six steps in the inventive process and potentially reduce the cost of invention. The combination of higher speed and lower cost computation provides an opportunity for early movers

CHARLES BABBAGE
Computer



JOHN MCCARTHY
Artificial intelligence



SAM ALTMAN
Generative AI/ChatGPT

AI/GENERATIVE AI
Technological Singularity?

to leap ahead and block competitors from emerging product and technology spaces. This creates a unique opportunity for new entrants and existing companies seeking to increase market share and pricing control.

Currently, invention speed is often limited by the rates at which humans can wade through computer-search results and either find specific pieces of information or summarize a collection of information. LLMs are now doing the reading and stand ready to do search and summary. Humans ask a question, AI provides an answer, the human (for now) fact-checks the answer and then digs deeper with the next question.

AI, particularly LLMs, can play the roles of a customer to enumerate common articulated problems, a technical expert to help develop solutions, a writer to describe

> ***There are three classes of people: Those who see; those who see when they are shown; and those who don't see.***
>
> Leonardo da Vinci

inventions, and a patent analyst to find prior art for solution evaluation and patent examination. All these roles might be carried out quickly, inexpensively and with 24/7 availability. Days and weeks can be eliminated from the invention and patent application timeline to get customer information from marketing, solution help from a technical expert, and then the write-up of invention disclosures and patent applications.

Globally, patents for identical inventions are awarded to the first party to file an application at a national patent office. If and when granted, the patent prevents others from making, using or selling the covered invention for 20 years from the filing date in the countries in which the patent is granted. It is a high-stakes race with a patent prize only for first place.

Core of Invention

Even with the acceleration provided by AI in certain elements of invention, there is still a critical need for humans who can take inventive steps beyond the strides of current AI technology. The core of invention is seeing: seeing once to identify a need and seeing again to identify a novel and non-obvious solution to the need. It is seeing that requires the human brain/mind/soul nourished by lived experience and strengthened by cognitive training. And now it is seeing, enhanced by magnification provided by AI. ▣

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[i] https://www.bitlaw.com/patent/requirements.html

[ii] https://ipwatchdog.com/2021/07/29/dabus-gets-first-patent-south-africa-formalities-examination/id=136116/

[iii] In February 2024, the US Patent and Trademark Office issued guidance on the patentability of AI-assisted inventions in the U.S.: https://www.uspto.gov/subscription-center/2024/uspto-issues-inventorship-guidance-and-examples-ai-assisted-inventions

[iv] In 2023, the US Supreme Court declined to hear the appeal of the district court's decision on AI as an inventor. The UK supreme court also decided against Thaler in that jurisdiction. https://cafc.uscourts.gov/opinions-orders/21-2347.OPINION.8-5-2022_1988142.pdf and https://www.supremecourt.uk/cases/docs/uksc-2021-0201-judgment.pdf , respectively.

[v] https://ipwatchdog.com/2024/02/29/brazilian-lawmaker-introduces-bill-allow-ai-inventor/id=173809/

[vi] The World Intellectual Property Organization (WIPO) and the US Patent and Trademark Office (USPTO) have been working on AI inventorship for the past five years. https://www.wipo.int/wipo_magazine/en/2019/06/article_0002.html

[vii] https://www.britannica.com/biography/Alan-Turing

[viii] https://www.britannica.com/science/perfect-number

[ix] https://www.britannica.com/science/time-complexity

[x] https://optimization.cbe.cornell.edu/index.php?title=Heuristic_algorithms

[xi] TSP heuristic solution examples include https://www.youtube.com/watch?v=SC5CX8drAtU and with more background https://www.youtube.com/watch?v=GiDsjIBOVoA

[xii] Two examples including metals: https://www-technologyreview-com.cdn.ampproject.org/c/s/www.technologyreview.com/2022/10/25/1062104/machine-learning-new-metals/amp/ and another related to drugs: https://med.stanford.edu/news/all-news/2024/03/ai-drug-development.html accessed July 6, 2024

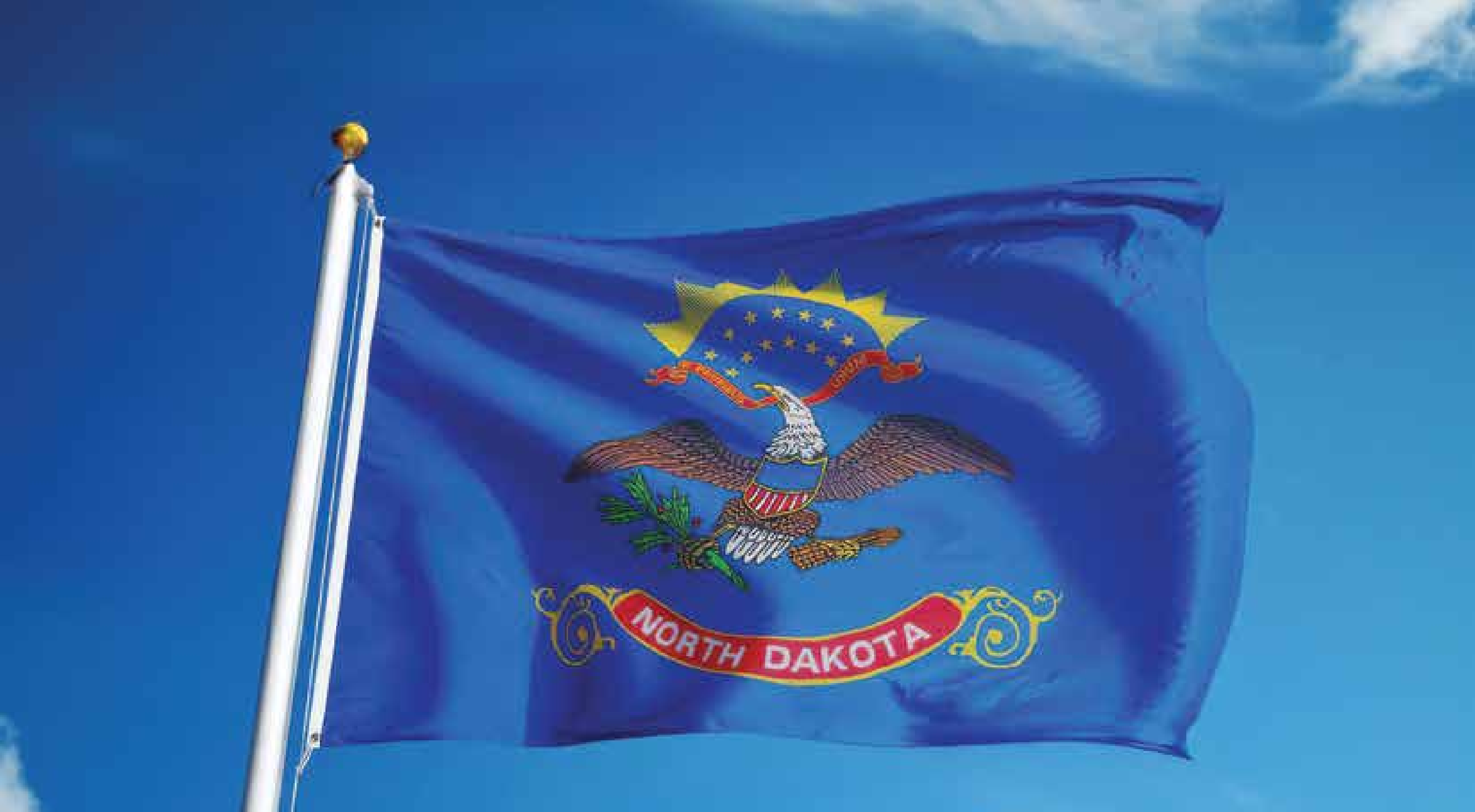
[xiii] Examples of art lawsuits: https://itsartlaw.org/2024/02/26/artificial-intelligence-and-artists-intellectual-property-unpacking-copyright-infringement-allegations-in-andersen-v-stability-ai-ltd/ and text lawsuits filed by newspapers: https://www.npr.org/2024/04/30/1248141220/lawsuit-openai-microsoft-copyright-infringement-newspaper-tribune-post

[xiv] https://www.cjr.org/analysis/ai-sued-suit-defamation-libel-chatgpt-google-volokh.php

[xv] https://www.americanbar.org/groups/business_law/resources/business-law-today/2024-april/navigating-ai-employment-bias-maze/#:~:text=The%20Equal%20Employment%20Opportunity%20Commission,to%20understand%20relevant%20EEOC%20guidance.

[xvi] https://bipartisanpolicy.org/blog/legal-challenges-against-generative-ai-key-takeaways/

[xviii] Note that patents do not require construction or operation of a prototype. Thus, a sufficiently developed concept qualifies for patent protection.



Digital Sovereignty in Localized Data Centers vs Cloud-Service Providers

ZIA MUHAMMAD, PHD SCHOLAR
Challey Institute, North Dakota State University

In the era of cyber warfare, countries have transformed cybersecurity from obscure tricks of the trade into sophisticated operations targeting the very core of our national security. Adversaries now use a suite of tactics—espionage, data theft, intrusion and system disruption—that not only undermine our economic stability but challenge the sovereignty of our digital landscapes. While digital infrastructure is the backbone of national security, cyberattacks from China, Russia and North Korea, among others, pose elevated risks to national security.

Adversaries now use a suite of tactics—espionage, data theft, intrusion and system disruption—that not only undermine our economic stability but challenge the sovereignty of our digital landscapes.

For instance, on July 25, 2024, the Cybersecurity and Infrastructure Security Agency and the Federal Bureau of Investigation released a joint advisory highlighting cyber-espionage activities conducted by North Korea's Reconnaissance General Bureau. This group targets defense, aerospace, nuclear and engineering entities to obtain sensitive technical information and intellectual property to advance the regime's military and nuclear programs.

Similarly, Equifax, a credit-reporting agency, was hacked, exposing the personal information of 147.9 million Americans. The breach included names, birth dates, Social Security numbers and addresses. Equifax data breach was allegedly carried out by Chinese military hackers.[i]

In another case, Russian hackers inserted malicious code into SolarWinds' software updates,[ii] creating a backdoor for unauthorized access, compromising SolarWinds' Orion software and infiltrating the networks of thousands of organizations. The attack also impacted multiple US federal agencies,[iii] including the Departments of Defense, Homeland Security and Treasury. As well, it affected top tech and security firms, including Intel, Cisco and Palo Alto Networks.

Nature of Nation-State Cyber Threats

Nation-state cyber threats exist in various forms:

Espionage:
Cyber espionage involves unauthorized access to confidential information for strategic advantage. Adversaries often target government agencies, defense contractors and critical infrastructure to gather intelligence.

Intellectual Property & Data Theft:
Stealing sensitive data, such as intellectual property, personal information and trade secrets, is a common tactic. This data can be used for economic gain or to undermine national security. Beyond data theft, this may involve stealing proprietary technologies, trade secrets and other intellectual property to gain economic advantages.

Cyber Intrusion:
Cyber intrusions involve breaching networks to gain control over systems. These intrusions can lead to the manipulation of data, disruption of services and even physical damage to infrastructure.

Critical Infrastructure Attacks & System Disruption:
Adversaries may launch attacks to disrupt critical systems, causing widespread chaos. They might target essential services, such as power grids, water supply systems and transportation networks, to cause widespread disruption and panic.

Cyber Warfare & Disinformation Campaigns:
In extreme cases, cyberattacks can be part of broader military strategies, aiming to weaken an adversary's defense capabilities or disrupt military operations. Cyber actors may also spread false information to influence public opinion, disrupt elections or create social unrest through social media and other online platforms.

In response to these multifaceted threats, policymakers are increasingly considering the architecture of their data-storage solutions—specifically, the balance between localized data centers and Cloud services.

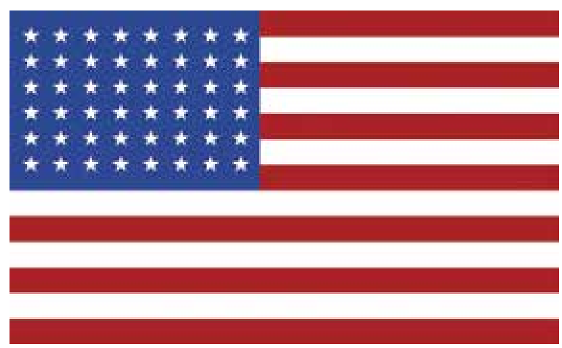
Localized Data Centers

Localized data centers are set up to store and process data within a specific geographic location. Data localization enables greater control over physical and network security. Localized data centers allow organizations to implement tailored security measures and have direct oversight of their data.[iv] Companies implementing these measures might be required to ensure compliance with local regulations and data protection laws, which are crucial for sensitive government and financial data, and can make the data centers more secure.

Importantly, reduced latency can be achieved as data is stored closer to the end-users, enhancing performance for critical applications.

Implementing localized data centers can ensure data remains within state or national borders, and governments can also impose stringent regulations and protocols designed to safeguard sensitive information from foreign interference. This approach theoretically minimizes the risk of external breaches, as data is insulated from global vulnerabilities and can be protected through localized cybersecurity measures.

However, the trade-offs can be significant. For example, scaling up infrastructure in localized data centers can be costly and time-consuming. Local data centers might lack the flexibility and agility that Cloud services offer, making it challenging to adapt to changing business needs and growing demands. As well, maintaining and upgrading physical infrastructure can be expensive, especially for smaller organizations. Local data centers require continued local involvement and monitoring.



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Cloud-Service Providers

Cloud-service providers are companies offering various online services and resources that might include computing power, storage and applications, which are hosted on remote servers, rather than on local infrastructure. They enable businesses and individuals to access, manage and analyze data and applications without the need for on-premises hardware and software.

Most organizations rely on Cloud-service providers, since they enable organizations to prioritize their core competencies, rather than getting bogged down by IT management and localized data-center implementation costs. This allows organizations to focus on key business objectives and innovation. Outsourcing infrastructure and software maintenance reduces the need for in-house IT resources and associated costs. Importantly, they operate on a pay-as-you-go model, meaning clients only pay for services and resources they use.

This allows businesses and other entities to quickly scale their resources up or down based on demand, which provides the flexibility to handle fluctuating workloads. Many Cloud-service Providers have data centers around the world, which enable organizations to expand their operations globally with minimal latency. Employees can access applications and data from anywhere at any time, as long as they have an internet connection.

Similarly, Cloud services can enhance collaboration among teams, regardless of location, allowing for real-time sharing and editing of documents and projects. The inherent scalability of Cloud-service providers allows organizations to access vast computing resources on demand, facilitating rapid innovation and deployment of new applications.

On the other hand, organizations may have less control over their data and rely on the Cloud provider's security measures. Therefore, ensuring compliance with local data protection laws can be challenging, especially when data is stored in multiple jurisdictions. There is also a risk of vendor lock-in, where organizations become overly dependent on a single Cloud provider.

Centralization raises the stakes since a single successful attack can have cascading effects, potentially compromising the data of numerous clients. Potential vulnerabilities in Cloud infrastructure can be exploited by adversaries since convenience makes Cloud systems attractive targets for cyber adversaries.

According to Gartner, Inc., the world's leading information technology research and advisory company, the three big Cloud service providers—Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP)— currently account for two-thirds of the global Cloud infrastructure market. Ranking fourth and fifth are Alibaba and IBM Cloud Services, leaving only about 23 percent for other providers. According to Gartner, Inc., Cloud concentration—both in the small number of controlling companies and in the growing tendency of businesses and other organizations, including government, to concentrate all their operations in a single provider—has emerged as a significant and growing risk regarding Cloud disruption, undue influence from Cloud providers and regulator compliance failures.

Further, the legal frameworks governing Cloud services might expose sensitive data to questionable regulations, particularly when data traverses international borders. As a result, reliance on third-party providers can lead to concerns about data sovereignty, exposure and control.

Digital Sovereignty

This leads us to the pressing concept of "digital sovereignty,"[v] a term that has gained traction as nations grapple with the implications of data localization. The urgency to control digital assets, including data and infrastructure, has prompted governments to implement protectionist measures aimed at ensuring data compliance within national jurisdictions. Such mandates are intended to foster self-reliance and protect against foreign threats, resonating with a growing sentiment that data, like territory, should remain under a nation's sovereign control. These mandates require data to be stored and processed within national borders.

The U.S. is actively working on several fronts to implement digital sovereignty. The Department of State's International Cyberspace and Digital Policy Strategy,[vi] released in May 2024, focuses on building a secure, resilient digital ecosystem. The strategy aims to promote economic prosperity, enhance security and protect human rights in the digital space.

The U.S. is increasingly focusing on data localization, requiring certain types of data to be stored within national borders.[vii] This aims to enhance data security and compliance with local regulations. These initiatives and regulations reflect the USA's commitment to maintaining digital sovereignty, protecting its digital infrastructure, and ensuring the security and privacy of its citizens' data.

To achieve sovereignty, many other governments around the globe are implementing data localization mandates. These mandates strictly require that data generated within a country be stored and processed within its borders.

There is also a need for companies to be more aware of where their data is stored and used, especially in light of the evolving regulatory landscape.[viii]

While data localization can enhance security and compliance, it also poses challenges of increased costs and potential barriers to innovation and rapid growth. Protectionist policies can inadvertently hinder innovation, disrupt global value chains and limit the collaborative potential that the digital ecosystem engenders.

The challenge lies in finding equilibrium—a way to safeguard national interests without retreating into isolationist practices that stifle economic growth and international cooperation. [ix]

The choice between localized data centers and Cloud services is not a binary decision. Organizations should make informed, responsible decisions that align with their security and operational needs, by understanding the nature of nation-state cyber threats and the strengths and weaknesses of each option.

Ultimately, achieving digital sovereignty requires a strategic balance of both localized and Cloud-based solutions, ensuring resilience against evolving cyber threats. Each framework comes with its own set of advantages and drawbacks that must be weighed against the growing cyber risks.

Collaboration across borders for intelligence sharing and threat assessment will further fortify defenses against adversarial cyber activities. As we navigate the complexities of sovereignty, there is a need to prioritize a strategic posture that balances localized control over data with the flexibility required for innovation. The stakes are high, and our adversaries are ever evolving.

Our approach to digital sovereignty will positively define national cyber-integrity and cybersecurity in the years to come—if we embrace a proactive and resilient cyberspace that's vigilant against threats, while fostering a culture of innovation and cooperation.

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i https://www.fbi.gov/news/stories/chinese-hackers-charged-in-equifax-breach-021020

ii https://www.techtarget.com/whatis/feature/SolarWinds-hack-explained-Everything-you-need-to-know

iii https://www.wired.com/story/the-untold-story-of-solarwinds-the-boldest-supply-chain-hack-ever/

iv https://www.cloudflare.com/learning/privacy/what-is-data-localization/

v https://www.scalecomputing.com/resources/data-sovereignty-data-residency-and-data-localization

vi https://www.state.gov/building-digital-solidarity-the-united-states-international-cyberspace-and-digital-policy-strategy/

vii https://natlawreview.com/article/tech-transactions-data-privacy-2022-report-current-landscape-data-sovereignty-laws

viii https://www.csis.org/analysis/real-national-security-concerns-over-data-localization

ix https://www.forbes.com/councils/forbestechcouncil/2023/07/19/the-future-of-data-security-data-residency-sovereignty-and-localization-are-all-here-to-stay/

How AI Is Stealing Our Autonomy

And What to Begin Doing About It

DENNIS COOLEY, PHD
Professor of Philosophy and Ethics
North Dakota State University

As a technological tool, artificial intelligence (AI) can free us from trivial or overly complicated busywork to pursue endeavors worthy of what it is to be human. However, perhaps German philosopher Martin Heidegger's claim—that technology enslaves us—might prove a prescient prediction about AI's impact on what makes us human, ironically even as AI might afford for us more time to pursue worthy goals.

AI Frees & Diminishes

According to a Scientific American article, "Today's math learning environment is observably more dynamic, inclusive and creative than it was before ubiquitous access to calculators." The article's authors add that current high school students do far better with graphing calculators and computers than undergraduate engineering students 20 years ago.[i] If these claims are true, then it might seem the fear mathematicians and teachers expressed in a 1975 Mathematics Teacher magazine survey was unfounded. With widespread use of calculators in the classroom, students learn more easily and became better at math, rather than worse.

"Tree #5 - No Road Back," reduction relief print, 2006, Eric A. Johnson.

At the same time, as calculators unchained mathematicians' and students' creativity and critical thinking to rapidly advance their field, however, most non-mathematicians now struggle to perform simple arithmetic *and* are dependent on calculators to do what previous generations of middle-school students could easily handle with paper and pencil, if not in their heads.

The question is whether AI will prove to be like the calculator, or will it pose an even more dire risk? With AI, incredibly data-heavy problems can be solved with ease. OpenAI's GPT-3 consumption of nearly 175 billion parameters to perform its tasks is now dwarfed by GPT-4's 1.8 trillion parameters and over one petabyte dataset,[ii] for instance. Enormous amounts of market data points or gigantic data sets can be sorted and analyzed according to certain words, phrases or details in mere moments, instead of a human laboring over the same task for hours, days or months. AI makes businesses and other human activities more efficient, informed and often more precise by replacing guesswork and habit-based thinking with predictions and algorithmic decisions

The question is whether AI will prove to be like the calculator, or will it pose an even more dire risk?

based on real-time data. It frees human talent to engage in what is more fitting for its usefulness, instead of squandering it in repetitive tasks requiring little thought or creativity. AI can even challenge us to innovate and make better decisions as it incentivizes us to break away from the automatic, habitual approach we generally use when a situation is familiar to us. One study, for example, found that when "superhuman" AI played Go against professional players, the technology forced humans to come up with novel strategies in attempts to beat it, because the program had become invincible to traditional play.[iii] That creative, autonomous thinking is humanity at its authentic finest.

Who other than a technophobe, therefore, would argue against giving up drudgery for something more interesting to think about and work on, whilst simultaneously developing our unique human skills to their fullest? No reasonable person.

However, misused AI is stealing our autonomy by making us more dependent on an entity that is programmed to addict us rather than enable us to become better autonomous, rational beings living in our complex society and environment. That in turn threatens our flourishing. It behooves us, therefore, to figure out how to distinguish between good and bad AI, and then take measures to encourage the good and prevent the bad.

Humans as Moral Decision-Makers

It is fairly uncontroversial to say that mature humans are autonomous, decision-making beings living in natural and social environments. Autonomy entails critical reasoning, creative thinking and abstract, rational and emotional communication, as well as intentional engagement in the world and free-will choice. Each of these abilities is essential to our nature, and together must surely be sufficient to make a living being into a person.

Decision-making also plays a central role in the quality of our lives as evolved social animals capable of both effective, efficient engagement with others and moral agency. Both moral agency and effective engagement require being able to understand with empathy others' intentions, emotions and thinking, which enables cooperation. Developing and using the above features, we can reasonably surmise, is what it is to be an authentic human engaged in our world.

Our technologists bear comparison to the sorcerer's apprentice, producing continuously improved means toward increasingly ill-defined ends. Unless we look to the humanities to clean up the mess, we stand a better than even chance of killing ourselves with our new toys.

LEWIS H. LAPHAM, "MERLIN'S OWL" COMMENCEMENT ADDRESS AT ST. JOHN'S COLLEGE IN ANNAPOLIS 2003

Human Autonomous Decision-Making: A Sketch

Autonomous decision-making is like being literate in a language. Literacy in autonomous decision-making requires early and lifelong learning, along with regularly sharpening our capabilities of decision-making, creative thinking, critical reasoning, communication and engagement with the world around us. For autonomy to function as it ought, we must be able to identify or create clearly defined alternatives, collect the right information, accurately weigh the costs and benefits from those alternatives, and measure how well each alternative and its foreseen outcomes fit with our goals and values. If we do it right, then any other autonomous, decision-making, literate individual should be able to understand why we decided as we did, although the person might not agree with us.

How moral agents become autonomous decision-makers is the result of both nature and nurture. We are moral agents interacting with our environment in time-tested ways: evolutionary adaptation and human learning about what works, and what to value and why. From nature, evolutionary adaptation to challenging environments created our brain structure, which enables us to learn a human language, which inherently involves autonomous decision-making, whereas living and learning in a social environment (nurture) account for our habits of thought, and content generation teaches us our language's meaning and grammar.

Emotion-Based Automatic Thinking

There have been a number of writers who divide our decision-making into two different realms. Joshua Greene, a Harvard experimental psychologist, neuroscientist and philosopher, states that our brains function like dual-mode cameras.[iv] Most of our thinking is governed by the emotion-based "automatic" system comprised of efficient, automated programs created and developed by evolution, culture and personal experience. This mode is instinctual and rather simplistic, which is normal given that automatic cognitive functioning develops in early youth as children begin to recognize and remember patterns. If an encountered situation is similar enough to what has happened enough times before, pattern recognition provides guidance for thought and action.

Reason-Based Flexible Thinking

If the situation is too complex or with significant content too novel for the automatic mode, our cognition goes into a second brain mode that uses greater conscious attention and flexibility in decision-making. Here is where, I think, we find fluid intelligence, which is "the mental capacity to deal with new challenges and solve problems without prior knowledge."[v] When the automatic system is unable to deal with a situation, this deliberative, flexible and controlled mode considers the big picture and then consciously creates a path for the individual to bring the novel circumstances under some form of control. What the person decides is most likely to fit with her values, short-, medium- and long-term goals, historicity and so on.

The second brain mode is that which most of us recognize as separating humans essentially from other sentient species, which are non-sapient, some with enough cognitive functioning to develop an automatic camera cognition. But what non-sapient animal brains cannot do is develop the nuanced, flexible cognition enabling the ability to ask and answer the question of what should I do and how to do it and answer questions of moral agency. Those queries demand that we consider and value possible worlds. Being able to ask and answer such questions requires a second-mode thinking with free will, creative thinking, critical reasoning, communication and engagement.

Coordination of Automatic & Flexible Thinking

Although it might seem counter-intuitive to argue that the automatic cognitive decision-making mode is essential to the second mode, I contend that the latter is impossible without the former. First, humans use probabilities, feedback and weight-additive strategies—all essential to good decision-making—in their reasoning as they mature through lived experiences.[vi] These cognitive features are involved in both modes and how they operate.

Second, the flexible mode selects from the emotional mode's existing habits and strategies, which are useful in the situation, and then modifies them or creates additional components for this particular moment when the second mode is active. Over time, as similar enough situations arise, this decision strategy may also become a habit in the automatic mode.

Third, the more-fluid level is dependent in some ways upon the intuitive mode—that is, the smallest, trivial, automatic decisions we make on a regular basis. Most of these insignificancies pass by unnoticed because they are, as Greene says, parts of our daily habit of interacting in the world and the world acting upon us. The car seeming to want to merge a bit too soon in front of us, our trying to decide between two ice cream flavors we like, or which stairs to take on a particular day all seem insignificant, but they are part of the overall decision-making process in which we practice decision-making language through the lived experience gained from using it. The constant, incremental adjustments and interactions with others and things in our environment imperceptibly sharpen our overall cognitive skills. Intentionally interacting with our environment keeps them at the ready to operate for small, simple, efficient decisions to large, complex, novel decisions, instead of quietly rusting out.

AI-Autonomy Threat

AI-autonomy is when moral agents formulate a question, AI answers it, and then moral agents automatically adopt that answer as their own without question or qualm. In other words, they surrender their autonomy to whatever result ChatGPT or whatever AI they are using produces for them.

With AI's subtle encroachment, we might not even recognize that we are losing our autonomy. One study, for instance, found that people counterintuitively perceive themselves having greater autonomy with flexible working hours under an AI boss compared to a human boss.[vii] But that doesn't make sense. The AI supervisor is merely a set of strict rules and algorithmic control, whereas a human boss can use nuanced decision-making when required by circumstances.

If language skills rust with disuse, furthermore, then what happens to our cognitive abilities when, among other experiences, we swipe mindlessly and addictively through videos selected by AI on Tik Tok or YouTube? One study on decision-making ability, psychopathology and brain connectivity found that "as many decisions are enacted in a social context, understanding the intentions and emotions of others is often crucial for choosing well and impacts on characteristics such as one's propensity to cooperate with others."[viii] So, what does that mean for human capacities when we don't have the experiences needed to develop them?

Google Thinking

Ever since there have been exams and papers, students have been cramming, regurgitating and then quickly, efficiently forgetting the information or skills required to get a decent grade. With the ready availability of Wi-Fi and the internet, that practice became even more widespread. To understand a concept or answer a question, all a person need do is search, find a website or two on the subject, read enough to get a gist of what the whole thing is about, paraphrase the material and then move on to other chores. Not much of anything enters long-term memory for true learning, as a result, because there is no pressure or need. This has been informally called "Google-thinking."

AI-Autonomy

Google-thinking morphs into AI-autonomy when users blindly, automatically adopt whatever results the technology gives them. Instead of the users doing the work, AI performs tasks essential to being human, as well as eliminating the need to retain information and its interconnections with other content, which we need in mind to help understand and make authentic decisions for ourselves. Students regurgitate AI's shallow average of all the data collected from available sources in response to inquiries, which creates an even more-depthless paraphrase. AI-autonomy and Google-thinking, therefore, have a shared result: no evidence that students learn any additional content. The best that can be said for AI-autonomy is that AI results often look right without being right.

> In *Thinking Fast, Thinking Slow*, Daniel Kahneman posits that there are two types of people: hedgehogs and foxes. A hedgehog's brain "operates automatically and quickly with little or no effort and no sense of voluntary control." Fox thinkers, on the other hand, are far more nuanced.

It gets worse. AI interferes with our biological processes by lowering cognitive capabilities, such as intuitive analysis, creative thinking, critical reasoning and the others mentioned. With AI-autonomy, the student doesn't even attempt to synthesize the information because the technology has already done that. AI can make people lazy because it eliminates incentives to become better thinkers and decision-makers;[ix] they lose or never become fluent in the language of autonomous decision-making.

Since challenging situations happen to each of us every day of our lives,[x] we need powerful, automatic and flexible cognitive modes to solve problems and make our world our own. Research has shown that there is a strong correlation between people engaged in more complex environments and higher cognitive functioning in the short- and long-runs.[xi] We know that when there were too few choices early in life to develop nuanced decision-making processes, older people's second (reason-based, flexible) mode is unable to handle the novel or overly complicated life experiences they encounter.[xii] The amount of experiential learning and knowledge produced early in one's life enable the older version of that person to make decisions more efficiently[xiii]—and also more effectively.

Hedgehogs & Foxes

Although reducing our ability to make decisions, and therefore, limiting the autonomy needed to be human moral agents is bad in itself, there is another factor that can make this much worse. In *Thinking Fast, Thinking Slow*, Daniel Kahneman posits that there are two types of people: hedgehogs and foxes.[xiv] A hedgehog's brain

Daniel Kahneman (1934–2024) was awarded the Nobel Memorial Prize in Economic Sciences in 2002 with Vernon L. Smith and the Presidential Medal of Freedom in 2013. His areas of acclaimed expertise included behavioral economics (integrating psychological research into economics) and the psychology of judgement and decision-making under conditions of risk and uncertainty.

"operates automatically and quickly with little or no effort and no sense of voluntary control." Fox thinkers, on the other hand, are far more nuanced. They know that many situations are complex, involving many different interconnected factors and relationships. From a large number of moral factors, the fox weaves a complex solution that works overall, although what that is depends on the contextual situation and what is trying to be achieved.

Kahneman's position could show the danger of Google-thinking and AI-autonomy replacing authentic varieties. With too rudimentary or underdeveloped automatic mental cameras, the hedgehog becomes more dangerous to himself and others. The one big thing he knows might make all his decisions the least nuanced or accurate of all options open to him. Since he is not learning content or skills, because AI is replacing much of that work for him, there are fewer and fewer opportunities for him to perceive that his one big thing is not functioning well enough to obtain the benefits he wants for himself and those he cares for. That is, he can't learn from his mistakes when he isn't learning anything. Therefore, there is never an internal check preventing the hedgehog from acting against his self-interest and that of others.

The fox in an AI-dominated society, of course, is extremely rare. When AI makes too many decisions, there is no inducement to learn how to become an entity capable of nuanced, second-mode thinking. People become passive, hedgehog spectators of their inauthentic lives.

What should be done?

What humanity and each of us and our society need are people who can think for themselves. This group include such individuals who among other things develop the right questions and know whom to ask for guidance and answers. They create searches for information from all relevant sources; evaluate the evidence for its relevancy, quantity and quality; create effective, efficient plans and the methods to achieve them; and then implement them with an ability to alter them as circumstances arise justifying those changes. In other words, they are moral agents with the wisdom to know the right thing to do at the right time for the right reason.

The good news is that AI cannot replace our essential nature, which is also part of how we make decisions. We have "a capacity for generating direct knowledge or understanding and arriving at a decision without relying on rational thought or logical inference."[xv] Our authentic essence includes:

***Critical Reasoning*:** Ordinal calculations, in which two objects, ideas or actions are compared to determine which is better or worse, instead of being judged merely according to quantity.

Creative Thinking: The ability to imagine worlds that do not exist when asking why something is as it is, or how the world could be different.

Communication: Reason and emotion are elements of most communication. There has to be some motivation to frame communication in a certain way or to expend energy to communicate at all.

Engagement: Private, public and political lives require that we, as social animals, engage with others in forming relationships, keeping in mind that all social relationships require some sort of emotion to bring them into existence and sustain them.

Free Will: The power to make decisions one's own, instead of determined by nature and nurture.

The above five components are mere sketches of what these capacities entail, but they give a powerful clue as to why AI-autonomy cannot replace our decision-making nor should be overused in our lives. Each of these activities requires both the human agent's emotion and reason: emotion through desiring the situation's moral values, our engagement and acting for ourselves successfully as social animals in a changing environment; and reason through determining if what we are doing is justified in the circumstances, relative to the outcomes we seek and other relevant practical factors.

AI Proto-Rationality vs Human Intuition

Perhaps AI can approach something along the lines of proto-rationality, but it cannot be the unique non-rational and rational unity that human persons are. Humans use a "more holistic, intuitive approach in dealing with uncertainty and equivocality in organizational decision-making than is captured by AI."[xvi] Although rationality is a core element of agency, moral agents are not always rational, nor do they need to be. In fact, "moral judgments appear in consciousness automatically and effortlessly as the result of moral intuitions," rather than being the result of non-emotional deliberation.[xvii] Moral reasoning, hence, is biased and *post hoc* because it "is not left free to search for truth but is likely to be hired out like a lawyer for various motives, employed only to seek confirmation of preordained conclusions."[xviii] Even if there are instances in which the process can be consciously controlled, many judgments seem to be "gut reactions" rather than reasoned ones, which seems to create an insurmountable barrier for anyone trying to replicate them with AI programming.

[T]hat which makes us human is the boundary line between good and bad AI. When AI encroaches upon that border, it needs to be prevented or stopped.

Human Realm for Important Decisions

So where should we draw line between AI and human decision-making? We ought to take seriously the difference between machines and people: Machines compute; people can do that, but there is a fundamental part that is not computative. Generally, and not controversially, the important choices ought to be relegated to the human realm. Who to hire or fire, how healthcare and other resources are to be distributed, what career path we should take and other issues significantly impacting human flourishing are questions vital to individualism and human well-being. These are ethical questions that can only be answered through human reason and emotion, such as desire. An appropriate answer to an ethical question is not akin to some mathematical sum. At the very least, it requires valuing, which includes desiring whatever is being valued. Love, care, hope and other emotions also come into play in ethical decisions.

Several years ago, I did an end-of-life consultation with a young Black professional whose father was in a permanent vegetative state after minor surgery. Her father's physicians were pressuring her and her family to remove life support because there was little chance of recovery. After talking with her for hours about her, her father's and her family's narratives, she decided that they would continue with the status quo. Why? Because her father had always taken care of her, and he would have known she was not ready for his death. He would have wanted the plug pulled but would have endured to give them the time they needed.

This example shows why AI should never be allowed to make decisions concerning human relationships, values, morality and other factors bearing on their thriving. In this case, the waste of resources for a hopeless case would have justified terminating the medical maintenance of the woman's father. AI would not have considered her and her family's needs for closure. At that time, it would not have understood why a Black family that grew up when Black lives mattered less than others would be less trusting of medical decisions based on a prognosis and request, which White families might not have questioned.

AI has no emotional attachments or ability to understand what they mean to our existence. It misses the situation's human components, and, more importantly, why those do and ought to matter. It cannot grasp human truths, such as historicity, which cannot be captured in algorithms. It would be the epitome of inhumanity in important decisions in medicine, the military (for example, regarding autonomous weapons systems), higher education and the value of liberal arts, especially since they can be used to humanize the technology. It cannot use mercy, grace, charity and human decency, because they are not justified by an algorithm.

Quantitative vs Qualitative

Let us take this thought further. Only humans can desire and value something for its own sake or for its moral worth. We also have an ethical duty to value and care about what is valuable, what is good, true and right, as well as make decisions based on these values. We have the ability to understand and act in mercy, charity and grace, which are gifts no one deserves. Those virtues and the actions caused by them are what make us humans and moral agents in the first place, because we can perceive how the world should be and care enough to make it happen. We as humans should pay attention to quality when that matters, and always question AI's quantitative reasoning, especially when it appears to adversely affect the flourishing of humans and other intrinsically valuable beings.

AI, therefore, should be limited to quantitative calculations and decision-making, which solely concerns quantities. Turning over criminal sentencing to AI algorithms to help reduce recidivism, incarceration and bias, for example, makes sense, but humans—preferably using the flexible second mode of thinking—need to control and evaluate AI analyses. In other words, that which makes us human is the boundary line between good and bad AI. When AI encroaches upon that border, it needs to be prevented or stopped.

As long as the individuals, companies and government agencies creating and using AI keep that reality in mind, then, hopefully, technology's use and design will better protect human autonomy. This won't guarantee safety, because now there are far too many technological distractions, such as scrolling through Tik Tok and YouTube shorts, which prevent us from being engaged in the world in an authentic, human moral-agent way. Yet this will better position us to be who we should be according to our nature.

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As Oscar Wilde wrote in The Soul of Man, "The difference between literature and journalism is that journalism is unreadable, and literature is not read."

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