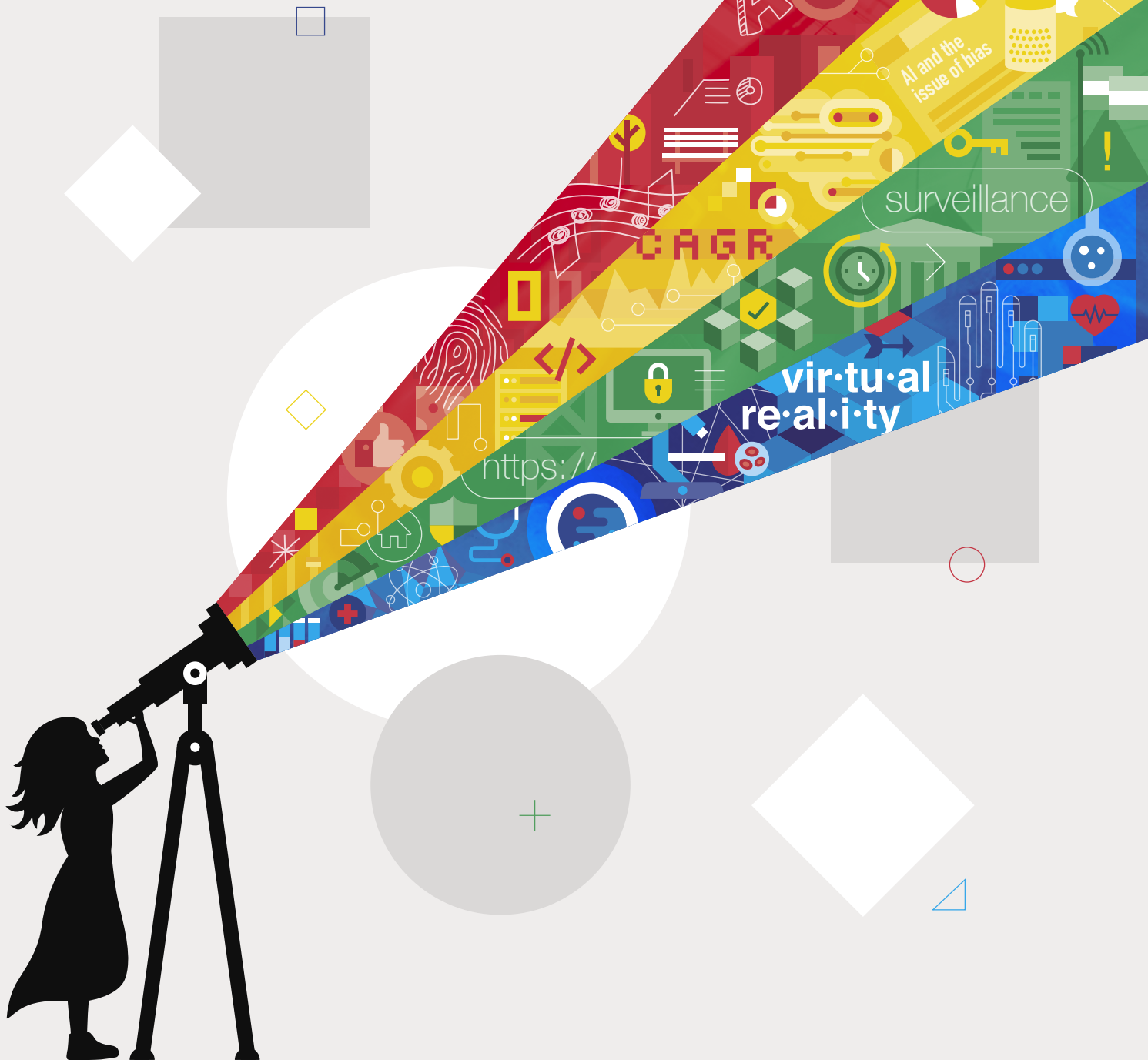


In collaboration
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Technology Futures: Projecting the Possible, Navigating What's Next

INSIGHT REPORT
APRIL 2021



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Introduction

Both practical and imaginative, this report aims to enhance strategic foresight by making the future a little less uncertain



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Plotting a course

The new technologies of the fourth industrial revolution, such as artificial intelligence (AI), cloud computing and robotics, are changing the way we live, learn and do business at a rate unprecedented in human history. This seismic shift is playing out in a world characterized by unreliable political landscapes and increasing environmental instability.

The global crisis caused by COVID-19 has compounded the challenge that leaders face in trying to plan ahead with conviction – the future feels more uncertain than ever. It is imperative, then, that the people responsible for plotting our collective course forward are able to access tools that offer them a better understanding of the possibilities that life beyond the near future holds.

Defining the future

The Oxford Dictionary of English offers nine distinct definitions for the word “future”; some are rather pedestrian (“the time that will come”), others more deterministic (“what will happen”). People, too, use a diverse set of words to describe their sense of the future. Many will tell you that it is “clear”, “transparent” and “entirely predictable”; others see it as “opaque” and “unknowable” – to them, time and energy spent divining the future feels like folly.

of the future), a strategic discipline that can help set a more intentional course towards tomorrow, using practical insights to help dodge oncoming headwinds.

Another of the Oxford Dictionary’s definitions for the future, “the possibility of being successful or surviving at a later time”, perhaps best describes the territory that we explore in this report. In the following pages, we examine a number of possible future scenarios, and identify where and how technology might play a role. We want to help you consider which technologies will be relevant to your organization in the future – not only in the next few years, but in the next decade and beyond.

In the following report, we argue that neither picture is accurate. Indeed, we see the future as being *translucent*, a collage of intriguing shapes and shadows, but few fine details. This perspective is grounded in futurism (the study

How this report is organized

Chapter 1 (“A brief history of the future”) identifies the themes that have characterized the development of modern information technology.

Chapter 2 (“Lines of the times: a framework for foresight”) introduces a novel methodology for projecting these historical insights forward, towards *foresight*.

Chapters 3–6 (each seeing the future through a different “LEnS”) puts this research-based rubric to work, marrying research with pieces of speculative fiction that offer a vision of the future through the lens of information/locality/the economy/education. The short stories that end each of these chapters are

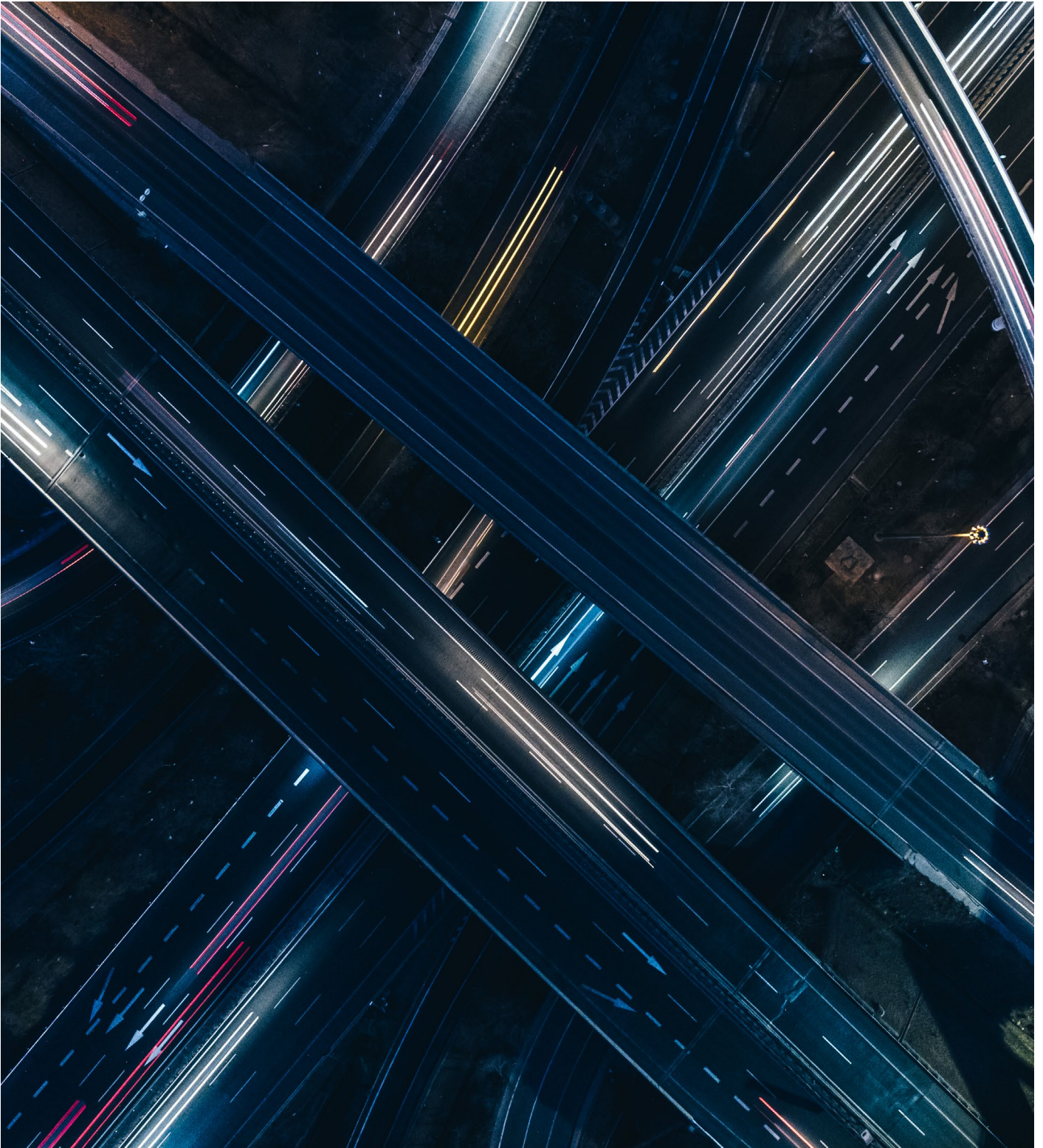
slice-of-life memoirs written from the perspective of four very different people in the year 2030-something; taken together, they help us think about a number of different possible futures and hopefully, to an extent, understand how they might *feel*.

Chapter 7 (“Ready to shape the future”) takes us up to the “So what?” and the “Now what?” Having studied the journey to the present (Chapter 1), suggested a model for considering the future (Chapter 2), and tried to imagine possible futures and the lives of people living in them (Chapters 3–6), we end by offering a set of actionable takeaways that should equip readers with the insights and foresight critical to tomorrow’s leaders.

1

A brief history of the future

Looking anew at the history of computing uncovers structural patterns that help us better see our digital path forwards



“ Computers, now two steps removed from their studious arithmetic origins, had become the global substrate for humanity’s higher-order aspirations.

In the 1940s, recognizably modern forms of information technology were anything but ubiquitous. The earliest digital computers were exceedingly difficult to use and were almost exclusively the province of men in white lab coats. ENIAC - by most accounts, the first general-purpose digital computer - was “a monstrosity”¹ that weighed nearly 27 tonnes and filled a 50-foot-long room. Able to calculate 5,000 arithmetic problems per second,² this mechanical oddity was formally debuted in 1946. Press reports at the time proclaimed the dawn of a new era of “giant, magic brains”. These brains, amusingly primitive by today’s standards, were first put to work on rarefied matters of nation-state security, such as calculating artillery firing tables.³

At the time, technologists and even entrepreneurs were notoriously conservative in their estimations of the eventual reach of their creations. IBM chairman and Chief Executive Officer Thomas J. Watson Jr. is often cited for a statement he reputedly made in the early 1940s that predicted “a world market for about five computers”.⁴

Enter Moore’s Law, the semi-famous assertion made in 1965 by research engineer Gordon Moore that, thanks to the transistor, computing power (and cost) would double (and halve) every two years.⁵ Certainly, PhDs with punch cards did gradually give way to professionals with printers. By the mid-1990s, Moore’s Law was proven by computers being in the hands of the majority of the developed world’s working professionals. Fifty years after ENIAC first started to crunch numbers, “24 million

Americans [were] using a home computer for some personal or work-related task”.⁶

It seemed that modern information technology had truly arrived. That is, until Robert Metcalfe, 3Com co-founder and networking pioneer, demonstrated that the usefulness of a computer system is proportional to the square of its number of users.⁷ In simpler terms, Metcalfe’s Law helped predict the next act in this unfolding technological drama: the development of the internet. Computers, now two steps removed from their studious arithmetic origins, had become the global substrate for humanity’s higher-order aspirations – calculation had taken a back seat to connection, creation and commerce. By 2010, an estimated 30% of the world’s 6.9 billion people were online.⁸ Clearly, information technology had reached its destination.

A decade or so earlier George Gilder, economist and investor, had noticed that bandwidth was growing at triple the rate of computing power. Gilder’s Law foresaw what the driver would be for the mobility revolution that helped define the first decade of the 21st century.⁹ In the years between 2000 and 2010 we witnessed the move from “America online” to “everyone online”, to “everyone online, everywhere we go”. Sit-down click-and-type gave way to on-the-go touch-and-swipe,¹⁰ and for better or worse, everyone was now always on, and always connected. End of the line, right?

Not even close. The journey doesn’t end with everyone online. The last few years have been marked by an explosion of connected “things”:



smart speakers, thermostats, doorbells, vacuum cleaners, etc. As of 2019, the average US household had over 11 digitally-connected devices,¹¹ but only 2.6 people. While no one has attributed this latest wave of change to a particular “law”, early returns would suggest that the proliferation of robot roommates is definitely set to continue.

But isn't this report about the *future* of technology? It's a fair question. Why are we looking back when our objective is to peer forward? As it turns out, futurists are closet historians. We look back to make sense of our journey to the present and, more specifically, to plot the trend lines that can help us chart our course towards what might be coming next. So, what insights can the brief history we've given above offer?

Firstly, that the future really is still coming. It's worth noting that reports of the death of technology as a critical business and societal catalyst are, and have always been, greatly exaggerated.

We tend to look back at the achievements of our predecessors with a curious mix of reverence and hubris. Reverence for what they were able to achieve with *so little* in the way of affordances and understanding; hubris in the self-affirming tone we adopt when we highlight our comparative superiority.

This same pride is what leads us to discount the inevitable future achievements of our successors. It is easier and more comfortable to assert that we have largely “arrived”. Our pride of place makes it singularly difficult to conceive of ourselves as

the unenlightened actors in some future author's history. It's human nature to crave exceptionalism, to feel as though we are the ones who've finally figured it all out, that we are the cohort uniquely privileged to live in what Francis Fukuyama famously dubbed “the end of history”.¹² It's clear though that, through the long lens of history, we're no more or less special than our predecessors or our successors.

The future is coming *faster*. The second takeaway is that the duration of these waves of change is shrinking. The lab-coat mainframe era lasted a good 30 years; the minicomputer/microcomputer era, 20; internet 1.0 changed the world in 10, and digital mobility changed it all over again in just five. Any reasonable taxonomy of technological change shares the following tenet: that technological progress follows the exponential function or, expressed another way, that the tempo of technology-driven change is accelerating.

The word “exponential” often raises resting heart rates. For many it recalls the anxiety of bygone maths exams. Those in the know, however, may get anxious because they understand that exponents quickly get out of hand. It is hard enough to get conversant with a bucket-load of new buzzwords, let alone face the looming dread that next year's bucket of neologisms may be that much deeper.

It is no surprise, then, that when faced with this disorienting feeling of “future shock”,¹³ many civic and business leaders cross their arms, lower their sights, and remain stubbornly in



the strategic present. Better, perhaps - they think - to focus today's time on the practical and tactical than on the fuzzy and fractal?

Any self-respecting strategist, however, would say that this should not be treated as a simple case of "either/or". A Japanese proverb also warns against taking a binary approach: "Vision without action is a daydream. Action without vision is a nightmare." And therein lies the challenge: how *can* we efficiently attain enough vision to maintain an informed action-orientation?

Thankfully, there is a calmer and more constructive means of sensing, and making sense of, the future. So, let's look backwards again, but this time a good bit further.

It's 1821. In England, astronomer John Herschel, asks his friend Charles Babbage, a smart generalist if there ever was one (a mathematician, philosopher, inventor *and* mechanical engineer), to double-check some manually-calculated tables of figures for him. Babbage, frustrated by finding error after error, muses: "I wish to God these calculations had been executed by steam",¹⁴ a humorous nod to the centrality of the industrial revolution in the popular imagination of the time – the mechanical muscle of things such as locomotives, steamboats and pieces of giant new factory equipment.

A decade later, Babbage's irritation would prove the inspiration for his and mathematician Ada Lovelace's design for the first general-purpose computer, "The Analytical Engine". Their project never came to fruition, however; the design specifications of their machine exceeded the engineering prowess of the day. Yet Babbage and Lovelace's notes clearly lay out four distinct functional components: the "mill", the "store", the "reader" and the "printer". The "mill" was the calculating unit, analogous to the central processing

unit (CPU) in a modern computer; and the "store" was where data was held prior to processing, which is exactly analogous to memory and storage in today's computers.¹⁵ The "reader" and "printer" represented the input and output mechanisms, respectively or, taken together, the user interface (UI). These three components: CPU, memory and UI continue to be the essential elements of every computer today.





Roughly ten years later, transcendentalist American author Henry David Thoreau famously left the hustle and bustle of urban civilization behind to go and live alone in Walden Woods in Massachusetts. His was an effort to not just slow down, but also to move up to a level above ephemera and glimpse the enduring. As Thoreau himself described it, this was an attempt to "Read not the Times," but rather "Read the Eternities".¹⁶

We can use a ladder of our own to climb above the detail and see a broader picture. Looking at the history of modern information technology in its entirety, from Babbage and Lovelace's design right up to the developments of the present, we suggest that there has been a surprisingly clear line of progress in three particular layers: interaction, information and computation. We would further assert that the entire *future* of information technology will continue to be a story of progress along these same three layers.

Yes, because the future is still coming there will continue to be unexpected disruptive innovations. And because the future is now coming at us that much faster, there are sure to be more of these with every passing year. But a Walden-inspired long view allows us to slow things down and see the forest for the trees. Consider the table below, which elevates the emergence of technology from a "blizzard of buzzwords" to something that clearly has direct relevance to the business of the boardroom.

“ We suggest that there has been a surprisingly clear line of progress in three particular layers: interaction, information and computation.

TABLE 1 A taxonomy of technological change

 Eternities	Babbage's design	First digital computer	Mid 20th century	Late 20th century	Early 21st century	2021: Today
Time (years)	t-175	t-75	t-50	t-25	t-10	t
 Interaction	Reader	Punched cards	Command-line	Graphical user interface (GUI)	Mobile devices	Virtual reality
 Information	Store	Arithmetic calculation	Relational databases	Descriptive analytics	Predictive analytics	Cognitive automation
 Computation	Mill	Mainframe	Minicomputer	Client server	Cloud architectures	Distributed platforms

2

Lines of the times: a framework for foresight

Combining different data-analysis tools allows us to shine a light on not only what is possible but also what is probable



2.1 Looking back: trend lines

“Taken together, we can use three types of pattern (linear, exponential or cyclical) to broadly characterize virtually any natural, social or technological trend.”

As we've already established, we must study the past to better understand where we are now and, in turn, to project those trend lines forwards in order to forecast the future. There's a key thing to remember about trend lines, though: there are different kinds, and they are not all created equal.

Linear

Linear trends are the province of traditional strategists and forecasters. The trusty equation “ $y = mx + b$ ” tells us that, for some trends, we need know only the rate of change (“ m ”, the slope of the line) to confidently understand, and in turn project, the state of affairs at any future date. In futurism it's tempting to over-rely on linear trend lines because they're intuitive and typically characterize phenomena that are already sizeable. For instance, the cost of housing in global terms is “high, and getting higher”, which makes for attention-grabbing headlines, but is not necessarily a trajectory that holds true in times of economic recession, or global pandemics.

Exponential

The thing is, most complex adaptive systems, whether they are natural or human-made, aren't linear. They're curved or, more precisely, exponential. Dr Albert Allen Bartlett famously argued that our Achilles heel as a species is our inability to understand the exponential function.¹⁷ Certainly if

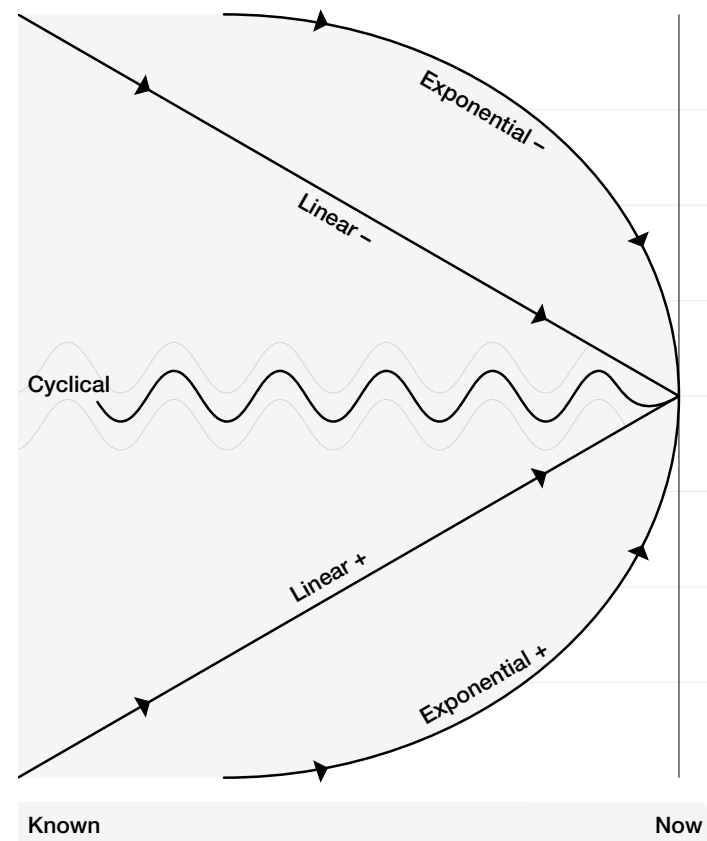
you ask a child (or frankly, an adult) if they'd rather earn 1 million euros or 1 cent doubled daily for a month, you're likely to hear a majority of irrational answers. In simple terms, exponential trends are those that start small, sometimes imperceptibly so, but repeatedly self-reinforce so as to become material, and eventually, game-changers. History tells us that the forces that most profoundly shape society tend to follow an exponential trajectory, for example, compound interest, population growth, Moore's Law and climate change.

Cyclical

From a too-close vantage point, every trend line looks as if it is following either a linear or an exponential trajectory. Pull the lens back, however, and some show themselves to ebb and flow over time. Here, life experience and/or an appreciation for history come in particularly handy, allowing the seasoned observer to say “I've seen this movie before.” Consider petrol, the price of which fluctuates not just due to cyclical demand but also to sporadic breakthroughs in the development of aspects of exploration, extraction and refinement.

Taken together, we can use these three types of pattern (linear, exponential or cyclical) to broadly characterize virtually any natural, social or technological trend, as illustrated here:

FIGURE 1 Trend lines



2.2 Looking forward: projections

Armed with an understanding of the different types of trend lines, we're now in a better position to project forward, proposing possible futures based on the aggregation and extrapolation of the data at hand. The word *projection* seems particularly relevant here, as it connotes three key characteristics of a "futures" exercise.

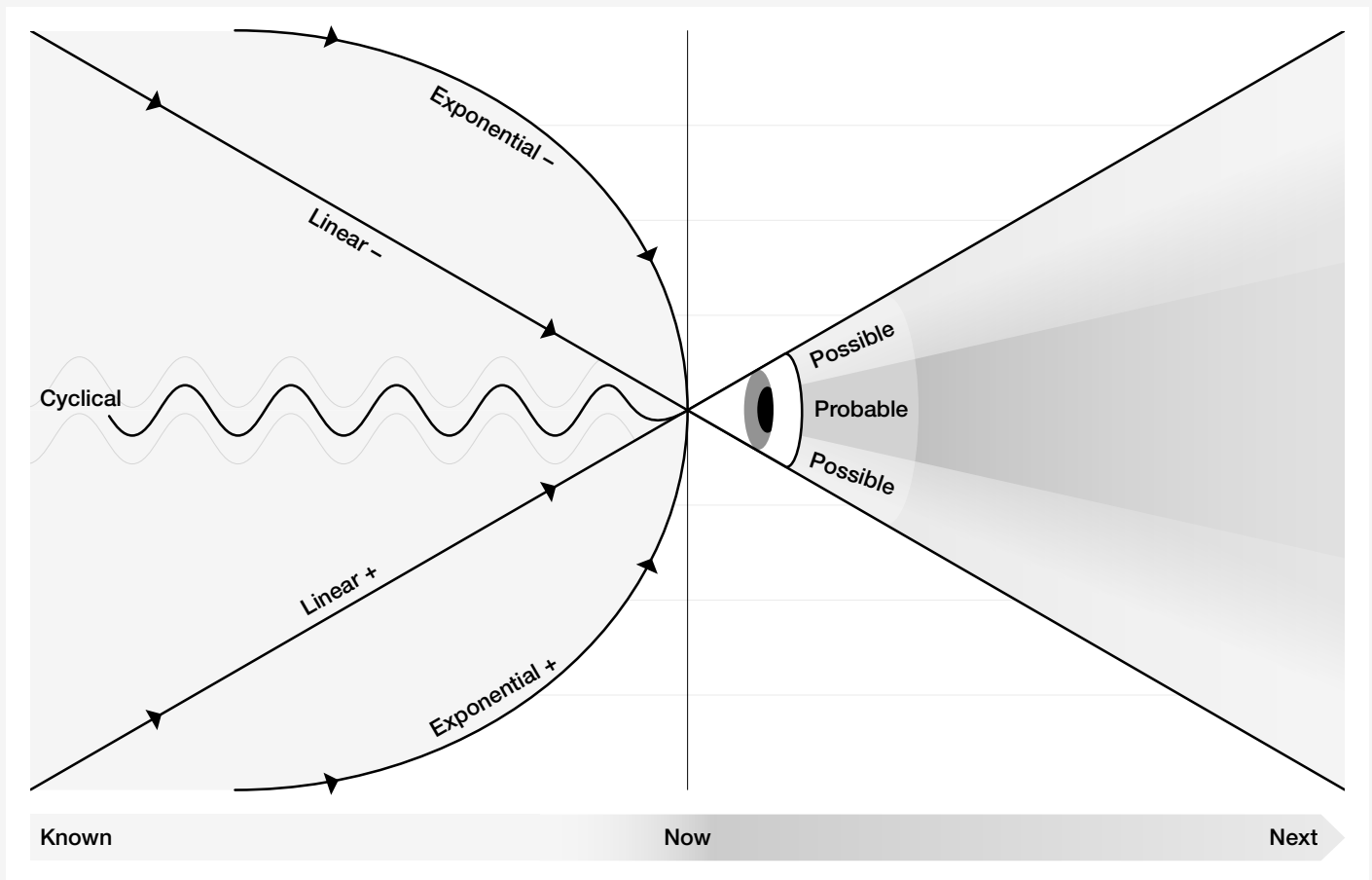
Firstly: like a beam projected from a flashlight, the range of potential futures is *narrower* closer to the present, and broader further away – so the further forward we move in time, the wider the aperture of feasible futures.

Secondly: the light gets *dimmer* the further out you go; this is of course intuitive, but it is worth noting that it's easier to "illuminate" scenarios 12 months out than 12 years out.

Thirdly: we can't characterize the sides of the projected beam as a stark, binary switch from bright light to black. Rather, there are shades of grey that drop-off in probability towards the boundaries. Respected futurists have all manner of "p-words" for the gradations here ("preferable", "plannable", "probable", "plausible", "possible", "potential" ... even "preposterous"!)

but for our purposes, the use of simply "probable" and (to denote "less probable") "possible" will suffice.

FIGURE 2 Projections

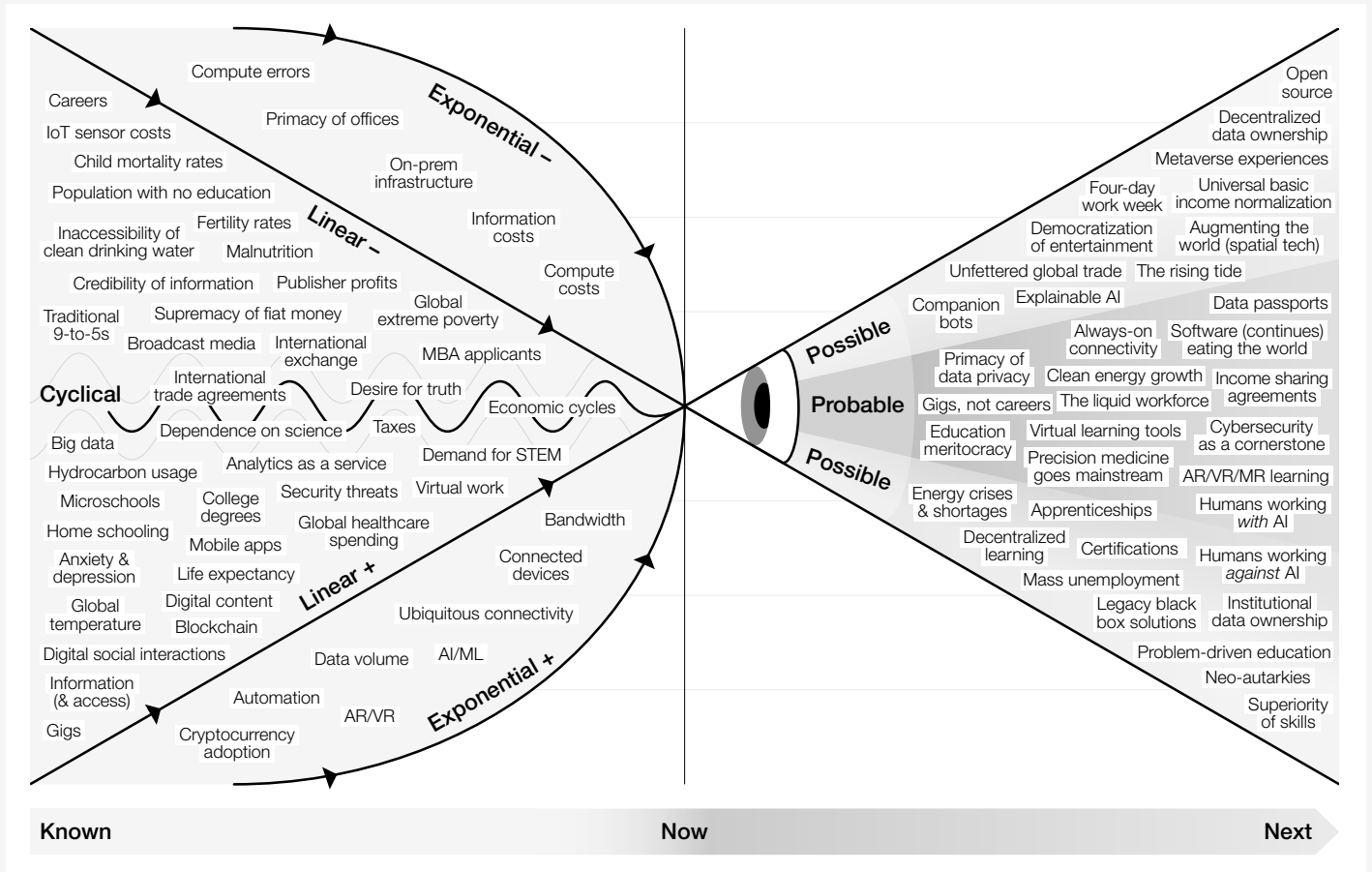


2.3 Making it meaningful: filters

As the data sources available to us exponentially increase, and the number of trend lines we are able to project forward also grow as a result, we find ourselves facing a problem: single “general relativity”

models that can account for all historical data and all future projections become an impossibility. Consider the diagram below:

FIGURE 3 Too much information



In 1971, American economist Herbert Simon argued that as information approaches infinity, our ability to meaningfully attend to it approaches zero.¹⁸ Or in other words: nobody likes an eye chart.

As a means of tackling this problem, we take a page from the realm of innovation management; we apply a domain-specific filter to serve as a liberating constraint, reducing noise, improving signal-to-noise ratio, and resulting in a projection space that is both more understandable and, more importantly, more useful. Rather than attempt to see the entire future, we can apply, for example, an education filter that enables us to focus our attention solely on the subset of trends and projections most relevant to education (see Figure 4 on following page).

Taken together, these three analysis tools – trend lines, projections and filters – come together to create what we call a “Longitudinal

Emergence Scatterplot” (LEnS), which, as we will see throughout the remainder of this report, provides stakeholders with a clear and compelling rubric for thinking about where domain-specific futures are headed.

There is no one right LEnS for any given foresight exercise. Just as different business models, industries and cultures create richness and resilience, so multiple LEnSes can help move us beyond a homogeneous viewpoint and towards a more holistic understanding of what may lie ahead.

For the purposes of this report, we’ve created four broadly applicable LEnSes that, taken together, demonstrate the breadth of applicability inherent in the framework: information, locality, economy and education. It is not this report’s intention to establish a mutually exclusive, collectively exhaustive (a “MECE”) series of domains but rather, to illustrate

how individual filters provide focus, multiple filters and depth.

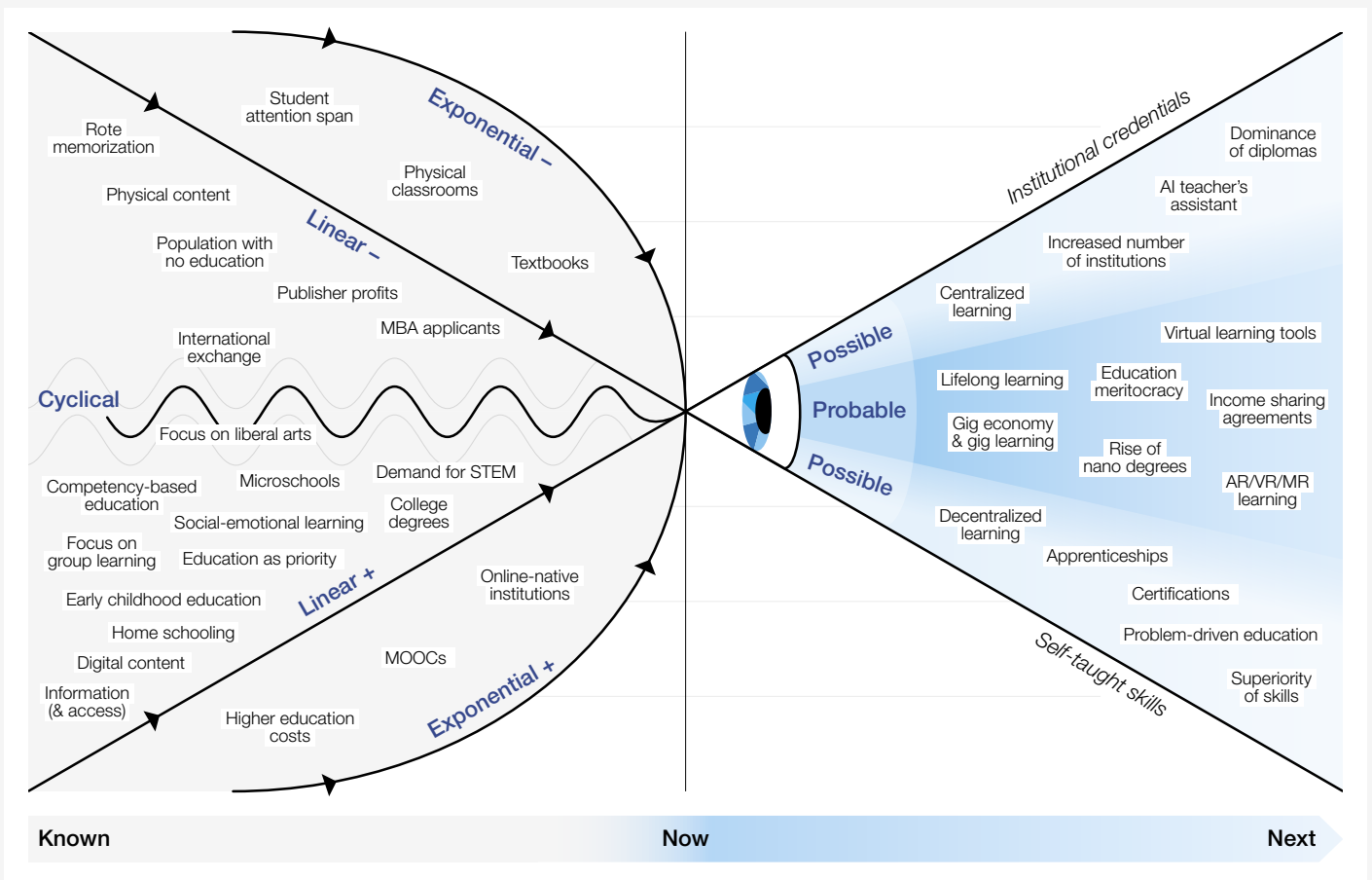
The following four chapters each begin with an introduction to one of our four LEnSes, and an explanation of the organizing principles we've used in establishing and examining our trend lines. We then project and detail a few relatively non-controversial *probabilities*, along with a handful of oppositional *possibilities*.

After thinking about each future, we then invite you to try and *feel* them by immersing yourself in

a series of speculative fiction stories that vividly personify worlds that could each characterize one of our projections. You will meet Maple, Frank, Alex and Maiah: citizens, students and leaders in the year 2030-something, whose memoirs serve as mimetic illustrations of the world seen through a particular LEnS.

Our goal? Demonstrating the "better together" use of foresight and fiction in helping us best prepare for tomorrow with both intellectual clarity and an empathic sense of purpose.

FIGURE 4 Education LEnS (Longitudinal Emergence Scatterplot)



3

The future through the LEnS of information

Data is the engine of our digital world, but where do innovations in storage, transfer and logistics look set to drive us?



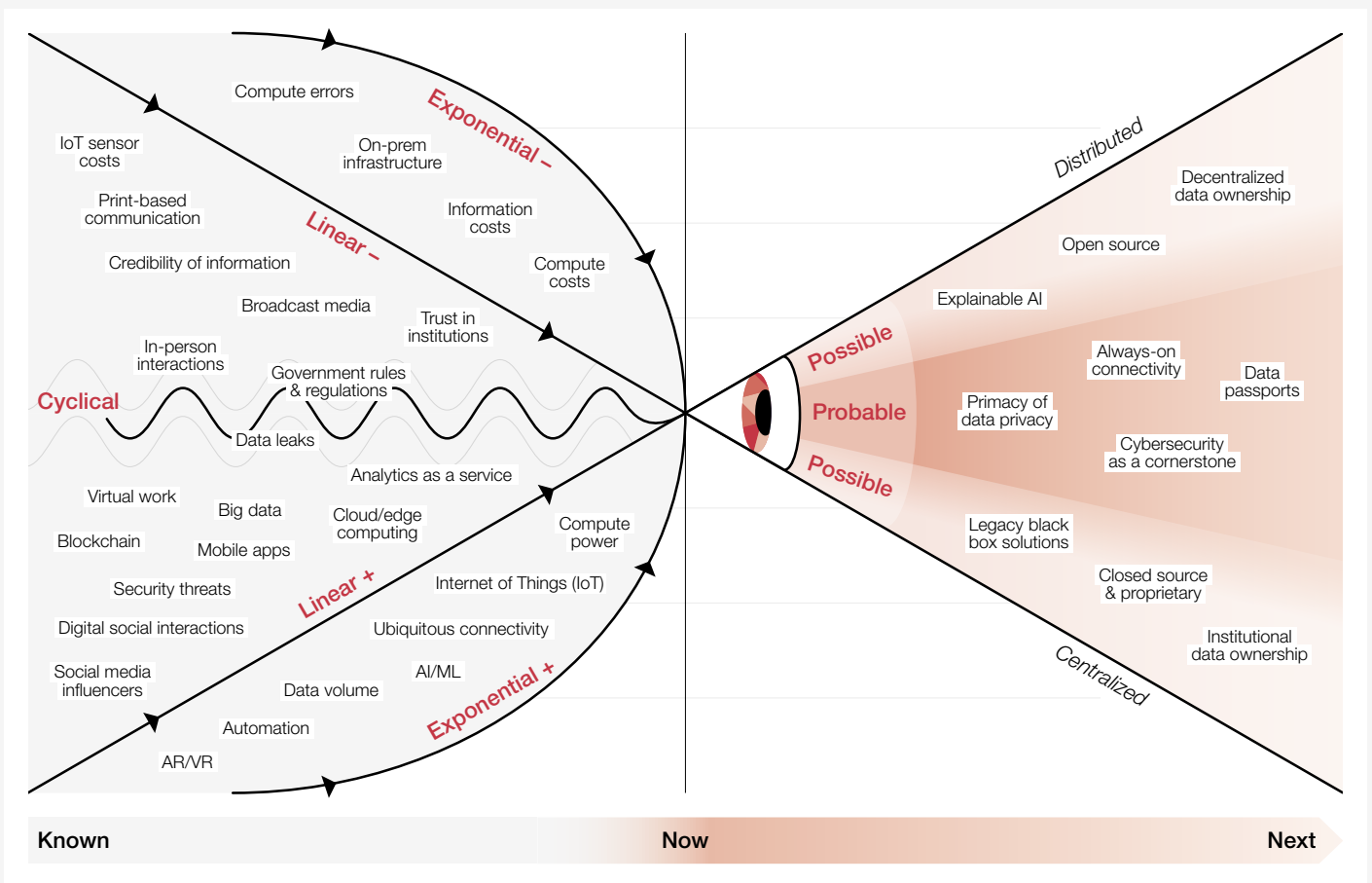
3.1 Context

Data lies at the heart of the progress of information technology. In classical computing, data is a series of bits (binary digits, with a value of either 1 or 0) that a central processing unit (CPU) turns into newer and more useful information.¹⁹ Today, with help from next-generation networks that reduce latency (the time it takes for data to travel from one point to another), and cloud computing that expands processing and storage capabilities, data drives just about everything.

Data volumes are exploding. And not only is the rate of data generated per individual increasing, but so is the rate at which we share information.²⁰ Yet increasingly, many wonder how, and to what extent, their personal data is being shared. And who it is being shared with, and to what end?

Today, lawmakers, organizations, ethicists and many others worldwide are trying to envision data's future. Will information remain centralized, as it largely is today? Or will we shift toward a distributed and open model of data distribution and sharing?

FIGURE 5 Information LEnS



3.2 The probable

Always-on connectivity

Gone are the days of laborious dial-up connections. Now, communicating and interacting online can involve actions as simple as a tap of the finger or a voice command, leading to substantial increases in data generation.²¹ For organizations, there is a steady increase in reliance on analytics that use enabling technologies²² such as sensors, the Internet of Things (IoT: the internet-enabled network of physical objects that can connect to and exchange data with other devices and systems), robotics and ambient computing – all of which rely on the huge amounts of data that stem from our many digital interactions.²³

As of 2020, 2.5 quintillion bytes of data were produced every day worldwide,²⁴ and it is estimated that by 2025, the generation of data per day will have reached 463 exabytes (a nearly 200x increase).²⁵ Human interaction is becoming increasingly digital, in part due to the rise of social media. In just one year, from 2019 to 2020, the number of people using social media worldwide increased by 10% to 3.96 billion,²⁶ with more than two-thirds of all internet users now active on social media.²⁷

The enabling technologies that contribute to the growth of online interaction are also taking centre stage, including artificial intelligence (AI), machine learning (ML),²⁸ ubiquitous connectivity powered by next-generation wireless technologies such as 5G,²⁹ and IoT devices.³⁰ Coupled with the decreasing costs for information³¹ and computation,³² these enabling technologies are gaining more traction across a range of industries.

We believe that, going forwards, as the gap between the physical and the digital narrows, the data volume of always-on connectivity will continue to grow steadily.

The primacy of data privacy

At the internet's inception, it was hard to imagine the extent to which our lives would be intertwined with digital technologies. Perhaps for this reason, the World Wide Web was not originally designed with security or trust in mind.³³ Today, though, increasing numbers of users are focused on how much of their personal information is shared online.³⁴

Data privacy informs how data is collected, stored, managed and shared. To address growing consumer concerns, governments and institutions in many countries around the world are enacting rules and regulations to better protect consumer privacy. Individuals are also aiming to take data ownership into their own hands through decentralized systems based on distributed ledger technology (which records data in multiple locations without centralized administration).³⁵

While it is too soon to understand the longer-term implications of the approaches to data privacy that organizations are now developing, a sense of urgency surrounding information security and trust looks set to remain part of the bigger picture for the foreseeable future.

Cybersecurity as a cornerstone

As digitization increases steadily across the globe, there are consequent security concerns about the possibility of cyber-attacks. Not only are these attacks growing in number but given our growing dependence on information technology their impacts are increasingly calamitous.³⁶ The total number of malware infections has risen over 600% since 2009,³⁷ and in 2020 the number of records exposed through data leaks reached a staggering 36 billion.³⁸ Unsurprisingly, companies and individuals are taking greater precautions to protect their data as a result.

With new technologies shaping how data is collected, shared and stored, the landscape of cybersecurity will continue to change as new threats emerge. For example, how will organizations react to cyber threats when today's public-key encryption algorithms (keys to algorithms that are discoverable and decryptable) are no longer secure?³⁹ With its tremendous power, quantum computing (which leverages quantum mechanics to enhance computational capacity) could eventually undermine even the most advanced encryption models. With this possibility in mind, to prepare for what is coming down the road, some forward-thinking organizations are already developing quantum cryptography mitigations (technology to avoid keys being decrypted, or hacked, at a rapid and exponential rate).⁴⁰

“ Organizations are now developing a sense of urgency surrounding information security, and trust looks set to remain part of the bigger picture for the foreseeable future.

Data ownership

Institutional

Across the globe, what were formerly rather vague responsibilities relating to data ownership are now being formalized into laws, rules and regulations. In 2018, the EU implemented the General Data Protection Regulation (GDPR)⁴¹ to regulate the protection and privacy of data. That same year in the United States, the State of California passed the California Consumer Privacy Act (CCPA),⁴² giving consumers more control over the personal information that businesses collect about them.⁴³ In addition, public officials in Europe and Asia have begun to call for the principles of data ownership to be developed beyond the scope of existing privacy laws.⁴⁴

These rules on data privacy and protection may prove especially helpful with the steady growth in the use of national Electronic Health Record (EHR) systems, which have seen a 46% increase in global adoption rates in the past five years.⁴⁵ While there is little regulation today that is specific to international data sharing for private health apps,⁴⁶ centralized health data and data sharing solutions have proven particularly essential with the onset of COVID-19,⁴⁷ and companies are partnering with large hospital systems to analyze patient data as part of the attempt to improve care.⁴⁸

VS

Decentralized

Today, the centralized institutions that collect personal data also actually own most of it.⁴⁹ Due to the various privacy and ethical concerns that surround third-party ownership of personal information, many users have taken a newfound interest in decentralized models.

Grounded in blockchain technology, decentralized data ownership provides an immutable and verifiable database that allows end-users to have full control over who accesses their data. There are currently a number of blockchain projects underway that are seeking to increase transparency and end-user data ownership through the creation of decentralized social media and web models.⁵⁰

Decentralized ledger technology (the basis of transaction-recording digital systems in which detail is recorded in multiple locations without centralized administration) is still in its infancy, and will need to overcome technological and security obstacles before broad adoption is possible. Nevertheless, we see decentralized technologies and approaches to data ownership playing a growing role in the future as consumers become more concerned about their personal data rights.

Approach to technological advancements

Closed and proprietary

As our world increasingly relies on data to drive computing algorithms and software programs, understanding how to take a strategically effective approach to related technological advancements is paramount to understanding the future of information. From a software perspective, a closed source approach keeps source code encrypted and inaccessible to the end user.⁵¹ This is the primary approach for many popular apps, games and programs.⁵² Likewise, many tech companies also use this approach to safeguard proprietary intellectual property.

As the amount of data collected, stored and managed grows, business and technology leaders are recognizing that many legacy data management systems cannot support their organizations' AI/ML agendas. As such, they are deploying new technologies and approaches to capture, analyze and store data. In doing so, they are building the future-ready foundation that cognitive machines will need to make real-time decisions at scale.⁵³

When it comes to AI, many current models rely on closed source scenarios in which humans cannot easily interpret how the machine is making decisions.⁵⁴ These "black box" models stem from low-stakes AI/ML decision-making (e.g. targeted advertising, which builds a picture of consumers' likes, personal information and previous interactions to determine which products to share). But as use cases for AI/ML applications grow, so do concerns about AI ethics and bias. In some situations, even the programs' designers cannot discern how their models are coming to certain conclusions.

With growing public awareness of and discussions around data privacy and ownership, the future of closed and proprietary approaches to software and emerging technologies could be hampered.

VS

Open and explainable

In an open sourced world, programs and algorithms are publicly available and modifiable by the end user. This model provides enhanced flexibility and lower associated costs for the consumer but can sometimes lack the end user technical support that comes with most closed source programs.⁵⁵

Open source approaches offer developers greater collaborative opportunities, and are gaining traction via the likes of Google (whose Android OS is based on Linux, an open source operating system), IBM (which acquired open source company Red Hat in 2019) and Microsoft (which acquired the open-source code repository GitHub in 2018).⁵⁶

Recent shifts to open source models are indicative of the increasingly collaborative nature of technology advancements, and of increased consumer interest in understanding how the technologies we use both work and impact our lives. However, there are still limiting challenges, such as funding for smaller platforms and security vulnerabilities.

These open source concepts are also permeating the world of AI. In 2015, Google shifted its AI engine, TensorFlow, to an open source model,⁵⁷ allowing users to access their suite of AI/ML search engine models. Explainable AI, the more ethical sibling of black box AI models, is providing developers with a window into how their AI models make predictions.⁵⁸

While these models may not fully eliminate closed source and black box approaches, open and explainable models will likely continue rising as regulatory efforts and conversations gear toward a more collaborative, open and ethical mindset.

3.4 Maple's story



By Amy Golem



I get out of bed to the intro of my favourite oldie:

*Wake up in the mornin' feelin' like P Diddy...
[Hey, what up girl?]
Grab my glasses, I'm out the door, I'm gonna hit
this city!*

Kesha was a star back in the '10s. And is still a star in my book. In my line of work, bolder is better. And no one was bolder than Ke\$ha, back when she was still replacing the "s" in her name with that fierce dollar sign.

I've been working in the creator industry since I graduated from high school. Even as a kid, I obsessed over OOTDs (Outfits Of The Day) and selfies from my favourite creators. That was back when we were puttering along on 3 x 5-inch glass screens, and content creation seemed to be mostly indie influencers peddling hair gummies.

These days, people demand variety and jump from platform to platform for fresh experiences. Lately, it's all about WOTDs (Walks of the Day) on BeMe, 360-degree virtual walkabouts where you experience slices of life directly through the creator's eyes.

This might sound like classic clout-chasing, but creators are big business. I did a bit on BeMe just yesterday, and some suit commented that creators like me now capture almost 90% of corporate ad spending. Not long after mass media gave way to social media, commercials pretty much gave way to creators. Alright by me.

I grab my augmented glasses from their bedside charging station and groggily put them on.

"MORNING, MAPLE!"

My glasses greet me with All Things Maple: my weather, schedule and tailored celebrity news, and bright red notifications from my social media manager (a must-have app that helps me keep track of my too-many-to-count platforms).

I hurriedly gesture towards them.

The good news: my follower count is up 14% overnight. Solid.

The better news: my favourite account, *TheDailyLife*, has uploaded an all-new puzzle post:

FIND THE GLIMMER IN THE SUN.
JOIN THE PARTY. JOIN THE FUN.

TheDailyLife is notorious for layering riddles into his WOTDs. This new outing seems to be taking place in City Park. A solved riddle doubles as an exclusive invite to a party hosted by Content Conglomerate

(or "C.C.", as we stans lovingly call it). A titan in the content world, C.C. employs the most followed and prosperous creators (including Hunter Brown, the guy behind *TheDailyLife*). Working for C.C. is all I've ever really wanted, and with my steadily growing follower base and unflagging determination, this riddle could finally be my shot.

First, though, I need to make some sales.

I gesture an enthusiastic thumbs up to register my 'Like' for the post, and grab my shoes.
I'm gonna hit this city!

*

I walk out of my studio apartment and squint my left eye to start a BeMe livestream on my glasses. Might as well try and cook up some content while I'm doing the job I actually get paid for.

I walk to the subway station near City Park and tap on a decidedly regular-looking olive-green bench. A slew of metadata sprawls before me:

ID: CITY PARK BENCH #216

BUILT: 2032/04/04

LAST_PAINTED: 2035/04/04

LAST_SERVICED: N/A

GUESTS: 13,178

HISTORY: GIFTED BY THE ROTARY CLUB
IN MEMORY OF THE KAISER FAMILY. TAP
MENU TO LEARN MORE.

An alphabetized menu floats before my eyes – olive green, like the bench. Finger in mid-air, I scroll down the list of RECENT GUESTS, hoping to find someone who *is* someone. Browsing through, I don't recognize a soul, let alone any celebrities that I could monetize with a new post. Just 13,000 nobodies, including myself:

NAME: MAPLE BRINKLY

DATA PROVIDER ID: 9372843

SOCIAL TAG: @LIVINITUP243

LAST VISIT: 3 MONTHS AGO

I sigh deeply and slump down onto the bench. I know I said my line of work is "content creator", but I was lying. Sure, I'm *trying* to be a professional content creator, but until I make it, I need money. And we all know the easiest way to make money these days is by becoming a data provider ("provider" for short).

My mom always told me to go to college, get a real job, and never *ever* stoop to selling my

data. But what does she know? “Real” jobs are boring. Who in their right mind wants to sit around all day working as an admin (straight talk: robot babysitter) for whatever shiny device BotCom drops onto the market next? Being a provider is the easiest and most flexible way to support myself while I build my career in content.

So this is what I do with my days. I mosey around, living my HashtagLife, and sell my digital exhaust to third parties who use it for “research and development”. At least I *think* that’s what they’re using it for.

My mom was uptight about my line of work because of the “privacy wars” in the ‘20s. “I didn’t work two jobs for you to... sell yourself”, she’d say to me. As if selling my data made me some kind of digital courtesan. I usually started tuning her out when the rants reached this point. “Okay, boomer”, I’d say, not really understanding what the tag meant, but knowing that she had weaponised it in arguments with her own parents.

Knowing I need to keep moving, I ditch the tragically unhip park bench and head to my next destination.

“What’s my next stop on the D.D.P.?”, I ask aloud, seemingly to no one. For those of you fortunate enough to not be a provider: the Daily Data Provider’s Sales Route is a crowdsourced list of entities that, on any given day, are offering the best prices for personal data. The latest and greatest in Supply meets Demand.

A map glows before my eyes, and my cochlear implant responds: “TAKING YOU TO MEDIDATA.”

Even though this information is delivered to me in the voice of Harry Styles (I went retro with my implant settings), I sigh. *Another med.*

Since at least the mid-2020s, medical data has been a particularly hot commodity. For us providers, it’s typically one of the quickest and biggest cash payouts. But selling my data to meds freaks me out. I tell myself it’s for the greater good – you know, helping some do-gooder AI better analyze and respond to new security bugs – but sometimes it keeps me up at night. What’s the cost to *me*? Who else buys this data from *them*? And will they use it against me?

My friend Harper swears she

overpays hundreds for anything vision-related because her dad sold her eye exam data for \$20 back in the 8th grade.

Whatever; I need the cash. I push my anxieties aside and use an exaggerated “come here” gesture to digitally hail an auto-taxi.

Minutes later, I’m looking up at MediData’s 20-story building. I once watched a BeMe tour of an old-fashioned skyscraper like this; there used to be tons of them back then, and all filled with people, apparently. These days, the few buildings like this that are left are filled with data centres, product warehouses or, like this one is, provider dumps.

Eager to get this transaction over with, I biometrically sign in at the kiosk, agree to the price, and initiate the data transfer. As I wait, an ad flashes over the progress bar:

BIOMETRIC SPECIAL! PROVIDE RED & YELLOW TO GET MORE GREEN!

My optical, aural, GPS, financial and social data? Have at it. My bodily fluids? Yeah, no thanks.

I remember signing a terms and conditions form when I first signed on as a provider for MediData, but between you and me, if a laser beam was aimed at my head I still couldn’t tell you what types of data they’re collecting from me, or even what they’ll use it for. Ignorance is bliss, right?

DATA TRANSFER COMPLETE. FUNDS TRANSFERRED. HAVE A MEDIDATA DAY!

What does that even mean, a “MediData Day”?

These companies need to realize that providers are broke, not stupid. Time to shift gears and get to work on that riddle. I hail another auto back to City Park.

*

I revisit *TheDailyLife*’s post, re-reading the riddle and looking for clues as to where in the park the BeMe was taken.

FIND THE GLIMMER IN THE SUN.
JOIN THE PARTY. JOIN THE FUN. ►

[*Maple’s story continues in the Annex, on p.50*]

4

The future through the LEnS of locality

As digital connectivity accelerates, the relationship between physical space and everyday activity is becoming far more fluid



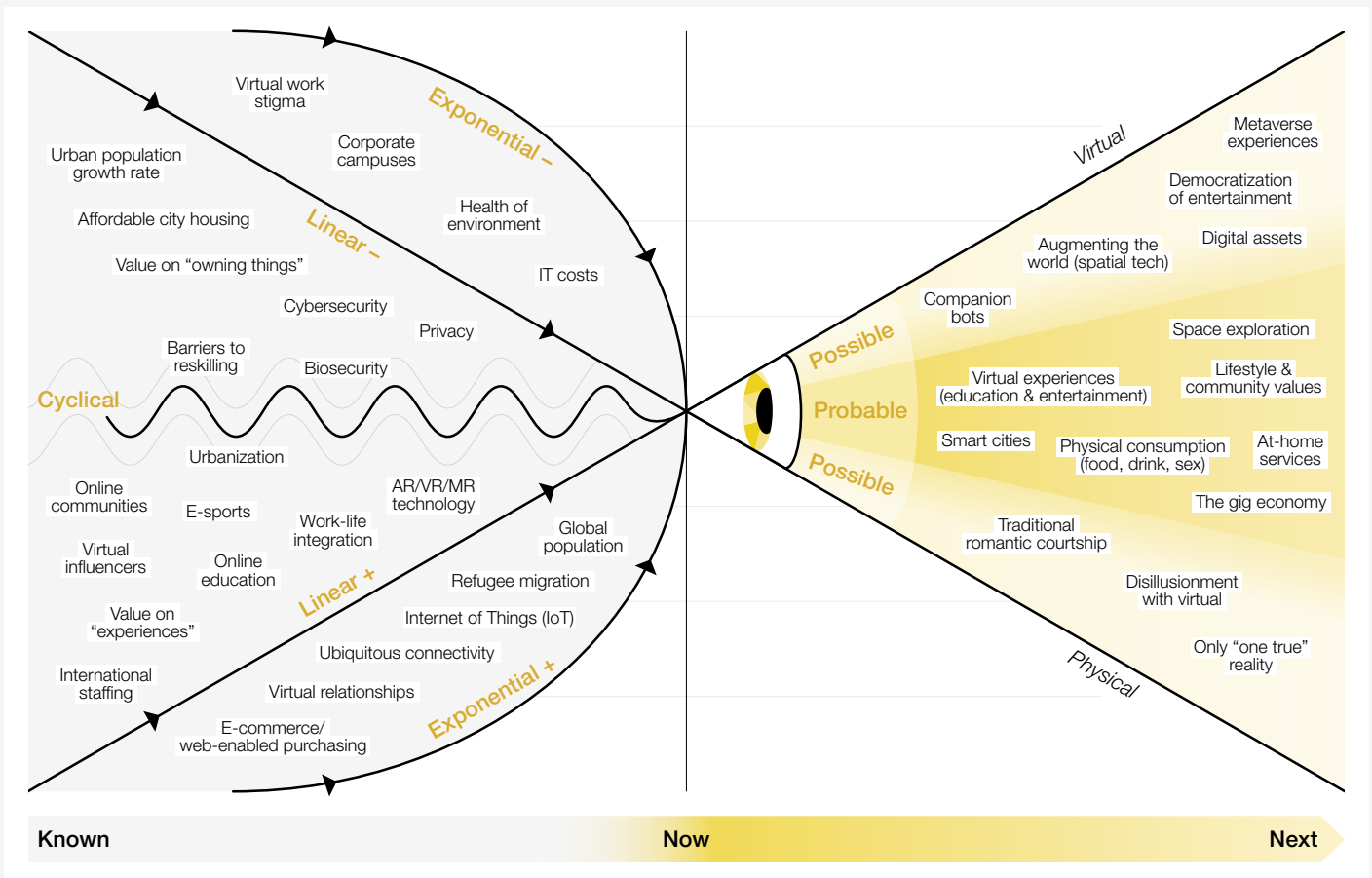
4.1 Context

According to British philosopher Alan Watts, “the real secret of life is to be completely engaged with what you are doing in the here and now.” Over the years, the idea of “here and now” has evolved from mere physical spaces to include virtual ones as well. It is now possible to define locality not only in terms of physical spaces but also in terms of the virtual ones in which individuals live, work, learn and connect.

Innovation and the ongoing COVID-19 pandemic have accelerated shifts in how human beings experience locality. For example, before the global pandemic, only 17% of US employees worked from

home; currently, 44% of people are doing so.⁵⁹ Just 7.9% of the global workforce worked from home before the pandemic, although research suggests that roughly 18% of workers have occupations and the technical infrastructure that would allow them to do so.⁶⁰ Against this backdrop, we see two potential extremes in the future of locality. Illustrated in the graph below, the first – a virtual extreme – represents an ongoing technological shift that favours digital and virtual interaction over the physical; the second – a physical extreme – places value on physical experiences and an underlying social discomfort with entirely virtual experiences.

FIGURE 6 Locality LEnS



4.2 | The probable

“ Large urban metropolitan areas may continue to spread, spurring innovation in transit, energy, services and infrastructure that exist beyond traditional borders.

Hiring anyone from anywhere

The COVID-19 pandemic has been a “trial by fire” moment for the long-entertained but seldom-tested concept of the virtual workplace.⁶¹ Interestingly, after a year of lockdowns and social distancing, 83% of employers in the US now say the shift to remote work has been a success, and plan to implement flexible workplace policies in the future.^{62,63} C-suite executives and employees alike are more enthusiastic about remote work than ever before.^{64,65} Virtual corporations that would only meet in person for bi-monthly “happy hours” were once considered a pipedream. Now, for some companies, this model may well become a standard operational option.

These very recent shifts in cultural acceptance are occurring in a world that is primed to capitalize on increased vocational flexibility: there is already a massive global talent market for employers to leverage. According to the *2020 World Investment Report* from the United Nations Conference on Trade and Development (UNCTAD), employment in foreign affiliates increased 3% last year.⁶⁶ Students are flocking to study abroad, and to international online programmes in droves.^{67,68} In the face of unprecedented demand for the skills of the future,⁶⁹ we expect that organizations will increasingly tap into this global talent pool.

Smarter cities with healthier humans

In 2020, there was a spike in the rate of American urbanites abandoning cities for the suburbs.⁷⁰ Pandemic-induced concerns over biosecurity make the likes of crowded metro systems considerably less appealing, and suburbs considerably more so.⁷¹ However, another catalyst for this radical change is that only 13% of the world’s cities have affordable housing.⁷² People are looking to the suburbs (and beyond) for space, affordability, health and prosperity.

Advocates of urban living argue that no suburb will ever compete with the productivity, efficiency

and cultural richness to be found in cities. This view has merit,⁷³ even though both millennials (the generation defined as those currently aged 25–40) and members of Generation Z (the generation from 6 to 24) are, according to recent research,⁷⁴ now more likely to communicate with each other digitally than in person.

The future of commuting will likely include driverless taxis that ferry professionals across cities on traffic-free roads at fast, synchronized speeds.⁷⁵ Though the increase in global urbanization is expected to continue well into the future,⁷⁶ we also foresee the growth of global suburbanization. Large urban metropolitan areas may continue to spread, spurring innovation in transit, energy, services and infrastructure that exist beyond traditional borders.⁷⁷

Virtual experiences with material influence

Amazon Prime added 14 million new members in 2020 alone – an increase of 12.5% on the previous year.⁷⁸ In the same year, e-commerce in Canada and the US had a striking 129% year-on-year growth,⁷⁹ and global digital streaming subscriptions grew by over 217 million members, a 28.3% surge.⁸⁰ To state the obvious, both shopping and video experiences that were once anchored in brick and mortar (at Blockbuster or your local supermarket) have now been replaced by frictionless, virtual counterparts.

The experiential economy is now in full swing, with 76% of consumers preferring to spend money on experiences (e.g. music concerts, live sports and travel) rather than material possessions.⁸¹ After the COVID-19 pandemic, it will likely take some time for communities to return to being entirely comfortable with in-person events. One study found that 66% of people won’t return to in-person events without first having a vaccine.⁸² And even before the pandemic, eSports’ parabolic investment growth of \$4.5 billion in 2018⁸³ indicated that a plethora of niche virtual experiences and communities look set to increasingly replace in-person gatherings.

The virtual revolution

More is more: the Metaverse

Since the start of the COVID-19 pandemic, engagement with social media has increased 61% across 30 global markets.⁸⁴ Meanwhile, digital identities are on the rise worldwide,⁸⁵ and virtual relationships (romantic or otherwise) are fast becoming a necessity.⁸⁶ Growing numbers of people are moving their entertainment, friendships, and romantic courtships to digital and virtual worlds.

Couple these cultural shifts with the rapid advancement of digital reality technologies,⁸⁷ and the projected growth in augmented reality (AR) and virtual reality (VR) markets to \$1,274 billion in 2030 (a robust 42.9% compound annual growth rate),⁸⁸ and we have a compelling case for a replacement of the physical world with a virtual one. Similar to the setting of the sci-fi movie *Ready Player One*, a VR-enabled Metaverse (a “virtual world” enabling millions of people to share 3D digital experiences) could present unique and complex experiences in all facets of life: business, education and entertainment.

Today, we have eye-opening disruptions such as Google Expedition VR,⁸⁹ UCLA Neuroscience⁹⁰ and VR treatments for PTSD.⁹¹ Tomorrow, we may see an even more dynamic and enhanced world through VR and AR Metaverses.

VS

Less is more: stoic simplicity

Many of our virtual and digital connectors – social media,⁹² online gaming,⁹³ video conferencing⁹⁴ – have surged in popularity since the beginning of the COVID-19 pandemic. Although these tools are designed to connect us, they don't seem to be working the way we expected. One study found that 34% of millennials were “always or often” lonelier due to the quarantines and social distancing demanded by emergency public health policy.⁹⁵ Despite having access to great virtual tools, many people feel that social distancing has proven that digitally-enabled reality is a poor substitute for in-person socialization.

Additionally, a recent study of social media users found that over 24.4% of individuals had, at some point, deleted their social accounts.⁹⁶ With renewed concerns over mental health, many people are choosing a “digital detox” over connecting online with friends.⁹⁷ Some studies even describe social media as “more addictive than cigarettes and alcohol”.⁹⁸

To complicate matters, the risk of cyber-attacks and leaks of personal data seems to be on the increase.⁹⁹ In a world with more data gathering and more available information online to keep us dependent, people may flee from networked services in order to intentionally simplify.

The physical resurgence

The spatial web

Internet of Things (IoT) devices are cheaper and more capable now than ever before,¹⁰⁰ and more powerful, too, thanks to near-instant 5G connections. During the third quarter of 2019, the number of 5G connections globally grew 329%, to over 17.7 million connections.¹⁰¹ When paired with AI algorithms, robotics and big data systems IoT devices have the potential to analyze, predict, recommend and overlay answers to almost every day-to-day challenge presented in both our personal and business lives.¹⁰² At its simplest, a driverless taxi could set your desired music, window tint and AC temperature the moment you hop in the car.

At its best, the AR cloud has the potency to launch a near-term revolution in the spatial web by mapping everything we do in the real world to digital information and enhancements. As one study puts it, the spatial web would “fully erase the line between digital and physical objects”.¹⁰³ Surgeons would, for example, perform diagnostics and surgery from another part of the world thanks to advanced haptics (technology that creates an experience of touch), precision robotics and enhanced 3D digital modelling, or students would learn about blood cells by exploring the human bloodstream virtually.¹⁰⁴ The possibilities are endless.

VS

Reality redux

In the past decade, spending in the US on live experiences and events (relative to total spending) has substantially increased.¹⁰⁵ Some reports released just prior to the beginning of the COVID-19 pandemic projected that the global live music market would accelerate at a 9% compound annual growth rate into 2024,¹⁰⁶ signalling an increased consumer preference for “being somewhere” instead of “beaming anywhere”.

In looking at the quality of our interactions with the surrounding environment, studies have demonstrated the importance of physical presence. It has been shown that proper exposure to sunlight and meaningful interaction with nature creates happier, healthier^{107,108} and more fulfilling lives.¹⁰⁹ Interacting with other humans and creating meaningful relationships also contributes positively to our health.¹¹⁰

It's not our projection that most people will entirely forego virtual tools – be it a convenient smartphone, an “always-on” spatial web that relays constant information to us, or an AI that predicts our every need.¹¹¹ Rather, we anticipate that, as virtual alternatives become more available, more people will struggle in determining when to choose reality.

4.4 Frank's story



By Lucas Erb



My car arrived at 7am sharp. As I was finishing breakfast, its chimes became louder and somehow less polite, as if to say, *Hurry it up in there!* I hated to keep people waiting, but there was a perverse pleasure in deliberately ignoring a machine. I took a lingering sip of coffee for good measure before walking out the door.

“GOOD MORNING, MR. DALTON THANK YOU FOR RIDING WITH CITYMOVE.” *Yeah, yeah, get on with it, I thought.* “WE ARE HEADING TO 2211 NORTH 1ST STREET. IS THIS CORRECT?”

“Yers,” I mumbled through the last bits of my breakfast. I put on my seatbelt – a regulatory vestige from the days of human drivers – and the car took off.

We cruised carefully through our neighbourhood, before making our way to the entrance of the e-lane. As we shuffled into the fleet of hundreds of Autopods, I reached for the control panel. Gradually, our speed increased, until we matched that of everyone else on the road: over 190 kilometres per hour. Though all of the vehicles were moving so fast, the ants-marching precision of their networked programming made their passengers feel they were stationary relative to those in other vehicles. My neighbouring commuters were always far too close for my liking, certainly too close for privacy. As usual, I dimmed my windows.

My ten-minute journey into the city was peaceful, a much-needed buffer between the beige suburbs and the colourful city. Back when the virtual revolution first began, it was hard to figure out what was best done where. Doctor’s visits, money transfers, grocery shopping? I was more than happy to move these activities to the virtual comfort of my own bed.

But meeting with friends at a pub, a caffeinated stroll around the city gardens, or celebrating weddings and anniversaries – these felt worthy of the time and energy required to be physically present. My rule of thumb had become “Action? Be there. Transaction? Beam there.”

*

Action? It was looking like that would be an understatement today. When the lift doors opened I realised that I had never seen this many people in our office before. There were Hannah, Valerie and Levi, teammates who lived outside the city, nearly two hours away by hyper-rail. They hardly ever came in. I noticed Parker over by the greenhouse,

looking pretty upset, and a large group of strangers who I would have thought had wandered in off the street if it weren’t for the green “auth” dots that my augmented glasses floated over their heads.

At first, I was curious. *Had I missed a memo for an All Hands?* But as I walked across the office floor, I started to feel uneasy. Everyone seemed to be watching me as I walked, and whispering.

“...two hours, as if!...”

“...I never thought they actually would...”

“...Parker fired? In what world...”

I soon realized that everyone’s eyes were on me, their stares converging as my assistant, Jon, stole me off into a huddle room.

“What the...” I started, partly as a question, mostly as a declaration of disbelief. Jon was always consummate, composed professional - well dressed, well mannered, well everything’d. But not today. Today he looked a bit crumpled, and that instantly had me incredibly worried.

Looking me straight in the eyes, and choosing his words with obvious care, Jon said, cutting off my question, “It’s the Gekko. We have a problem.”

*

“Where the hell have you been?” Stacey barked from behind her monitor.

As our CEO, Stacey enjoyed unrivalled authority, but her gravitas lay in her unparalleled capacity for candour. I tried making a point of staying on her good side.

“I, uh...”

Stacey quickly cut me off: “Frank, how is it that my own VP of Algorithms has no idea what the algorithms are doing?!” she demanded.

Now I was *really* afraid. Jon had said there was an issue with the Gekko. I was secretly hoping it had been a technical one but an *algorithmic* issue meant real problems. Model drift? PII leak? Data manipulation?

Last year, our largest shareholder had forced the board to spend a cool \$40 million implementing a new HR optimization bot. Named after a fictitious Wall Street character and priced to match (the project ate up nearly twice our annual algo budget), the “Gekko” was trained to maximize shareholder value through enhancing organizational efficiency, removing costs and focusing on earnings. The whole MBA-flavoured enchilada.

Although the Gekko technically reported to our Chief Human Resources Officer (CHRO), it had

only made a few anodyne recommendations since its go-live. A gentle warning to underperforming sales staff here, the placement of an online ad recruiting to fill skills deficits there. The procurement department, to the surprise of everyone, even got a raise. All in the name of the Gekko's singular goal: profitable growth.

Maybe the algo had just given Pat's legal team a raise too? I could see that pissing everyone off...

Stacey interrupted my inner monologue. "Your program ordered a 30% pay cut for the entire company, including *you and me!* It deemed our 'fair market value' to be 'significantly lower than legacy HR estimates'."

"It can do that?" Even as the VP of Algorithms, I had no idea that the program had that kind of autonomy.

At this point, smoke was practically pouring out of Stacey's ears. "And to top it all off, the algo has requested that half of our staff be recharacterized from full-time to hourly, 'in recognition of their implied productivity metrics to date'."

Before I could get a word in edgeways, Stacey steamrolled on.

"Two hours a day, Frank. The Gekko believes half of us add only two hours of value per day!"

My mind was racing. I was increasingly certain that my team was to somehow to blame for this catastrophe.

Stacey continued on: "Jessica resigned an hour ago", she said. "And guess who, or in this case *what*, battlefield-promoted itself to interim CHRO, Frank?"

I knew better than to answer that question.

Stacey's glare suddenly softened. "But what I don't understand is *why?* *Why* did some members of our team get the hourly cut but not others? I looked at the data and it seems random, nonsensical even."

I was equally perplexed. Could it be that the algo had seen something in-market that justified the wage decreases and cut in hours? Doubtful – I had looked at market adjustment data just last week. Or maybe the cuts were meant for some other outfit with the same name as ours?

Or maybe...

"Stacey, I need to go."

Her softened face suddenly went taut again. "Are you kidding? I have a meeting with the board *tonight*, and we are going to need answers."

I took a slow breath, making the seconds

count. "Do you remember last year when that bank had to walk back 0% interest rates for its female customers? Or a few months ago when those cobots at the factory downtown got called out for 'bot-splaining' general information to employees on H1-B visas?"

Stacey nodded impatiently. "Get to the point, Frank."

"I think the Gekko might be biased."

Biased – the word hung in the air between us. Bias was the biggest issue for people working with algorithms. If the Gekko was indeed biased, we should be able to re-engineer its decision-making process to isolate the discrepant variable. But I would need some help.

"I need to head back to my home office to get some privacy – I want to call in a few favours. I'll let you know what I dig up."

"So you're going to leave me here with the torches and pitchforks?", Stacey asked.

"Hey, I only get paid for two hours a day. As far as I'm concerned, this is overtime", I joked, before hurrying out the door, struggling to disguise my unease.

*

On the Autopod ride back home, I must have skimmed through a hundred angry emails:

You really think I only put in two hours? You don't even know my name!

Do you have any idea how this will impact my family?

I have never been more disgusted by an organization.

Reading them broke me. Even though these employment changes could technically be reversed in the future, in the short term real people were going to suffer. A breach of trust, however temporary, is a breach of trust. It was going to be a Herculean effort to untangle this mechanized mess, but I knew I had to act, and act quickly.

*

"Dial Ryan from Digital Forensics," I shouted into my home office as I paced the hallway just outside. One of my smart speakers picked up the command, coordinating with all my other smart devices to optimize the processing time for my request. ►

[Frank's story continues in the Annex, on p.51]

5

The future through the LEnS of the economy

In the face of finite physical resources, the world needs well-informed strategic responses to avoid an unsustainable future



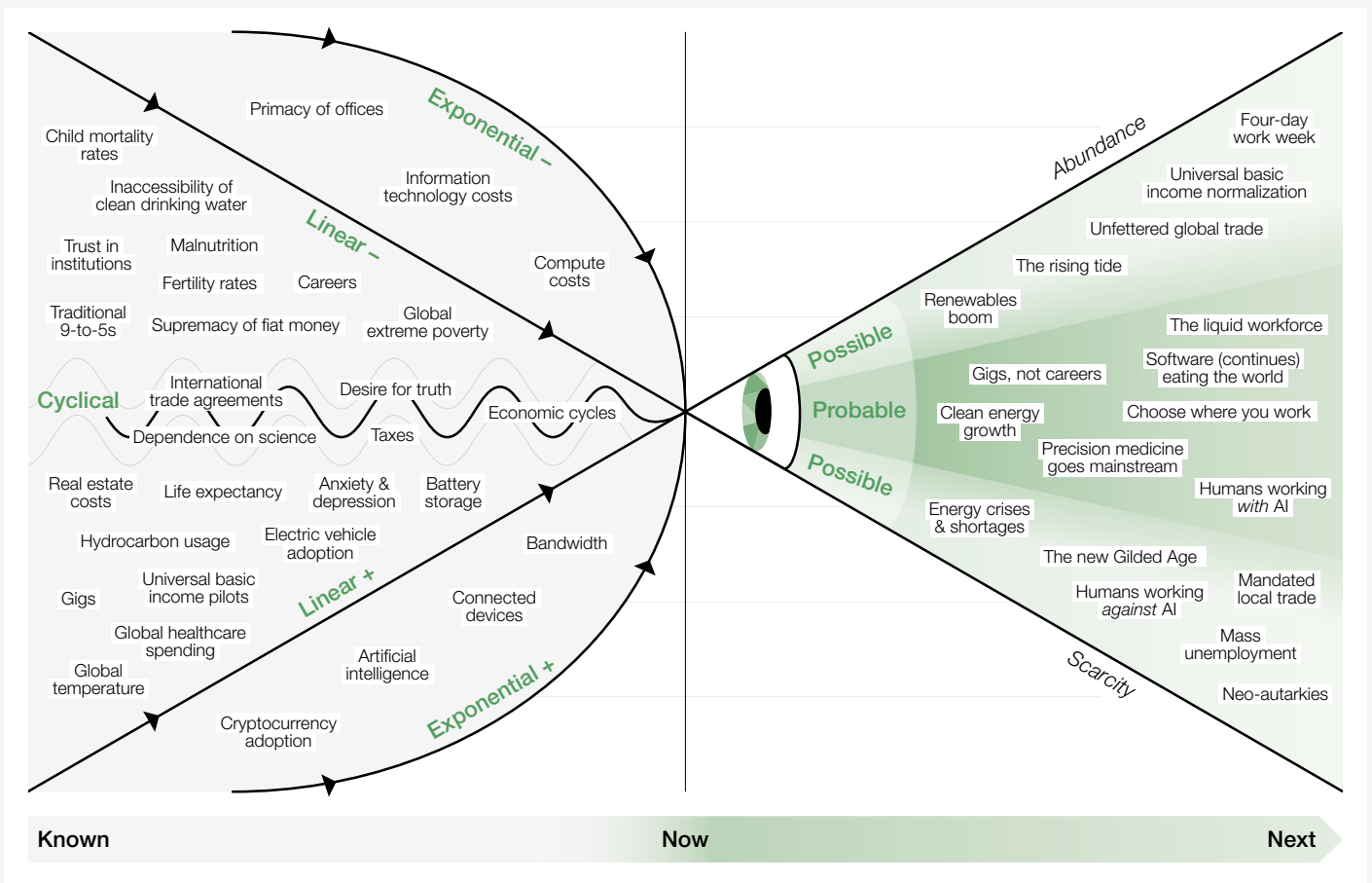
5.1 Context

The economy LEnS considers finite raw materials and their development into higher-order economic outputs. Resources (energy, infrastructure, clean water, etc.) are obviously necessary for humans to both survive and thrive. "Economy" covers the value-added creations that are developed from those materials (jobs, trade, production, etc.).

In a world where technological change is constantly disrupting the availability and usefulness

of resources, the ways in which we embrace technological innovations can often matter more than the technologies themselves. Will our collective future be characterized by abundance, with resource availability and economic growth rising along with the tide of increasing global technological prowess? Or, will we find ourselves in a world of scarcity, where global inequality and tribalism result from a dearth of access to resources?

FIGURE 7 Economy LEnS



5.2 The probable

Software (continues) to eat the world

The exponential rise of artificial intelligence usage,¹¹² bandwidth capacity¹¹³ and spend on IT and computing¹¹⁴ signal that software advancements will continue to drive and enable global economic output. As the costs of IT and computer purchasing continue to fall¹¹⁵ (i.e. we have an ability to purchase more with less), we expect to see not only more grassroots innovation in this sector, but also more adoption, across different industries.

The liquid workforce

The rise of the “gig worker” is helping shift the established pattern for work from the traditional “9 to 5” to “whenever suits my preference”.¹¹⁶ This rapid move towards flexibility is affecting not just the gig-work sector but also traditional companies, as they must now manage employees’ increasing demands for work styles that allow for personal plasticity. More people are rejecting the once-dominant principle of “one career, one company”¹¹⁷ in favour of the concept of a “liquid workforce”¹¹⁸ that supports their changing needs. Add to this dynamic two more factors: the increase in pilots for a universal basic income,^{119,120} and a continuous increase in the elderly as a proportion of population.¹²¹ Both trends signal reconfigurations

not just of *how* we work but also of societal expectations about why we work and for how long.

Clean energy growth

Fossil fuel consumption has risen by 9% globally over the past decade, with roughly 84% of primary energy coming from coal, oil and gas in 2019.¹²² It is an understatement to say that our energy needs are increasing. Against a backdrop of exponential growth in connected devices^{123,124} and rapid industrialization,¹²⁵ our current energy supply will be limited in its ability to support future demand.

Currently, renewable and low-carbon energy sources show increasing commercial viability¹²⁶ and consumer adoption.¹²⁷ Moreover, advances in battery technology, such as solid-state electric vehicle (EV) batteries,¹²⁸ are paving the way for an EV-led future.¹²⁹ Although non-automobile EV adoption is expected to lag behind that of automobiles,^{130,131} we anticipate that alternative sources of clean energy will further fuel a gradual shift into increasingly “clean” transportation. Although traditional oil and gas sectors will continue to comprise a large portion of our energy supply for the foreseeable future, it is probable that clean energy adoption will continue to increase over time.

“ Against a backdrop of exponential growth in connected devices, and rapid industrialization, our current energy supply will be limited in its ability to support future demand.



Sustainability

Both kinds of “green”

Advancements in renewable energy sources, alongside broader societal trends such as falling birth rates,¹³² will lend a significant hand in the fight against climate change.

Although devastating in many different ways, the COVID-19 pandemic has also brought a temporary decline in CO₂ emissions, with a nearly 17% decline by early April 2020 as compared to 2019 levels.¹³³ International travel alone declined by 70% from January to August in 2020.¹³⁴ The duration of this contraction is expected to remain closely related to the severity of the pandemic.

How we choose to embrace sustainable practices in a post-COVID world will be pivotal in our fight against climate change. It is possible that we will return to travel-intensive, commuter lifestyles that help fuel climate change. However, it is also possible that we will refuse to return to our pre-pandemic version of “normal”, instead forging a new sustainable path forwards for our world, that does not sacrifice corporate profitability.

Many companies have already created policies that promise to help enable the move towards a new “normal”;^{135,136} for example, San Francisco’s largest private employer, business software company Salesforce, announced in February this year that after COVID-19 restrictions are lifted it will let most of its employees work from home two days a week.¹³⁷ The extent to which more companies and governments follow suit will be a significant determining factor in our collective fight against climate change.

VS

A return to “normal”

Rising fossil fuel consumption and deforestation have led to a rise in global temperatures, at a rate of roughly 0.18°C per decade since 1981.¹³⁸ Although an imperceptible rise of 0.18°C per decade might seem marginal, even almost irrelevant, to us as human beings, it is already having an impact on the world’s ecological systems.

A return to “normal” in a post-pandemic world would further accelerate the undesirable march towards a rise in global temperatures.¹³⁹ Although nearly half (48%) of US employees currently working at home for their employer have said they would like to continue working remotely after the COVID-19 crisis is over, that also means that just over half would like to *continue* commuting to physical office spaces for work.¹⁴⁰

Travel to and from work is also just one part of the complex picture on emissions. In 2016, emissions from transport made up only 16.2% of global greenhouse gas emissions.¹⁴¹ To make significant headway on fighting climate change, emissions will have to be cut across other categories such as “industry” and “energy use in buildings”, which account for 24.2% and 17.5% of greenhouse gas emissions respectively.¹⁴²

To paint a rosy picture for a future grounded in sustainability is to ignore reality. Advancements in clean energy show promise,¹⁴³ but technological advancements without proper adoption will likely leave us no better off than when we started.

Economic opportunity

The new Gilded Age

In the 19th century, the US experienced a period of unprecedented economic expansion, which not only produced huge profits but also increased income inequality and class conflict.¹⁴⁴ Dubbed the “Gilded Age”, this era shows some flavour of the world today.¹⁴⁵

Globally, although extreme poverty has consistently fallen for decades, it is expected to have risen again in 2020.¹⁴⁶ This is because the COVID-19 pandemic has disrupted the effectiveness of efforts aimed at continually reducing the causes of extreme poverty,¹⁴⁷ even if the overall rate has continued to decline.¹⁴⁸ It is uncertain whether extreme poverty (especially in locations such as South Asia and Sub-Saharan Africa, regions that together are home to nearly 85% of the world’s poorest people¹⁴⁹) will continue to decline (albeit slowly) or if a cyclical pattern will be established, with rises and falls pegged to the current state of global affairs.

Extreme poverty is one measure for evaluating economic prosperity; the concentration of capital is another. Just as extreme poverty is regionally distributed, so too are the levels of capital concentration in different countries.¹⁵⁰ Although it would be an oversimplification to suggest income inequality is on the rise everywhere, some of the world’s most populous countries (the US, China, India and Indonesia) have seen a rise in income inequality over the last 25 years.¹⁵¹ Pair this with falling trust in institutions,¹⁵² rising real estate costs,¹⁵³ and mass unemployment as a result of the pandemic¹⁵⁴, and declarations of similarities with the “new Gilded Age” no longer appear tenuous.

VS A rising tide

Over the last few decades, technological innovations have driven improvements in supplies of clean water, access to proper nutrients, and the quality of healthcare.

In 2000, over 38% of the global population did not have access to clean drinking water.¹⁵⁵ Just 15 years later, that percentage had dropped to 29%.¹⁵⁶ Although there is much progress to be made, especially in regions such as Sub-Saharan Africa,¹⁵⁷ over time a greater share of our global population is expected to have access to clean drinking water.

In looking at the regional daily supply of food calories from 1993 to 2013, all global regions have continued increasing their food available for consumption, with increases most significant in Africa and Asia.¹⁵⁸

As for healthcare, decreasing fertility rates,¹⁵⁹ decreasing child mortality rates,¹⁶⁰ and increasing life expectancy¹⁶¹ all indicate real progress is being made on improving global health. Although healthcare spending continues to expand faster than the economy (between 2000 and 2017, global health spending in real terms grew by 3.9% a year, while the world’s economy grew 3.0% a year¹⁶²), breakthrough advancements in gene sequencing,¹⁶³ 3D-printed organs,¹⁶⁴ and artificial intelligence applications in life sciences¹⁶⁵ indicate a future of “more bang for your buck” on healthcare spending.

5.4 Alex's story



By Ruth Hickin



“Alex, what are you thinking? Do you want me to respond? The President needs an outcome in time for the 5pm press conference. They asked if we have a deal... Alex, you need to make a call on this. Do we have a deal?”

*

When I was young I never considered myself a political person or really even a technical person. So I can't quite believe I'm now a well-known cybersecurity expert – I still pinch myself when I get interview requests via the President's press office. My career started just after I wrote my thesis on the movement that brought six billion users onto the internet in the early 21st century, an event that occurred in tandem with open cross-border data flows. The progress we'd made in the digital arena was truly staggering; it convinced me I needed to pursue a career that maintained the integrity of the hugely expanded internet.

I'm proud to live in a world with free data movement, carbon neutrality and genuinely global trade for all. I think about my cousin Mel, who lives in East Africa and develops IP for robotic arms. The materials are produced somewhere near China but are paid for and 3D-printed by customers here in France, and around the world. Thanks to a complete overhaul of global trade agreements and taxation made possible by the Breton Woods for Tech Agreement, the economic benefits of this supply chain go to my cousin, the materials producer and to France – it's a legal, transparent process executed securely in a blockchain-based system.

In some ways, the world is simpler now, yet in other ways, it's far more complicated. But it's hard to remember what it was like only a few years ago.

*

I was just out of graduate school and starting a job at the Global Internet Alliance. I was passionate about creating an open and free internet, one that mirrored the better world we were trying to build. At the time, I was inspired by the progress some nations were making on opening up borders to enable free trade and more effective data use. This ultimately lay the groundwork for the incredible strides we've made since in trying to achieve carbon neutrality and eliminating infectious diseases.

I thought that the internet was going that way too, especially when government took on a bigger role in regulating it. Following that historic shift, data

oligopolies ceded power to the people, who took legal control of their own data. This, in turn, created room for new businesses and services to grow.

Little did I know how pointless most of my graduate studies would end up being. Six months into my first job, I was recruited by the Department of Defense. They needed someone with an expert understanding of the internet and cross-border data flows to join a top-secret new project. Once my security clearance went through, I was invited to attend a morning briefing with the new team. I stared across the room at other people who looked as unsure as I felt about being there.

The briefing centred on a staggering revelation: our team leaders told us that for years a small, top-secret group had been analyzing major decisions taken in our country and the degree to which they had been influenced by online manipulation, enabled by a significant level of compromised access to our data. It was clear that the degree of manipulation and cyber espionage was more significant than we could ever have imagined. The data of *virtually every citizen in the country had been compromised*, from welfare benefits and healthcare records, to the state grid.

I didn't believe it. “How can you be sure?” I asked, anxiously. Looking back, this was a rather stupid question. Ongoing advances in technology, especially quantum and fact-checking algorithms, had made it relatively easy to discern how widespread and damaging the misinformation that targets specific groups is. My next question was just as underwhelming: “We have to let people know. What are we doing about this?”

How naïve I was.

“Do you think anyone cares?” responded one of the team leaders, coolly. “We've been seeing this for years. What we need to do now is understand which countries represent the greatest threats to us, and what their agendas are. Then we can decide how to act on that information.”

I didn't recognize it at that moment, but this meeting marked the beginning of a decade of change that would profoundly transform the way people around the world interact with each other. Our team leaders said that our first task was to eliminate immediate threats. For years, they explained, we had been “putting out a welcome mat” to our internet and opening the door to intruders. This had to stop.

I led the team charged with identifying “bad actors” – whether they were governments, political

or criminal organizations, or individuals – who meant us harm. One by one, we began building walls to keep out those we didn't want to be part of the internet we existed within. Our mission was to protect the wellbeing of our citizens. I wanted to give my children the gift of a securely benign internet – one offering learning, greater communication and useful insights. I also wanted to connect my rural parents to the rest of the world, and give them a voice. This fight was for them and for freedom (within limits).

Another taskforce focused on fighting fire with fire. They ran campaigns that forced our enemies to confront uncomfortable truths about the way they'd been operating. This taskforce worked closely with our press office, but other than that, they kept a tight lid on their work. If my German grandpa had known about it, I think he would have called this work "propaganda". But to us, it was just one of many lines of defence – for bigger threats we had a cyber division that could take out power supplies to stop conflict before it starts.

Of course, we couldn't have the Europe we'd built over the past 100 years without co-operating with our neighbours and building those walls together. Sadly, global political unification around the internet was never going to be possible, so alliances had to be built around shared belief systems, and with national and regional sovereignty in mind. What we ended up with wasn't perfect, but it worked from a communication perspective and didn't necessarily get in the way of trade.

We always thought the splinternet would be binary: us versus them, government versus businesses. But surprisingly, the biggest binary pair was always the North Americans and the Europeans. With one New Yorker and one Londoner as parents, I easily understood the cultural differences that exist between different parts of the globe. My mom and dad could never agree on where to draw the line between free speech and hate speech, on the merits of free education versus paid education, on the role of government (or not), and importantly, on privacy.

In a global, data-driven world, what exactly is privacy? GDPR set the tone a long time ago in Europe and has been the cornerstone of how we think about and manage data ever since – especially what is considered *personal* data. California tended to agree with us, which is why we brought them into the European Internet Alliance. Yet with many other groups or regions, seemingly intractable differences remained. We haven't been able to all live together

in a unified, global internet since.

That is, perhaps, until today.

*

It all started with one video call, president to president. Two leaders decided to rekindle a relationship. They reasoned that although the world might have 18 internets, it only had three internet superpowers, and that they needed to work better together.

One of the biggest downsides to our progress in online safety has been the decline in our progress on data sharing for societal benefit. One of the most amazing advances that happened when I was a child – one that I remain passionate about today – was the ability to share data to achieve better insights. Data sharing was a game changer. It made our carbon-neutral world possible. It drives my sister's thriving agriculture business. And, thanks to precision medical treatments tailored around sharing a patient's genomic data, my mother is now cancer-free. What other global challenges could we help solve with this move towards greater internet sovereignty?

Since the new administration came in, there has been more internet-related collaboration across borders. And following the We the People movement, the idea of internet passports now seems feasible.

*

When the two leaders hung up on the video call, my boss – the President – tasked me with turning the discussed vision of internet cooperation into reality. My mind began racing. Could we really make it work? How could we bring other countries and political leaders to the table? Once they were there, could we trust them?

The work hasn't been easy. I have three children now and am constantly trying to balance their safety with the potential of technology to benefit our society. Yes, there are potential risks in bringing new countries into our global alliance, but there are potential benefits, too. I always ask myself the same three questions, to help balance the trade-offs we know we'll have to accept:

1. What are the potential threats to national security?
2. What are the biggest benefits to our citizens and the world? ►

[Alex's story continues in the Annex, on p.52]

6

The future through the LEnS of education

Educational norms relating to where and how people learn, and at what point in their career, are rapidly being dissolved



6.1 Context

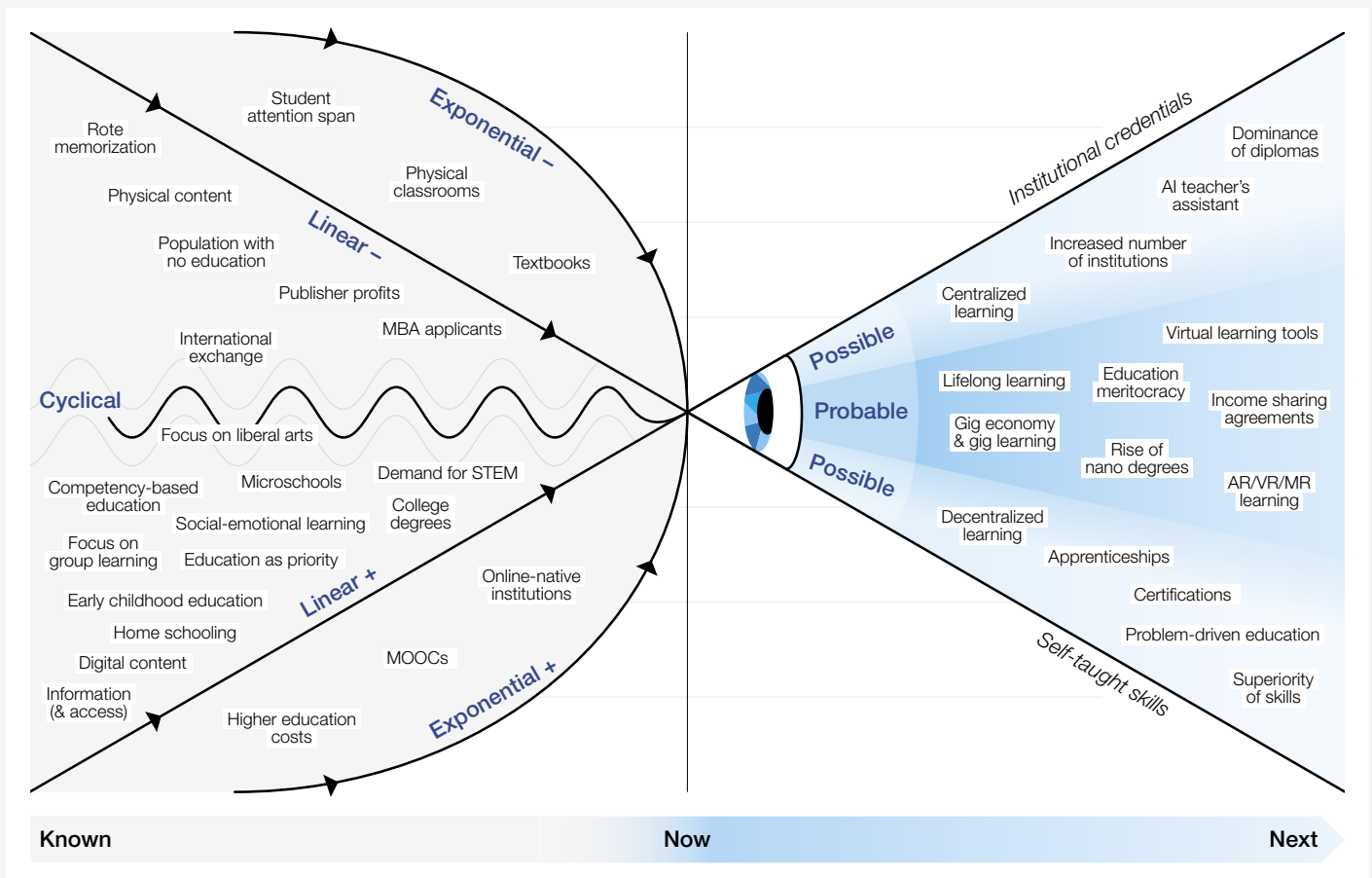
Famously dubbed “our passport to the future” by Malcolm X,¹⁶⁶ education can be broadly defined as the way individuals learn and how we teach the skills they need to build successful careers.

Every day, in countries all around the world, people make a conscious decision to learn something new, using formats and programmes such as digital and physical resources, skills-based training and self-paced training to absorb information. Advanced modes of accessing information are driving dramatic shifts in the ways people learn and institutions teach, a trend that is likely to lead to the development of two future educational norms. In the first, which we describe

as “institutional credentials”, the kind of structured education traditionally offered by school systems and universities will remain in place, but with new tools and teaching methods. In the second, more disruptive scenario, traditional education with its emphasis on formal accreditations will give way to a more meritocratic system of “self-taught skills” that prizes demonstrable competency, real-life problem-solving and the creation of measurable value.

Despite all the unknowns, several trend lines that have been established over the last decade help bring into sight futures that, although uncertain, are still substantially plausible.

FIGURE 8 Education LEnS



6.2 The probable

Personalizing education

If the “gig working” economy continues to increase in the future, so too will the “gig learning” economy. The pace of technological change in the workplace is unlikely to slow, with current projections making assertions such as “65% of children entering primary school today will ultimately end up working in completely new job types that don’t yet exist.”¹⁶⁷ Thus, in tomorrow’s careers, lifelong learning will become a necessary means of staying relevant.¹⁶⁸

Over time, enough people investing in lifelong learning might naturally encourage a decoupling of degree and diploma programmes. This decoupling could support the expansion of “nanodegrees” (a “project and skills-based educational credential”¹⁶⁹ delivered entirely online, which is far quicker to obtain than a conventional degree) into areas of study beyond computer science, allowing individuals to more easily keep pace with a rapidly changing skills landscape. Although the number of conventional learning institutions continues to rise,¹⁷⁰ the cost of the tuition they provide is also increasing to match.¹⁷¹ These rising prices could make institutional education unattainable for future generations, forcing students to re-evaluate the value of traditional accreditation. Instead of students asking themselves, “What do I want to be when I grow up?” they might very well ask instead, “Which job looks interesting as a starting point?” So if the answer to the first question was, “I want to be a

doctor, and go to medical school for seven years”, it could equally be, “I’m interested in science, and want to explore a short course on biology”; acting on those intents leads to a very different skillset, as well as requiring a different upfront investment.

Digitized and virtualized content

The demand for both physical classrooms and physical textbooks is falling exponentially,^{172,173} and as an inverse mirror to these twin trends, the market for digital classrooms is growing exponentially. One illustration of this is the 10% year-on-year growth of massive open online courses (MOOCs).¹⁷⁴ Digitizing and virtualizing education is certainly economically efficient, but there are a few other potent incentives in this transformation.

Today our access to information from around the world is unparalleled in scale to any other period in human history.¹⁷⁵ In addition, there is certain evidence that globally, attention spans - especially in young learners - have decreased dramatically.¹⁷⁶ These trends create a rich soil for innovations in two key attention-holding learning technologies: digital classrooms and AR/VR learning experiences. For example, one European business school now has a “100% digital campus”,¹⁷⁷ and companies such as Google Expeditions VR,¹⁷⁸ VR Education¹⁷⁹ and zSpace AR¹⁸⁰ are pioneering the future of a range of different AR and VR learning experiences.

“ Instead of students asking themselves, “What do I want to be when I grow up?” they might very well ask instead, “Which job looks interesting as a starting point?”



The virtual revolution

Proven competency

For millennia, students have looked to expensive, formal institutions to access knowledge and train for their desired profession. Recently however, *Harvard Business Review* identified a severe “skills gap” caused by the inability of formal education to keep pace with technological advancement.¹⁸¹

As employers are increasingly confronted with the need for people with rare skills, they may become more comfortable with non-traditional, decentralized sources of knowledge, with candidates proving aptitude through real-world projects and problem solving.¹⁸² Google, Apple and Netflix are a collection of the most successful tech companies in the world, and yet they do not require employees to have tertiary education.¹⁸³ “Gig work” further disrupts the traditional rules of recruitment by enabling a company to hire a single employee with specialized skills instead of a team of well-rounded, institutionally-trained generalists.¹⁸⁴

Aside from a recent rise in applications that is largely attributed to the uncertainty caused by the arrival of COVID-19, the number of MBA applications is overall following a downward trend in the US.^{185,186} Demand for competency-based education is increasing steadily and perhaps will replace formalized college degree programmes.¹⁸⁷ If these trends continue – both the relaxation of corporate requirements and a decrease in demand for institutional education – we believe the future of work could be increasingly characterized by more meritocratic, skill-based hiring, and by a focus on apprenticeships and other forms of on-the-job training.

VS

Tertiary degrees

Traditional institutions offer something that no informal education can: respect as a result of the institution’s historic reputation, as well as a de facto “seal of approval” for any student that graduates with honours. The University of Oxford, founded nearly 1,000 years ago,¹⁸⁸ is as influential now as it ever has been, with an endowment of over £6.1 billion and an annual budget of £2.14 billion.¹⁸⁹ Finances aren’t the only aspect of traditional education that is flourishing, however. By 2030, the number of young people completing a tertiary degree across OECD and G20 countries is expected to increase to 300 million, up from 137 million in 2013.¹⁹⁰ To accommodate this demand, it’s reasonable to expect a continued increase in institutional capacity, as well as the number of traditional institutions.¹⁹¹

As digital learning disrupts long established pedagogies, respected institutional brands may increase their capacity and expand their enrollment in a wide variety of online courses. It is reasonable to expect that bolstered global interest in virtual attendance at the world’s leading universities,¹⁹² as well as technologies including AI, will help traditional institutions personalize learning and maintain their stellar track record as they scale to a broader audience.¹⁹³

Institutions have survived and thrived through centuries of advancements in locomotion, electricity and computation. Therefore, it is reasonable to expect this resilience will continue in the face of current shifts in demand, and that those institutions will readily adapt to the rapidly growing international market for education.

Financing the future

Alternative financing

The meteoric rise in tuition costs and increasing demand for certain skillsets means that the development of alternative financing in higher education appears likely. The cost of tuition is rising globally “eight times faster than wages”,¹⁹⁴ a fact that has the potential to dissuade many talented, potential students from even considering higher education. The good news is that in the internet age, since the early 1990s, the percentage of the global population that has had no formal education has dropped dramatically – nearly every country has seen a 50 to 100% decrease.¹⁹⁵ The bad news: there is still a lot of unmet demand for science, technology, engineering and maths (STEM) skills, as well as other future fields as yet unknown.¹⁹⁶

In response, alternative forms of tuition financing will increasingly be available to support students in investing in courses that gain them highly sought-after skills. Income-sharing agreements (ISAs) – financial agreements in which students share a portion of future earnings to pay for their tuition – are one such financing option that is currently garnering interest from investors. The start-up Blair received \$100 million¹⁹⁷ in 2019 and, in the same year, online coding platform Lambda raised \$30 million¹⁹⁸ in funding to double-down on their ISA programs. It is likely that a rise in alternative financing options will empower students to pursue skills-based training while forcing institutions to offer concrete evidence of the value of the skills they teach.

VS

Traditional loans

The cost of tuition is rising. However, this rise is justified by the market, as there is an increased demand for courses at higher education institutions.¹⁹⁹ Prices don't seem to be deterring students: in 2015, in the UK it was found that “students' attitudes toward taking on student loan debt were more favourable in 2015 than in 2002”,²⁰⁰ and that the student loan market is thriving.²⁰¹ Consequently, universities with a global reach have bigger average endowments than ever before.²⁰²

And who should foot the bill for a student's education? Although government aid in the form of tuition forgiveness may help many students pay for tertiary degrees,²⁰³ this support may have the adverse effect of disincentivizing an institution to be economically efficient.²⁰⁴ Though income-sharing agreements are gaining traction in niche courses that teach lucrative skillsets,²⁰⁵ there are still students from low-income backgrounds who cannot readily use an ISA.²⁰⁶ Perhaps alternative sources of funding will increase in popularity for small percentages of the student loan market; however, the majority of students may still wish to pay for tuition through a traditional loan offered directly by their college, government, or financial services provider.

5.4 Maiah's story



By Raquel Buscaino



As hundreds of faces turned towards me, I reached for my hands and put them on. They were too big, as expected. My real hands were small, even for a nine-year-old's.

As the crowd stared, I knew exactly what to do next. I had seen my friend Sanda go through the ceremony last year when the United Educators (UE) had come to our village. I lifted my heavy new hands and began waving to the faceless crowd.

*

Two weeks earlier, the admission ambassadors of the UE had arrived in my village for their annual visit. They were there to announce which of the local kids would be offered spots at the Global Virtual School (GVS) – a recently founded, yet already prestigious, virtual academy for what the grown-ups called “bright sparks”.

Like every nine-year-old in the country, I had taken standardized tests that covered everything from reading and writing to mathematics and logic. Because an impressive result could have a huge effect on a child's future, my friends and I – and our parents – were really anxious.

When the UE ambassadors knocked on my family's door to give us their good news, I was as shocked as anyone. My mother cried happy tears; my father, who had told me many stories of how different education was when he was young, beamed with pride.

*

“Maiah, how does it fit?” asked one of the ambassadors. I nodded and the portal wobbled loosely on my head. “You've got a small head for a child with such a big brain. Bolin, will you grab me a smaller one?”

As Mr. Bolin fetched another portal (Mom still called them “virtual reality headsets”), I played with my new hands. The haptic gloves were also slightly too big, but I was beginning to get used to them.

“How does this one fit, Maiah?” I nodded my head again. The portal didn't wobble this time. “Looks like that's the one.”

The ambassador turned to look at me. She must have seen me as I saw myself: not as a prodigy, but as a small, nervous child.

“Maiah, today is the first day of school with your 30 new classmates from around the world. This will be their first day of class too, so if you're nervous just remember that everyone else is too.”

I nodded. She seemed to understand what I was feeling.

“Do you have any questions before class begins?”

My mind was spinning. I'd known I would be in a virtual classroom, but it was the first time I had thought to ask: “If the other kids come from different parts of the world, how will they understand me?”

The ambassador smiled. “Speak in your own language as you normally would, and the other students will understand you perfectly. Your microphone is equipped with language processing and generation, so it will automatically translate everything you are saying into your classmates' languages.”

Bolin said, smiling, “We call it *Babel* for short.”

“Will my Babel voice still sound like me?” I asked.

“Yes. Your voice, your tone, your laugh: all still yours. It only alters the *words* you are saying so that they will make sense to the others.”

I remembered my mother telling me about this. Supposedly, when she was a girl, Natural Language Processing and Natural Language Generation were a mess. She said the technology made everyone sound like robots.

I was happy that I could at least keep my own voice.

“Are you ready to meet your classmates, Maiah?”

I nodded, not quite sure.
“On the count of tres, deux, one...”

*

The next three years went by quickly, but the memories of that time are vivid.

I remember the first time I tried writing with my virtual pen. I curled my hand into a loose fist and moved it down to my lap, piercing my paper straight through. I would have been embarrassed if I hadn't seen a dozen other kids do the exact same thing.

Another strong memory is of the time I was on the playground when one of my least-favourite classmates threw a water bottle at me. I knew it wouldn't hurt me in the real world, but I flinched anyway, causing my portal to jolt backwards and hit the wall behind me.

But more than anything, I remember my friends. Paige and I would talk about what we

had for dinner the night before – food so different I sometimes couldn't understand what she was talking about. I simply couldn't fathom how her father could grill cow muscle every Friday for dinner. Mark and I would sometimes turn Babel off, laugh about how funny we both sounded speaking our own languages. And during our free time Raphael and I would sneak off into different Metaverses, exploring hidden caves and riding age-inappropriate roller coasters.

Those early years were good years. The world was my park, and each of my classmates' countries a different playground. But not everything was perfect: time spent with my virtual classmates meant less time with my local friends, and I had to eat at unusual hours to sync to our GMT-pegged schedule. But, as my mother would remind me as she tucked me into bed each morning, "A GVS girl is a lucky girl."

*

"Celia, you've shown a strong aptitude for mathematics, engineering and creative writing. What track would you like to choose?" Celia stood up proudly, "I would like to pursue mathematics." Our class gave a rousing round of applause.

The professor continued down the register. It would take some time before the professor called my name, but I was already bursting with excitement. For the last year, I had been meeting with different mentors – scientists, business leaders, other professors – with each one giving me advice on which field of study to tackle. I was grateful for all their input, but I had always known where I'd wanted to specialize.

"Maiah, you've shown a strong aptitude for chemistry, biology and sociology. What track would you like to choose?"

As I was about to speak, I realised that this was not only the start of something but also an ending, too; after today I'd no longer get to see all my dear friends, people I now realised I'd never *really* seen at all. But I knew that I had to take this next step, and in which direction.

"I would like to pursue surgical medicine."

*

Classes began the next day, but it would take a week to set up my med kit. The expensive bit – the new portal core – was shipped directly

to our nearest city, and required a bus ride and my father's actual paper signature. Dad muttered much of the way to the ministry about "Luddites" and "insurers getting with the times".

My remaining college supplies were 3D-printed at the nearest Auntie Addie's. This was more Dad's speed, and he would gleefully drop whatever he was doing to watch every delivery drone make its three-minute buzz over the valley to our deck.

I was amazed, if a bit disappointed, at how little equipment there actually was in my med kit. In the vids I had watched with my father, the doctors had so many tools: microscopes and exam tables, cast saws and ventilators, even lollipops for after the patients had been fixed.

Yet all that sat in front of me were my new portal, my new hands and a bright pink vest. I wondered what the vest was for. It certainly wasn't to do with fashion.

But as I began to look more closely at the gear and to try it on, I started to appreciate the details. The dexterity of the haptic gloves was astonishing – as if they were actually my own hands, a second layer of skin. The portal also represented a major upgrade. I could control it with my eye movements, summoning overlays to appear on demand. Two blinks for diagnostics. A squint for zooming in. A wink to open a chat box.

*

"And who can tell me another function of endoplasmic reticulum in the cell?"

A boy from a country in Northern Africa raised his hand, stating hesitantly, "To transport proteins and other materials within the cell?"

Our new professor gave a simple nod. Two weeks of review had taken its toll on all of us. Thankfully, seeming to see the risk of his students' collective disconnect hitting an all-time high, the professor then said, "It seems like now is as good a time as any for our next lab. Today we'll focus on observing the functions of a white blood cell."

After a short flash, I was in a tunnel, speeding down a waterslide on an inner tube. On closer inspection, I realized it wasn't a tube at all – it was a red blood cell. I looked up with just enough time to dodge a flying platelet. *Of course*, I smiled, *I was inside an artery!* ►

[Maiah's story continues in the Annex, on p.53]

7

Ready to shape the future

An explanation of where the probable futures we've seen are likely to converge offers clear take-homes for robust planning











7.1 Signals in the noise

The preceding five sections of this report are all characterized by divergent thinking. In section 2 we looked at technology-enabled futures that follow enduring, accelerating trajectories. The next four sections (3 to 6) fleshed out this assertion by using LEnS, a novel model for foresight that projects historical trend lines through domain-specific filters. Then the story sections dove right in, complementing a research-based understanding of the future with four attempts to describe what it might actually *feel* like for the people who will inhabit it. Just *thinking* about different kinds of futures is insufficient. We must also work to try to imagine and, in a sense, *feel* them. How is that for divergence?

However, it is now time to focus on convergence, and in doing so empower leaders by offering them some means of *preparing* for these futures.

Luckily, there are signals in the noise. In section 1, we described the three “eternities” that have characterized the trajectory of information technology since Charles Babbage and Ada Lovelace designed their “Analytical Engine” in the early 19th century: interaction, information and computation. Armed with this broad-brushstroke understanding of tech’s journey to the present, and a LEnS-inspired extrapolation from the technologies that are currently emerging from universities, start-ups and corporate R&D labs, we are able to see that the development of each of these three layers appears to be converging towards a clear and coherent endpoint.

TABLE 2 From eternities to endgames

 Eternities	Babbage's design	First digital computer	Mid 20th century	Late 20th century	Early 21st century	2021: Today	Horizon next	Furthest stars	 Endgames
Time (years)	t-175	t-75	t-50	t-25	t-10	t	t+10	t+n	t=∞
 Interaction	Reader	Punched cards	Command-line	Graphical user interface (GUI)	Mobile devices	Virtual reality	Ambient experiences	Brain-computer interfaces	 Simplicity
 Information	Store	Arithmetic calculation	Relational databases	Descriptive analytics	Predictive analytics	Cognitive automation	Affective AI	General AI	 Intelligence
 Computation	Mill	Mainframe	Minicomputer	Client server	Cloud architectures	Distributed platforms	Spatial web	Quantum computing	 Abundance



LEnS framework utilized to project **t+** timeframes

7.2 “Simplicity is the ultimate sophistication”

Though erroneously attributed to everyone from Steve Jobs to Leonardo da Vinci, artist Leonard Thiessen’s quote²⁰⁷ is still endorsed by the history of information technology, which has really been a story of our building ever more natural and intuitive interfaces. Early punched-card input/output was exclusively the province of PhDs. Command-line interfaces, only slightly less Byzantine, led to a generation of professional computer operators having to take night school classes to keep up with the pace of change. There were graphical user interfaces (GUIs), then mobile became de rigueur, and now we’ve got to the point where

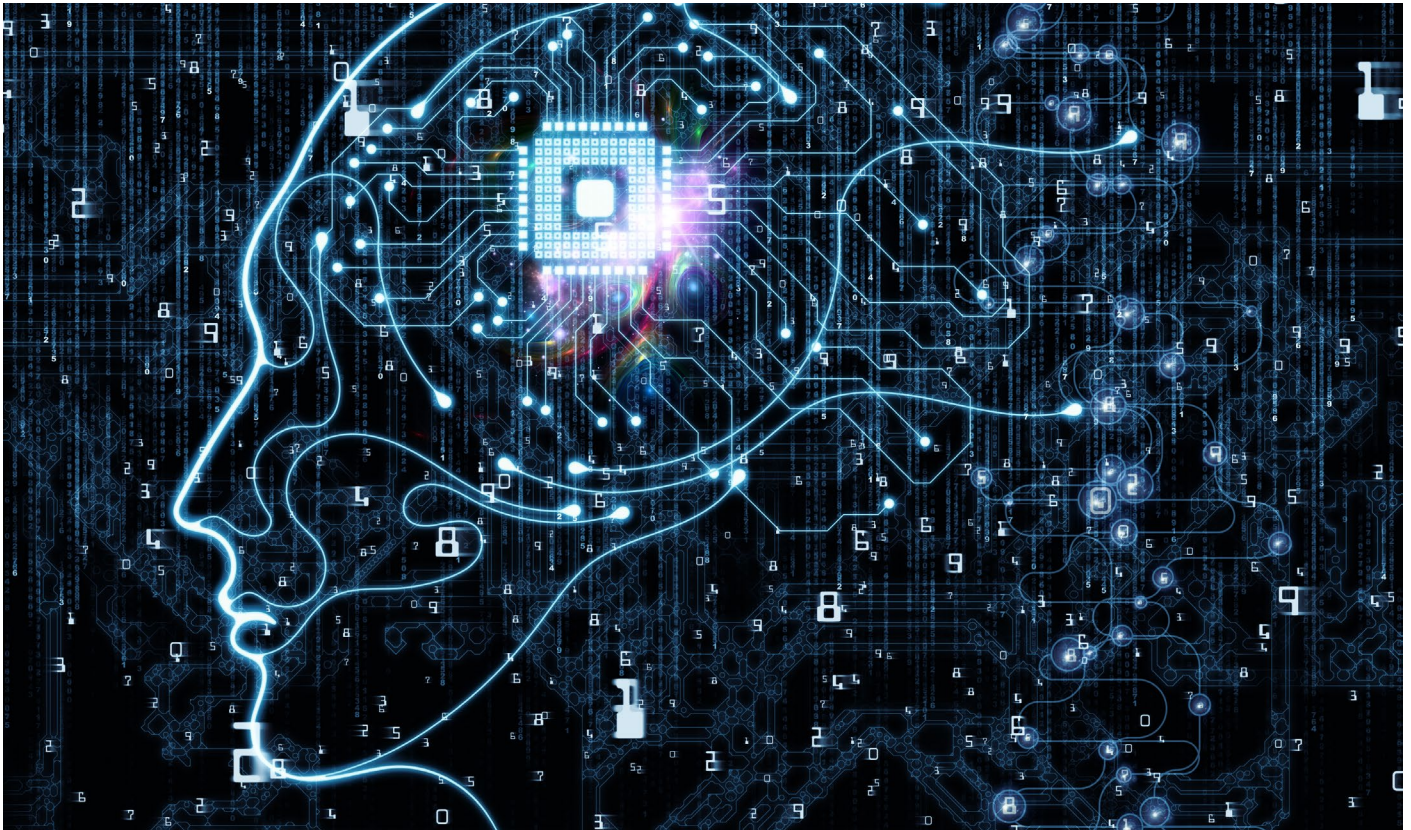
the idea of an interface requiring instructions, rather than being intuitively easy to use, is starting to seem anachronistic. Today’s conversational interfaces (think smart speakers and phone-based digital assistants) and emerging AR/VR overlays require only that you are able to speak your native language, or physically gesture towards your intentions, respectively.

If smart speakers and AR get us “beyond the glass”, ambient interface technologies (a collection of autonomous devices and technologies that interact and which are sensitive to human needs)

move us “beyond the device” entirely, creating digital awareness in the user’s entire environment. The prospect of 15 separate digital assistants in every room and context is unwieldy, and thus unlikely. As such, the next wave of interfaces is likely to “get out of the way entirely”, becoming cloud services in much the same way that yesterday’s servers and desktops did before them. In this projected scenario, “[Device], what’s the weather?” gives way to a far simpler, “What’s the weather?” The idea here is that the most qualified digital entity snaps to attention with the highest-confidence answer, as brokered and/or sub-contracted through a network of digital assistants, moving all the way down the line. In this digital

Downton Abbey, the user need not know the names of all his or her staff.

And in the furthest conceivable future? Brain-computer interfaces. As startling as “microchips in brains” may seem from the present, when looked at through a long lens this proposition is simply the removal of the final communicative barrier between human and machine: speech. Why bother asking, “What’s the weather?” when you can simply *think* that question and have it answered? Or, when the sun goes down in the evening, enjoy the thermostat’s dotting response to the subconscious call of your parasympathetic nervous system for warmth?



7.3 Mind the digital gap

While underlying enabling technologies grow more complicated, their reach, accessibility and usability grow exponentially. Leaders would be wise to plan for a world where every interaction is mediated through a technological interface. In 2011, venture capitalist Marc Andreessen famously said, “Software is eating the world”.²⁰⁸ His statement recognized the fact that it is bits and bytes, rather than bricks and mortar, which will define our future. Digital experiences are more scalable than physical. Software, thanks to updates, can improve over time. Physical hardware depreciates while compiled code is protected and less prone to reverse engineering. COVID-19 has further catalyzed this shift. As the pandemic stressed physical supply chains beyond their limits, digital networks proved

as elastic and resilient as ever.²⁰⁹ The primacy of digital is no longer in doubt.

The governance and policy takeaways are myriad, but the increasing primacy of digital, virtual and ambient experiences brings with it a risk of an exponentially widening digital divide. Today, commercial sports stadia are being constructed that require the use of a mobile phone to enter (digital ticket), transact (digital wallet) and engage (digital scoreboard).^{210,211} Will tomorrow’s public services be designed in such a way as to require digital ID’s? AR glasses? It may be critical to ensure that access to necessities doesn’t gradually begin to require, or even presume, the availability of certain commercial technologies.

7.4 Intelligence is as intelligence does

“ How can we develop artificial intelligences that embody our explicitly shared financial, social and ethical values?”

Forrest Gump said that, “Stupid is as stupid does.” Cinema’s consummate everyman recognized that a person should be judged by their actions, not their appearance. Our research suggests that Gump’s homespun wisdom applies equally well to the future of information and machine intelligence. Indeed, a perspective informed by the long arc of history suggests that even the term “artificial intelligence” (AI) may well become an anachronism – a label belonging to a transitional time, one in which we were yet to realize that, whether it sits *in vivo* or *in silico*, intelligence is intelligence.

Consider the impact of AI: as machines become more capable, feats considered to require intelligence are often stopped from helping to define what AI is. “AI” has thus become a catch-all term for whatever machines cannot do *yet*. Our human need to feel exceptional finds us simultaneously dismissive of past advances in machine intelligence (e.g. the computer Deep Blue beat chess champion Gary Kasparov in 1996, and in 2015 AlphaGo became the first computer to beat a human professional at Go without handicaps) and doubtful about upcoming milestones.²¹²

Our psychological fragility notwithstanding, AI’s next act is likely to be *affective* intelligence: the ability to discern and emulate human emotions and, in turn, to begin to engage in empathic interactions and even relationships. Imagine humorous machines, charming machines, or even spiritual machines. To the degree that humour, charm or spirituality continue to become describable by data, they in turn become increasingly learnable by deep neural networks. There is probably little in the way of individual human skills – even soft and creative skills or the coherent expression of beliefs – that, given

enough information and computation, machines won’t one day emulate.

And after that? The furthest conceivable informational futures point toward versatility. Machines’ astonishing ability to learn and subsequently master individual skills is one thing, but the ability of a single machine to emulate a well-rounded individual’s skills and personality is still a long way off. That said, when it comes to general intelligence the standard for “success” isn’t set with reference to Einstein or Shakespeare. In their earliest incarnations, digital personas will likely underwhelm. It is likely, though, that thanks to exponential increases in training data and processing power – and an increasing symbiosis between technology and human biology – we will likely see mechanical minds quickly follow an upward path towards eventual parity with, and even superiority to, our own.

The rise of the machines is already well under way, and accelerating. Popular science fiction tends to make this a story about malevolent sentience – mechanical minds as super villains with dark agendas. In truth, software has always been neutral, manifesting the explicit orders and tacit biases of its developers. As information technology continues to evolve from our *telling* machines what to calculate towards *teaching* machines what to discern, it will be increasingly important for organizations, governments and regulators to closely monitor the “curriculum”. How can we develop artificial intelligences that embody our explicitly shared financial, social and ethical values? We must train our digital children well, training them to do as we say, not necessarily as we’ve done.

7.5 Don’t bet against an abundance of ingenuity

As already described in our section on the economy LEnS, our planet has a finite supply of certain precious elements, chemical compounds and organic species that we would clearly be wise to steward well. In contrast, human ingenuity – our shared creative capacity – is inexhaustible.

Consider the current computational shift towards trustless distributed ledger platforms, a technology based on a new trust paradigm that eliminates the need for third-party processing. This computing evolution speaks to the recognition that perhaps none of us is as trustworthy as all of us. If the 20th century marked an evolution from “In God we trust” to “In man we trust”, the current century would

seem to be heading towards “In maths we trust” – specifically the mathematics of cryptography (protecting information through the use of codes).

When, in 2014, French economist Thomas Piketty’s new book *Capital in the 21st Century*²¹³ warned of widening inequalities in both wealth and income, few foresaw then-emerging technologies such as Bitcoin (let alone Reddit) as a populist counter-punch. Together, blockchains and cryptocurrencies signal the possibility of radical disintermediation. In a world where trusted hubs give way to trustless spoke-to-spoke transactions, information and capital are freer to flow, and seeking payment for it (rent-seeking behaviours) harder to justify. If the

internet brought about the death of the salesman, the distributed web promises to bring about the death of the middle man.

The distributed web also stands to enable an altogether new “Web 3.0”, or “spatial internet”. As the lines between the physical and digital continue to blur, a new generation of internet architectures stands ready to append information to every physical person, place and thing. The idea here is that our conception of physical reality itself will be coming online. No single government, or company, could reasonably be trusted to hold all that data, but a trustless distributed computing network may

provide just the balance of privacy and performance needed to power our AR and AI-enhanced future.

And after reality goes online? Imagine reality itself used as a computer. Quantum computing gives us the power to solve certain classes of complex problems faster, and other classes of previously intractable problems for the first time.²¹⁴ Current academic references to quantum’s theoretical efficacy in chemical compound simulation tend not to stir the heart, but the possibility that those simulations could in turn yield medicines and genetic interventions that may cure cancer, or even delay or defeat death altogether? Now you have our attention.

7.6 Invest in moonshots

“ Though the challenges we face are becoming progressively more complex, our collective creativity and intelligence appears to be evolving faster than the challenges themselves.

Our species has always been defined (or at the very least, differentiated) by our ability to learn, create and adapt. Roughly 2.6 million years ago, *homo habilis* created the first stone tools, thus freeing time and energy for higher-order pursuits.²¹⁵ The Sumerians created the first written language 5,000 years ago as a life hack for offloading knowledge.²¹⁶ Like stone tools, this advance also freed time and energy for other pursuits, except this time of an even-higher order. Five hundred years ago, the printing press similarly provided a life hack for communication,²¹⁷ and 75 years ago, the digital computer²¹⁸ one for calculation. When seen through this long lens, projected advances in computing are neither hero nor villain. Rather, they represent the latest in our species’ long series of transformative adaptations in the pursuit of efficiency.

Though the challenges we face are becoming progressively more complex, our collective creativity and intelligence appears to be evolving faster than the challenges themselves. Humanity’s ability to come up with life hacks – whether made of stone or bits and bytes – seems set to continue to give us an exponential edge in raising a response both to today’s threats and tomorrow’s perils.

Leaders should consider allocating time, mindshare and money for moonshots – projects

that might not help us compete today, but given enough inspiration and perspiration, can help us create tomorrow.

American architectural pioneer Daniel Burnham (known for his city plan for Chicago) captured the clarion call of the long view in 1891:

*Make no little plans; they have no magic to stir [our] blood and probably themselves will not be realized. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone be a living thing, asserting itself with ever-growing insistency. Remember that our [children and grandchildren] are going to do things that would stagger us. Let your watchword be order and your beacon beauty.*²¹⁹

Inspirational quotes are not business cases. But in the context of the long view (looking both forward and backward) they remind us it’s imperative that we as business, civic and academic leaders spend time thinking beyond quarterly numbers and quarreling constituents. Indeed, we must plant seeds in a field we will never harvest.

That’s not just stewardship, that’s leadership.

Annex

Maple's story (continued from page 20)

► I watch the post on repeat. *I need an invitation to that party*, I think to myself as my glasses alert me to my raised heart rate.

On something like my 47th viewing, I notice a slight ripple on the word "SUN" right when *TheDailyLife* walks by that olive-green bench on his way into the park. I walk back there, scouring every inch of the immediate area for the clue. After nearly an hour of walking in circles, I sit on the bench, take off my glasses and rub my eyes. I feel defeated.

My head in my hands, I stare at my shoes. I slowly notice that the concrete path, usually obscured by the GPS arrows of my glasses, is laced with tiny flecks of what appears to be gold and silver. It's actually kind of pretty. Sparkly. Wait... they *glimmer*.

I put my glasses back on, and the AR lightshow commences: photonic flecks bouncing around like Pop Rocks before my eyes. Shimmering in rhythmic unison, gold and silver sparkles gradually resolve into a message:

YOU'VE FOUND THE GLIMMER,
MS. BRINKLY.
LIMO TO PARTY EN ROUTE.

Adios, rideshare; I'm a limo gal now!

*

The car lets me out in front of my apartment. The party's *here*?

I take a seat on the green bench at the bottom of my stoop. As I do so, a document pops up on my glasses, signalling me to tap it open. An ornate cursive message pops out of a virtual envelope, like an old-fashioned eVite:

CONGRATULATIONS, AND WELCOME TO THE SIGNING PARTY!

A sprinkle of virtual confetti puffs over the message. I guess this is how fancy corporate events work these days?

The confetti dissipates, and I continue reading:

YOU HAVE BEEN REFERRED TO US BY @THE DAILY LIFE AND HAVE SUCCEEDED IN REACHING THE REQUIRED NUMBER OF FOLLOWERS ON YOUR SOCIAL ACCOUNT(S). ATTACHED IS YOUR CONTRACT OF EMPLOYMENT. WE LOOK FORWARD TO YOUR ACCEPTANCE OF TERMS WITHIN 24 HOURS.

I let out an excited "Eep". I minimize the congratulatory message and open up the document. It's impossibly long and full of legalese, but I'm effervescent when reading the title confirms its status:

CONTRACT OF EMPLOYMENT

WITH: CONTENT CONGLOMERATES [EMPLOYER]
FOR: MAPLE BRINKLEY [EMPLOYEE]
D.P. ID: 9372843

I immediately search for the SIGN HERE line to seal the freaking deal. *Honey, aren't you going to at least read that over?*, says my mother's voice in my head. *Ugh*. I start begrudgingly skimming the 30-page contract.

I'm three lines in when Harry Styles interrupts me with a spatial update. *Not now*, I think, realizing that I forgot to set my spatial notifications to DO NOT DISTURB. Since I know I won't be scrolling for D-listers on benches for much longer, I tap it open.

But the entry stops me in my tracks:

NAME: HUNTER BROWN
DATA PROVIDER ID: 6924714
SOCIAL TAG: @THE DAILY LIFE
LAST VISIT: 2 DAYS AGO

TheDailyLife? Why would a Richie Rich like Hunter Brown still choose to provide data?

Curiosity gets the better of me, and I double tap into his metadata:

NAME: HUNTER BROWN

DATA AVAILABLE: FINANCIAL; LOCATION; APP USAGE; HEALTH; FITNESS; CONTACT; MESSAGING; WEB HISTORY; SEARCH HISTORY; CALL LOG; CALL TRANSCRIPTS; CON'T (PAGE 1/7).
DATA GOVERNANCE: ALL
DATA PROPERTY OF CONTENT CONGLOMERATES. CONTACT FOR LICENSING.

Ooooooh. Ohhhh... no. No, no, no, no.

I quickly shift screens back to my contract, sick to my stomach and suddenly beginning to sweat. I skip to the very last line, and my heart sinks:

EMPLOYEE HEREBY CEDES ANY AND ALL RIGHTS TO ANY AND ALL PERSONAL DATA, DATA ACCESS, AND DATA PROVIDER DETAILS, TO EMPLOYER. EMPLOYER IS FREE TO LICENSE

AND OR RESELL ANY AND ALL DATA, DATA ACCESS, AND DATA PROVIDER DETAILS IN PERPETUITY AND IS HEREBY INDEMNIFIED AGAINST ANY THIRD-PARTY MISUSE OF EMPLOYEE DATA. FOR A REPORT DETAILING WHERE AND HOW WE MONETIZE YOUR DATA, PLEASE CONTACT YOUR TALENT ADVISOR.

SIGNED:

X _____
Maple Brinkley (9372843)

Oof, my internal Mom Voice exhales in unison with my own.

I flash back to every one of my mom's rants ever, as if I'm finally *hearing* her for the first time.

"You are not for sale, Maple. You're the captain of your own ship. Don't you want to be more than just a crew member *when it comes to your own life?*"

A single tear carves the make up out of my cheek. I guess that old "grass is always greener" idiom applies to life-long dreams, too.

*

Wake up in the mornin' feelin' like P Diddy [Hey, what up girl?]

Grab my glasses, I'm out the door, I'm gonna hit this city!

I head out of my apartment, this time leaving my augmented glasses behind. I also mute Harry Styles for good measure.

I walk to City Park as usual, but it feels decidedly *unusual* without my gear. No alerts, no sales routes, no riddles. Just the street, the sky and, I suddenly notice, that olive-green bench. I take a seat, and for the first time, notice how the bench actually feels. It's cold, still dirty, but sturdy. No longer a producer of fodder for gossip columns, *just a bench*.

I feel... untethered? Weightless?

You feel free, a voice in my head says.

Definitely my mother's again. I smile and look up, knowing she would be proud of me.

Free now of digital prompts I walk of my own volition across the street into a non-descript office lobby. The screen behind the receptionist shows my future in baby blue: *BotCom*.

"Hi," I say, with a clarity and confidence that I haven't felt since I was a kid. "I'm here for a job."

While I'm filling in the application, over the waiting room speakers, I hear a familiar lyric:

Tick-tock, on the clock

But the party don't stop, no

I look up from the paperwork, smile at the receptionist. "Great taste in music," I tell her.

I think that 2020s Kesha, the one who was really in touch with herself, the one who spelled her name with an "s" not an \$, would be proud of me.

Frank's Story (continued from page 28)

► "Hello, this is Ryan Marks with Digital Forensics. I see I'm talking to a Mr... – oh, hey *Frank!* Wow, says here we haven't talked since you threw up on that low-orbit thing we did a couple years back! How you doing, man?"

Thanks for the reminder.

"Hey Ry, really don't want to skip to the chase, but I um... I really need your help."

I laid it all out on the table. The Gekko's decision-making, my hunch that it was rooted in bias, the fact that my neck was on the line.

"Well Frank, I hear you but the timing's not great, buddy – all of our Investigation Bots are booked solid tonight. The cost to spawn you a new one at such short notice would be astronomical – it's the licensing. How about we do it the old-fashioned way and see what I can do myself? Send the data over."

"Investigation Bot?" I replied. Although years ago I'd worked at Digital Forensics with Ryan, I'd had never heard of such a thing.

"Oh yeah – most of what you'd remember as our actual 'work-work' is all bots now. The no-collar team frees up the white-collar team to do more of the high-level digging and planning. Problem is the intelligence servers are expensive. I still have to fight tooth and claw over them."

I flashed back to my early days in the business when I thought AIs were going to replace

us altogether. But, people still had jobs. On the other hand, here I was having a discussion with a human former colleague trying to get his bots to debug *my* bot. What a world!

"Ryan, thanks man. I know it's a lot to ask, but is there any chance you could turn it around by this evening?"

"Oh sure, Frank! Would you like me to build a skyscraper in your backyard, too?" I realized how absurd my request had sounded as Frank continued, "Look, I can tell you're pretty squeezed on this one – I'll do my best."

*

When Ryan rang back, I did my best to keep up as he sped through his analysis. He said that his first stop had been the Intelligence Regulation and Governance Agency, to audit the publicly available training data used on the Gekko. Back when AI went mainstream about ten years ago, the agency was formed to mandate that all publicly sold algos disclose and expose their training sets, and post open-source bounties for ethical hackers (so obvious now, but so memorably controversial at the time).

Ryan had sifted through tons of data, parsing it for the staff that had their hours cut. He started with the major protected classes – race, religion, gender – and worked towards more

subtle variables such as education, employment and social media histories. Overt “on the nose” discrimination was pretty rare now; it tended to show up in proxies. For example, zip codes could be a proxy for income, or name length a proxy for race or ethnicity.

As Ryan finished describing hitting plus-50 territory on data types he’d ruled out, I heard a slight rise in his intonation, which in turn raised my heart rate.

He continued, “You know, man, I was about ready to give up, but then I realized you snuck one piece of employee data into Gekko’s mix that wasn’t in any of my usual checks...”, he shouted this last bit, “*home addresses!* And every person on that list you shared lives well outside of the city.”

What does a home address have to do with an employee’s salary or actual hours worked?

As if Rick was reading my mind, he replied. “Gekko married those zip codes up with the last publicly available demographic cut it could find, which was crazy stale: from the late teens – way before the cities really emptied out after COVID-26. I think your interim robo-HR boss has an old-fashioned grudge against the exurbs. Figures everyone who’s in the sticks still has a crazy-low cost of living.”

“But that’s almost our entire workforce! Only our service contractors and tradespeople still live in the city.”

“I know – the whole geo-economic pattern’s been inverted, right? I think there’s good grounds for an AI bias case here. For years I figured that...”

Ryan kept talking, but my mind was already onto other things. I hastily thanked him, hung up and dialled Stacey. It was time to help her make this right with the board.

*

Nine people in expensive suits, all with the same serious demeanor. To an outsider, the boardroom might have looked more like a courtroom. When I arrived I was grateful I’d been able to use the ride back to the office to put together both a technical remediation strategy (blocking address data from the algos, however up to date it was) and the beginnings of an internal comms strategy to keep our employees on board. I had also, of course, secured the admin credentials required to demote “Chief Gekko” to “Analyst Gekko”.

The board’s Chair started the ball rolling: “First order of business today: profitability. After glum Q2 sales results, we need to decide whether to accept or overrule the acting CHRO’s recent interventions in personnel management.”

What? How was this even a question?

She went on: “Can someone provide an argument in favour of management’s position?”

Management?

“Enhanced profitability is, on balance, pretty hard to argue with,” one board member intoned.

“Greatly reduced COGS with a substantially improved CAGR projection? What’s not to like?”, offered another. All heads, some physically there, others projected into the room virtually, nodded in agreement.

I couldn’t believe what was happening.

“Any arguments against?”, the Chair asked.

After what felt like an interminable three-second silence, I found myself blurting out, “The algorithm is biased, and based on out-of-date data that’s no longer even ethical. It’s bad maths driving bad decisions that are driving bad outcomes for our team and their families!”

I looked pleadingly towards Stacey, but she didn’t say a word.

The Chair looked at me, looked away, and then asked, totally impassive, “All in favour?”

Alex’s Story (continued from page 36)

► 3. Will the other side accept our most important red line: the data privacy of our citizens?

*

It’s been exactly four days, five hours and 33 minutes that I’ve been negotiating with my counterpart. We’ve made advances in online healthcare, education and areas of criminal justice reform that would benefit from greater collaboration. We are aligned on data-governance protocols. We agree that personally identifiable data should not be compromised. But we’ve been going round in circles now on Clause 15.2, and can’t make any headway.

“The government doesn’t get to decide what

hate speech is! We need to allow companies to regulate this, and have an open market.”

“We need better protections in place.”

“One person’s hate speech is another person’s freedom of expression.”

“You can’t monitor everything.”

*

Our respective bosses – and the countries they lead – are waiting. It’s politically important we make this work. We’re enough aligned to agree on this. We can always think of ways to protect ourselves.

“Alex?”

“OK, we have a deal.”

Maiah's Story (continued from page 44)

► I zipped through the tunnel, slowing down only to pass by several blood clots and plaque build ups. Each time I passed an anomaly, a few questions appeared on a suspended overlay in front of me. "Based on the size of this patient's blood clot, which of the following procedures should be recommended?" I ticked the correct boxes before my tube cell took off again.

Before long, I encountered the antagonist of today's session: a pernicious virus. With a hundred tentacles pushing out from its globular core, it looked as menacing as any baddie I had seen in a vid. A white blood cell came to my rescue. After a quick game of cat and mouse, the white blood cell had surrounded the pathogen, slowly digesting it as if it were a tasty snack. I marvelled at the sight.

How did med students manage in a world before interactives? Best guesses? Instincts? I suppose every generation looks at their predecessors with a mix of reverence and pity: how did they learn and accomplish so much with so *little*?

Another short flash and everyone was back in the classroom.

*

The next four years were the most intense of my life. Between advanced organic chemistry, bioinformatics and my virtual residency at a hospital in South America, I had acclimated to a near-constant state of exhaustion. On top of that, the days were much longer than I had initially anticipated. I got up four hours before my parents and went to sleep before sunset. I savoured our lunches together, which were my only meaningful connection to the physical world.

I was seeing my hard work pay off, though. I was in the 97th percentile globally at repairing fractured vertebrae, and 99th at removing bone spurs for patients in need of spinal cord compression surgery. I was a solid 80th-plus on brain tumours and ulcerative colitis.

Initially it had seemed underwhelming, but my gear had, over time, become less equipment and more a natural extension of my mind and body. As long as the remote surgical site had a Genbotic Operator v2035 or later, I could anaesthetize, diagnose, align and administer almost anything, to anyone, anywhere on the globe. And I could do it all sitting at the faded desk in my childhood bedroom.

Oh, and that curious bright pink vest? That was my "hippo", named in honour of the Hippocratic Oath. It was an eyesore but it was clever: equipped with heart rate monitors, blood oxygen level detectors, and a suite of hundreds of diagnostics about me and my environment. If I were to hyperventilate, nod off or in any way become incapacitated mid surgery, this garment would detect the anomaly and freeze the equipment in the remote operating room before I could even register what was happening.

Thanks to these vests, it was near impossible for a patient to be harmed by any lapse – physical, biological, neurological or network related – on the part of their doctor.

*

I had just finished a routine physical on a patient at the South American hospital when I heard a sudden frantic banging on the door of the examination room. No, wait. Someone was banging on my *actual* door.

"Maiah, help!"

Alarmed, I tossed off my portal, and staggered squinting towards the door, blinded by the harsh daylight.

"Maiah, Maiah, quick!" I recognized the voice as that of Ayaan, my old friend Sanda's younger brother. I threw open the door.

"He was coming, and I was going, and it all happened so fast, and you know he was just lying there, and..."

"Ayaan!" I tried to get him to focus. "Ayaan, I need you to calm down, okay? Now, what happened?"

He told me that Sanda was hurt. Badly.

*

A neighbour who had seen the accident had taken Sanda directly to our local clinic, where physicians were stabilizing his wounds as best as they could. He was a mess – but a breathing mess. The clinical workers gave me the information they had captured as I further checked his vitals: *Major lacerations from the frontal lobe to the postcentral gyrus. Ruptured spleen, life-threatening internal bleeding. Vertebral fractures with high risk of nerve damage.* I knew exactly what needed to be done.

Without thinking, I reflexively reached to my left to grab my haptic hands from my hippo. But both they and the bright-pink vest were still in my bedroom.

"Maiah, what's wrong?" I heard a clinic worker ask.

I felt like I was turning to stone. "It's..." I trailed off into my own fear. "I've never operated without my gear before."

I looked down at Sanda's wounded body lying on the table. I had relied upon my medical gear for so many years. I felt as if I were missing a limb.

I inhaled deeply. In my early days I had struggled to express my physical self virtually. Now, I was struggling to express my virtual self physically.

I closed my eyes, picturing myself inside my portal. The tools I needed, the tasks I would perform, the calculations I would have to make – all the things I had done a thousand times in another world.

The road ahead suddenly became very clear. I exhaled, opened my eyes, and for the first time before a surgical procedure, I washed my hands.

Then, I began to operate.

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