FUTURE OF THE ECONOMY

INDUSTRY & COMMERCE IN THE NEXT ERA OF HUMAN-MACHINE PARTNERSHIPS

ABOUT INSTITUTE FOR THE FUTURE

Institute for the Future (IFTF) is celebrating its 50th anniversary as the world's leading nonprofit strategic futures organization. The core of our work is identifying emerging discontinuities that will transform global society and the global marketplace. We provide organizations with insights into business strategy, design process, innovation, and social dilemmas. Our research spans a broad territory of deeply transformative trends, from health and healthcare to technology, the workplace, and human identity. IFTF is based in Palo Alto, California. For more, visit www.iftf.org.

DELL TECHNOLOGIES

Dell Technologies is a unique family of businesses that provide the essential infrastructure for organizations to build their digital future, transform IT, and protect their most important asset, information. The company services customers of all sizes across 180 countries—ranging from 99 percent of the Fortune 500 to individual consumers—with the industry's most comprehensive and innovative portfolio from the edge to the core to the cloud.

ABOUT THIS RESEARCH

Dell Technologies has partnered with the independent futures research group IFTF to explore how emerging technologies will reshape our economy over the next decade. The research builds on the organizations' collaboration in 2017, when IFTF distilled informed opinions from 20 experts from around the world and forecast the "next era of human-machine partnerships." A year later IFTF forecast how a new dynamic between man and machine will transform our economy in 2030.

To execute this, IFTF relied on its decades-long study on the future of work and technology, alongside in-depth interviews with relevant stakeholders from across the globe.

Experts informing the report include:

Oluwabunmi Ajilore
Foresight Adviser, Global Forum on Agricultural Research

Heather Canon
Vice President, Worker Engagement, ELEVATE

Nikhil Chouguley
Co-Founder, Resident Tax

Toni Lane Casserly
Founder, CULTU.RE

Mark Frauenfelder
Research Director, Institute for the Future

Jeremy Kirshbaum
Principal, JJK.FYI

Karen Lightman
Executive Director, Metro21: Smart Cities Institute at Carnegie Mellon University

Piero Pelizzaro
Chief Resilience Officer and Sharing Cities City Lead, Milan, Italy

Eldar Tuzmukhametov
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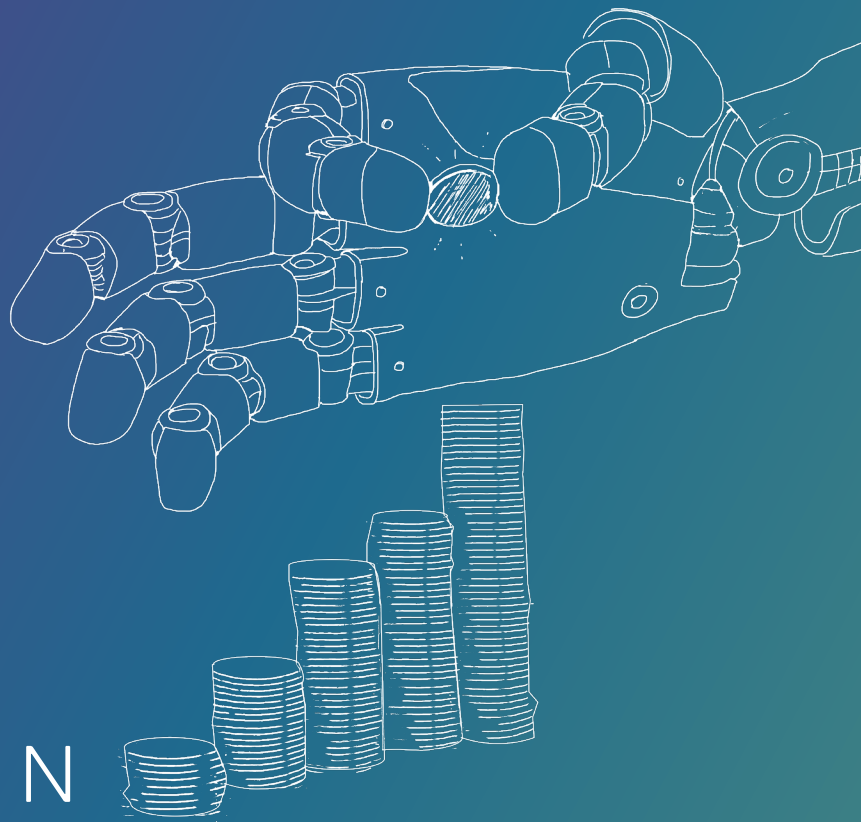West Coast Director, ConsenSys

Brad Kreit
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INTRODUCTION

A new cadre of technologies is creating a world where the complex and seemingly impossible are now possible. You can order your groceries from an app on your smart fridge —and quickly prototype a new device or innovation with 3-D printing. Business has become untethered to place. Everything from sales enablement, content marketing, and customer relations to back-end processes like shipping and invoicing can be done remotely, through apps and services. All of this is happening in the present day. Which begs the question— what does the next decade have in store for us?

Dell Technologies and IFTF have collaborated over the last three years to research how the world will evolve as a result of emerging technologies. Building on our forecast that we're approaching the next era of human-machine partnerships, we are now examining how these deeper, more immersive partnerships with technology—as it becomes embedded in our lives, work, and business—will bolster, accelerate and secure everything from our supply chains, product, and service delivery, to how we consume and purchase goods.

In this report, we'll explore the impact of today's emerging technologies—including Blockchain, artificial intelligence (AI), 5G, Internet of things (IoT) and cryptocurrencies—on organizations and the economy at large. Many of the forces have already started to transform the way we communicate and exchange information and will take deeper root in our economies by 2030. They have the potential to reduce— and even eliminate—frictions that prevent individuals,

organizations, and governments from collaborating throughout the economy.

We've asked a variety of global experts, across an array of disciplines, geographies, and demographics, how will these human-machine partnerships reshape our economy? Where are the opportunities to usher in greater security, convenience, and efficiency? How might a combination of advances remake supply chains and manufacturing? How might we eliminate frictions that limit access within our economy and instead create opportunities to improve the lives of many?

IFTF has partnered with Dell Technologies to tackle these questions. We invite you to join us in our exploration and read our forecasts for the future of the economy.

EMERGING TECHNOLOGIES SHAPING THE ECONOMY

The economy of 2030 will be built on technical innovations emerging from present-day labs, startups, and tech companies. Ranging from ultra-fast 5G connections that reduce latency, increase bandwidth, and enable real-time machine-aided decision-making, to advances in artificial intelligence. These technologies will mature and proliferate over the next decade. On its own, each technology has the potential to spark major changes. In combination, these technologies will enable large-scale shifts in our economy.

5G to 6G

By 2030, 5G will be commonplace and 6G standards will be emerging. Widespread adoption of 5G technologies will provide an effective low-latency, low-power-consumption network to authenticate users, run credit checks, and detect fraud continuously, in the background.

Ubiquitous 5G will bring forth a new wave of hyper-fast wireless connectivity, virtually eliminating any network speed delays. This will allow us to push computing power ever closer to the edge, improving processing times of calculation-heavy algorithms. It will also provide the backbone for billions of IoT devices, creating real-time intelligence for both humans and AI entities that will be

driving the friction-free economy. Particularly exciting is the technology's ability to leverage unused and mostly idle processing power available in place, similar to the way Uber empowers auto owners to better utilize the car sitting in their driveway. Micro-hubs will line our streets. Cities and towns will become more connected than ever, paving the way for smart cities and digital infrastructure, along with a more intelligent industrial infrastructure that thrives on automation.

Artificial intelligence

Artificial intelligence can support the economy by rapidly validating transactions, providing continuous authentication, and powering autonomous algorithms to make decisions on behalf of the customer. Meanwhile, intelligent systems will monitor the full life cycle of a supply chain to determine the optimal speed for product creation, leading to less waste and better demand fulfillment. Prediction models will quickly determine possible fraudulent behavior, and create personalized recommendations for customers.

⚙ SIGNAL OF CHANGE

The Fire Risk Analysis project created an AI tool using predictive analytics to help the Pittsburgh fire department and the public safety department determine which commercial buildings will be more at risk of fire. By learning what the predictors are for a fire in a commercial building, accuracy improved from .02 percent to 85 percent (without having to physically inspect 20,000 buildings).

Internet of things and sensors

IoT devices allow us to capture fine-grained tracking details, revealing additional data that we would ordinarily miss or be unable to consider, while enabling a myriad of devices to act on our behalf. Through this data we can better anticipate customers' wants and needs, create more robust authentication, and revise processes to improve efficiency. As this takes place, we'll gain unprecedented abilities to orchestrate networks of machines and people to get things done.

In the next generation of IoT, humans could cease to be the only kind of manager. Heather Canon, Vice President of Worker Engagement at ELEVATE Global, suggests that by 2030 both machines and workers will be overseen by IoT devices gathering and reporting data to both human and, increasingly, artificially intelligent systems.[1] Gig workers for services like Uber and Lyft are early examples of this: the algorithms for these services function like managers and direct drivers to their next destination.

> **"Who would have thought you can grow a plant in a warehouse without soil and sun? We're doing it on a commercial level. Our vision is to allow everyone to have access to great tasting food all year around. The world needs a new paradigm to feed people. AeroFarms is illustrative of technology's potential to provide more with less."[2]**

David Rosenberg, CEO of AeroFarms

⚙ SIGNAL OF CHANGE

IoT in action today

Today agriculture consumes 70% of our fresh water and is responsible for 70% of our fresh water contamination. Feeding an ever-growing global population while conserving valuable natural resources will be one of society's greatest challenges in the coming years and decades. AeroFarms is seeking to address these challenges by combining sophisticated sensing and IoT devices to reinvent agriculture. Its indoor vertical farms are 390 times more productive than conventional field farms, use no pesticides, and use up to 95 percent less water. Through diverse data sets, generated by connected sensors in its Internet of things (IoT) solution, and advanced data analytics technologies using artificial intelligence, AeroFarms creates the optimum safe environment for maximum yield, balanced nutrients, and the best-tasting foods.

Blockchain

Blockchains provide an immutable, transparent data storage mechanism, allowing all parties to objectively access transaction data. They enable applications like smart contracts, where transactions are algorithmically triggered when objective criteria are met. By 2030, use cases for blockchain will abound.

For instance, Canon suggests blockchain will be instrumental in protecting workers' contract and payment details, by allowing smart contracts to automatically execute and pay upon job completion.[3] Nikhil Chouguley, co-founder of Resident Tax and chair of a European Financial Services initiative for the adoption of blockchain to disseminate regulatory product data, believes blockchain will capture complete supply chain sourcing, allowing anyone to query any aspect of the supply chain to ensure sustainability.[4] Toni Lane Casserly, founder of CULTU.RE, forecasts that blockchain will enable a transition from an economy of information asymmetry, where information is withheld or simply not shared with known parties, to universal accessibility, which will translate to a more symmetrical relationship with trade and the economy.[5]

DEFINITION

What are smart contracts?

Smart contracts help people exchange anything of value in a transparent, conflict-free way, while avoiding the services of a middleman. They define the rules and penalties around an agreement and enforce the obligation—meaning they determine whether an asset is exchanged or refunded. Smart contracts take the form of computer programs. They are converted to code and supervised by a network of computers that run the blockchain. The decentralized ledger then stores and replicates the document, which gives it a degree of security and immutability.

Cryptocurrencies

Using blockchain to create cryptocurrencies has created alternative currencies that are global, are less prone to fraud, settle immediately, neutralize identity theft, and allow person-to-person payment with no intermediaries. In the future, citizens may empower themselves by moving to more stable, private currencies. Forty-seven percent of business leaders surveyed by Dell Technologies expect to conduct more transactions through blockchain in the next five years, while 37 percent anticipate using cryptocurrencies as a form of exchange.[6]

Over the next decade, many new cryptocurrencies will emerge, some pegged in value to a fiat currency. Such currencies, known as stablecoins, may finally allow cryptocurrencies to move beyond highly speculative investment vehicles.

DEFINITION

What are initial coin offerings (ICOs)?

An ICO is essentially a fundraising tool. A startup creates a new cryptocurrency or digital token via a number of different platforms. Investors can then buy the newly minted digital tokens with other cryptocurrencies. The coin can be used on a product that is eventually created or left to appreciate in value and then traded for profit. In 2017, ICOs came under increasing criticism following cases of fraud and failed projects (leaving investors out of pocket). And yet, they're still being pursued as an alternative form of fundraising.

OPPORTUNITIES FOR HUMAN-MACHINE PARTNERSHIPS: THREE SHIFTS TOWARD A FRICTION-FREE ECONOMY

Technological advances have reignited age-old debates about the roles of people, technology, and jobs in recent years. IFTF and Dell Technologies' research into The Next Era of Human-Machine Partnerships built upon this discourse and explored how mankind's relationship with exponential technologies will further shape our economy and business by 2030.

Today, we can use the lens of deeper, more immersive partnerships with machines to imagine opportunities to eliminate frictions—where humans and machines work together to surpass human limitations and enable greater efficiency, convenience, and security. In fact, the signals of change are all around us today—underpinned by emerging technologies' propensity to reduce frictions and create new digital marketplaces.

Advances in machine learning are giving people increasingly sophisticated analytical tools to understand how individual decisions affect entire systems. Blockchain and distributed ledger technologies are disintermediating financial transactions and enabling peers, businesses, and machines to transact directly. The rise of the Internet of things is removing difficulties in connecting directly with users and enabling businesses to serve their consumers in increasingly personalized ways.

Each technology points toward new ways to create value. Taken together, this combination of technologies will shape large-scale opportunities to circumvent inefficiencies and

usher in new ways of conducting business and exchanging value. The macro implications will be transformative.

For instance, over time, many mechanized commercial activities will become autonomous as machines become consumers, using a mix of sensors, software updates, and artificial intelligence to sense when they're functioning sub-optimally, need replenishing, or could otherwise be improved. This will pave the way for a rise in anticipatory forms of production—where long lag cycles will be augmented by everything from micromanufacturing to enthusiast communities that enable manufacturers to meet sudden spikes in demand, on the fly. The promise of the friction-free economy won't be limited to the wealthiest users. Rather it will introduce technical advances that unlock inclusive development, by democratizing innovation and value creation.

How these shifts play out depends upon overcoming fundamental barriers to change and mitigating potential risks of unfettered access to technology—which we explore further down.

SHIFT 1:
AUTONOMOUS COMMERCE—MACHINES AS CONSUMERS

While investment in virtual, digital assistants—such as Siri, Alexa, and Cortana—will continue over the next 10 years, we will also see the rise of another kind of intelligent assistant: Intelligent machines, such as coffee makers and electric toothbrushes, which use narrow artificial intelligence to manage their own operation to support us. They'll oversee their own maintenance while monitoring our movements, preferences, and behavior to anticipate our needs. While the activity of any single machine will be limited, the aggregate impact of the different machines will transform consumer and enterprise models.

Many of the earliest experiments with self-managing machines can be found on Amazon through their Dash replenishment service: printers, water filters, trash cans, and other home appliances that have enough sensing capabilities to detect when they're low on supplies and automatically replenish themselves through Amazon.[7] While these kinds of efforts might appear prosaic at first, their simplicity conceals a profound shift. In their own limited way, these self-replenishing devices have become economic actors.

Consumer devices will move from transacting with one prescribed vendor toward becoming increasingly capable of open-ended action and decision-making. Objects will be able to comparison-shop among preferred vendors and make a purchasing decision based on filters such as quality, sustainability, cost, and other variables in the same way a human shopper might. For example, the ADEPT proof of concept combines blockchain and several other distributed protocols to enable a laundry machine to conduct transactions that range from negotiating with other local

appliances to prioritize energy and water usage to detecting a maintenance issue and hiring a local contractor to fix the problem.[8]

In the near future, your house could detect a problem with the heating, find and hire a repair crew and pay for the repair—all while you're at work and unaware of the problem.

Machines won't just transact with humans but with other machines—driven, in large part, by ongoing advances in the blockchain and cryptocurrencies. Cryptocurrencies, pegged to stable fiat currencies, can be traded in tiny fractional amounts, opening the intriguing possibility of "streaming money," which flows from one machine to another in real time, at a pre-negotiated rate.

Smart contracts will also make it possible to have "programmable money" that changes its value and characteristics according to algorithms that run on blockchains.

Frictionless upgrades

Machines are not only discovering and purchasing products; products are becoming software-defined, upgradable, and, in that regard, perpetually unfinished. They will increasingly seek out software to improve how they function, given a user's underlying needs.

In 2018, Tesla released its long-awaited Model 3. Consumer Reports noted that its braking distance was unsafe—that it took longer to stop than full-sized pickup trucks.[9] Within a matter of days, Tesla had solved the problem. Its engineers released a software update that decreased the braking distance to match average compact cars. According to Jake Fisher at Consumer Reports, this was "unheard of" for a software update.[10] The automaker had addressed a glaring flaw that threatened to sink its flagship car—and managed to do so while bypassing traditional costs of recalling and repairing vehicles mechanically.

The Tesla update is a reminder that as more things in our world are enhanced with software, objects will be able to seek out ways to not only repair problems, but also improve themselves and take on new capabilities.

? WHAT IF?

What if products could adapt to their environments?

Today's product updates generally add new features or security enhancements. As climate change becomes increasingly urgent, we'll see a wide array of efforts aimed at using software-defined upgrades to adapt products to shifting local environments and improve the sustainability of a product. Over time, these kinds of upgrades may become a strategy for businesses to sell a more profitable and efficient service—that is also better for the climate.

The rise of the experience economy

It's easy to look at these forces and imagine that digital technologies will spell the death of physical retail stores. Instead they will evolve. In the classic book *The Experience Economy* (1999), Joseph Pine and James Gilmore argue that as markets mature, products tend to get commoditized. To compete, businesses will need to focus more on services and experiences.[11] While machines will increasingly ensure that we have basic goods available around the house, retailers will find success in appealing to our more emotional needs. Some retail models in this new environment will focus less on actually selling products and more closely resemble an in-person catalogue. Canon suggests that "retail as a demonstration" will become increasingly common, where the store is a place to "touch products and see the shape and size and weight of them." Purchasing will still be available but retailers will monetize in other ways too.[12]
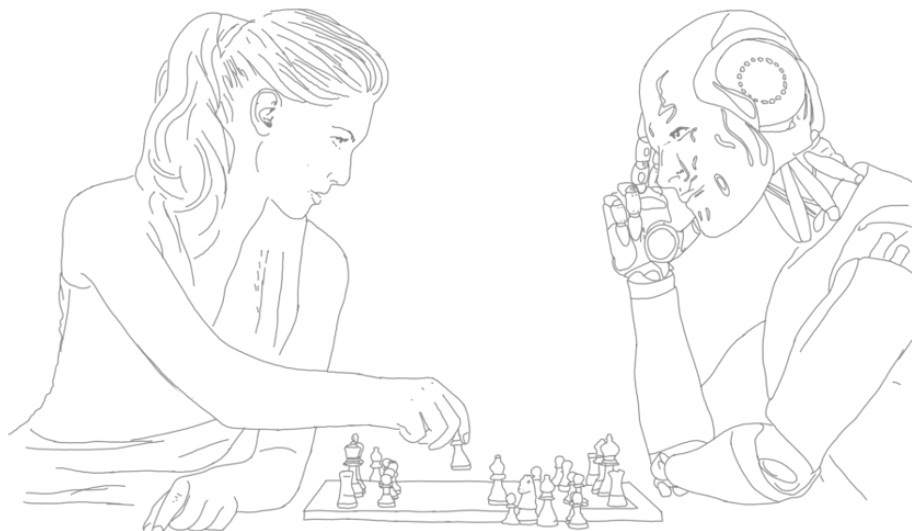
SHIFT 2:
ANTICIPATORY PRODUCTION—MEETING DEMAND ON THE FLY

A DAY IN THE LIFE—2030

MANDEVILLE,
LOUISIANA, US

Geraldine, 42, owner of a restaurant franchise, used to dread Mondays. She'd spend the entire day on restaurant operations: ordering ingredients and supplies, running payroll, bookkeeping, and so on. Now, all those tasks are run automatically through a software platform. The program has already collected about three years of data, which it uses to trigger certain actions automatically. For example, based on receipts and camera sensors in the restaurant, the software knows they go through hundreds of orders of tofu on a typical Friday and only 15 on Tuesdays. With this information, the software program can send orders to local suppliers for just the right amount of ingredients on any given day of the week. Geraldine now worries less about waste, and spends her time preparing for special events.

Over the next decade, traditional mass production will be replaced by forms of automated manufacturing in which objects are customized to individuals' particular circumstances and desires. While efforts to push toward on-demand manufacturing aren't new, advances in low-cost robotic and 3-D printing systems, combined with data streams from IoT and sensor devices, will radically reduce the time needed to understand a product's uses and pitfalls. Manufacturers will be able to identify and improve defects in real time—either through over-the-air software updates or rapid-cycle manufacturing improvements. By 2030, the barriers to understanding market demand and addressing needs with tangible product offerings will have greatly receded, opening up opportunities for more flexible, small-scale efforts to meet targeted demand.

Over the last few years, we've moved almost seamlessly into an on-demand economy, where it's gone from magical to mundane to hail a ride in real-time on a mobile phone or receive a shopping order in a matter of hours. In these transactions, businesses are responding to, rather than anticipating, demand. Once a consumer signals an intent to purchase, companies respond to that demand as efficiently as possible. Technical advances will build on these efforts to enable businesses to fulfill consumer demand in ways that are more timely, personalized, and anticipatory throughout the value chain. Anticipatory production will leverage increasingly sophisticated models to understand how demand changes over time.

Some of these technologies will provide real-world usage information to help manufacturers better understand the strengths and weaknesses of their products. Other advances will come in the form of distributed manufacturing and robotic systems that allow for localized production. These advances will accelerate the speed with

which new products can be developed, produced, and consumed. Already, 51 percent of business leaders surveyed by Dell Technologies say they will struggle to meet changing customer demands within five years.[13] As advances in production continue, businesses will need increasingly flexible, technology-driven approaches to meet demand.

SUPPORTING DATA

More than 75 percent of international business leaders surveyed by Dell Technologies expect to deploy emerging technologies to forecast customer demand and manage resources in the next five years.[14]

Low-cost manufacturing meets maker communities

In many instances, barriers to entry in manufacturing are being lowered as individuals and small businesses gain access to sophisticated computer-aided manufacturing capabilities as a cloud service. For example, Plethora, a startup that offers a CAD-embedded plugin for small-batch prototyping and production, enables real-time feedback on part geometry. Specific to the facility's manufacturing process, the software suggests fixes for issues and creates instant price estimates for jobs.[15]

Digital technologies have also removed a lot of the risk. For instance, digital twins enable "what-if" experiments, so innovators can check viability before making substantive changes to the physical twin.

Increasingly sophisticated forms of on-demand, iterative production will give enthusiast communities new opportunities to influence the supply chain. Individuals and enthusiast communities have been making, modifying, and repairing things since humans began using tools. The maker movement that started at the beginning of the 21st century represents a new kind of making, which could be described as meta-making. Over the last few decades, makers have expanded their efforts into creating prototyping tools, technologies, processes, and services that allow people with limited technical knowledge and experience to inexpensively manufacture complex things and sell them to a global market. In the same way that a person with a $50/month Internet connection and a webcam has access to a larger potential audience than a multibillion-dollar television network did 25 years ago, an individual today has access to cheap manufacturing processes and systems that were previously only available to large multidepartment organizations.

The democratization of innovation will be a double-edged sword for large companies. On the one hand, low-cost DIY alternatives to traditional product development, manufacturing, and marketing methods will give large organizations less of an advantage than they once had. On the other, larger companies will be able to make use of makers' leaner, lower-cost, more agile ways of bringing new products to market.

DEFINITION

What are digital twins?

A digital twin is a digital copy of an existing component, machine, factory, or larger system that receives real-time streaming input from sensors installed on its real-life counterpart. Digital twins can be used to more effectively plan maintenance (rather than take equipment offline) as well as create feedback loops, leading to product and system improvements.
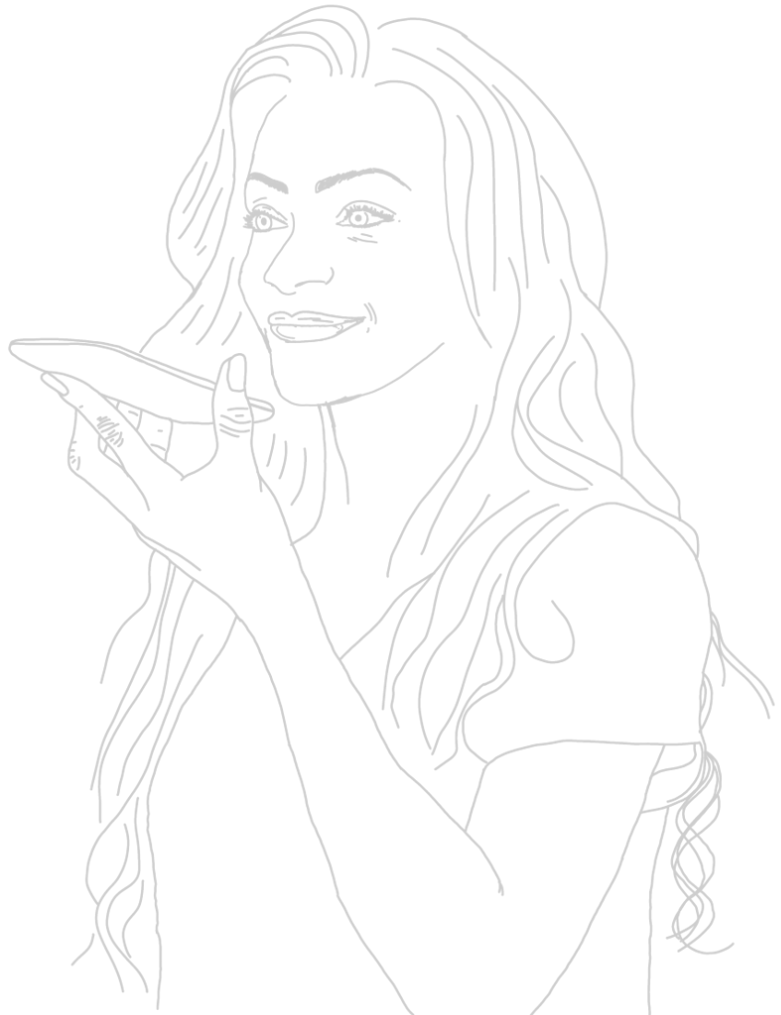
SHIFT 3: LEAPFROG ECONOMIES— UNLOCKING INCLUSIVE OPPORTUNITIES

A DAY IN THE LIFE—2030

NAIROBI, KENYA

Kelechi, 29, entrepreneur, has an idea for a new business but he needs to move quickly. He flashes a smile to his smartwatch to initiate the "paperwork." Kelechi uses a subscription-based company enabled by blockchain, AI, and 6G technologies—which automates the entire process of starting a business all in one day. After receiving the concept and company name, the service takes over with each action triggering the next: pulling personal data from Kelechi's profile to fill out registration forms, submitting them to the local commission for business registration, logging it in the public Internet-blockchain network ledger, paying for the tax registration fee, and creating a bank account with an initial deposit. The money came from a peer-to-peer investing platform allowing anyone to pre-invest in an entrepreneur's next big idea with as little as a penny, based on satisfying a few criteria. With this program, Kelechi bypasses barriers he had faced 10 years ago, such as credit checks, references, finding investors, tax forms, waiting time, and lawyers.

As costs of developing new technologies continue to decline—from mobile handsets to lightweight manufacturing—new opportunities are emerging to bypass traditional large-scale infrastructure and create more inclusive approaches to innovation, development, and financial services. Innovations will include new ways of accessing capital and financial services, as well as efforts that build on connectivity to improve access to key resources such as health services, energy, and water. These advances will reduce substantial barriers preventing people around the globe from participating in the formal economy.

In recent years, this kind of leapfrog development has been most apparent in the adoption of mobile phones, where millions of people who lacked access to fixed telecommunications infrastructure adopted mobile handsets first, instead of Internet-enabled desktop computers. Doing so powered new kinds of innovations. For example, M-Pesa—a secure system for transferring money through mobile devices—launched in Kenya in 2007, long before similar kinds of secure, mobile money transfer systems reached the United States, Europe, and other wealthier markets.[16]

This dynamic will likely continue as emerging economies more readily embrace frontier technologies. For instance, more business leaders surveyed by Dell Technologies in emerging markets expect to use cryptocurrencies (43 percent) compared with those in developed markets (32 percent).[17] However, there are a number of dependencies. For instance, first we must ensure Internet access is available to all. At present, nearly four billion people still lack network access.[18] More opportunities will emerge as Internet access expands globally.

Creating self-sovereign identities

Technology presents a huge opportunity for more inclusive development. The capabilities of mobile devices and distributed ledger technology could create better records of identity, land ownership, and other critical records. The World Bank estimated in 2017 that 1.1 billion people globally lack formal identification such as a government-issued birth certificate.[19] ID2020, an international group focused on creating new systems to address these identification challenges, describes a birth certificate as having "almost incalculable value"—noting that the lack of identification makes it harder for children to get vaccines and education and for adults to purchase mobile phones, access credit, and vote.[20]

A variety of partnerships among nonprofits, startups, and international development organizations are striving to solve the issue. For instance, uPort is using blockchain for "self-sovereign identities,"[21] enabling users to control the information stored about them and determine who can access that information. Because blockchain technologies remove some of the need for centralized authorities to vouch for a person's identity, they can be used to authenticate people born in remote locations, beyond the reach of government infrastructure, or under repressive regimes.

Likewise, the combination of mobile technologies and blockchain is uniquely capable of addressing land titling and documentation issues that prevent unbanked populations from accessing and using their own assets. This problem is widespread. Approximately 78 percent of land and housing in Ghana is untitled, which makes such assets easier to dispute and hard to sell or use for credit.[22] This is an example of what economist Hernando De Soto describes as "dead capital"—assets that people own but can't use or trade due to lack of documentation, which is estimated to be as high as $20 trillion globally.[23]

Again, a number of initiatives are underway to reduce the challenges of dead capital by enabling individuals and governments to place land titles onto the blockchain. For instance, Bitland is working in Ghana to address land titling issues.[24] While other barriers remain—particularly a lack of acceptance of new kinds of records among community, government, and financial service organizations—this kind of solution offers a first step to addressing challenges around proof of ownership and points toward the kinds of practical uses of blockchain technologies that we may see mature first in leapfrog economies.

Unlocking new forms of value

Similarly, new technologies could unlock new kinds of value and revenue generation. There is a growing category of financial services that are giving smaller-scale entrepreneurs the ability to access relatively complex financial services and create new kinds of microservices. For example, because the power grid in Nigeria is relatively unstable, most households use multiple sources of energy, including local generators that produce excess energy. Jeremy Kirshbaum, a researcher and Principal of JJK.FYI, notes the rise of experiments with blockchain to create microgrids in the United States. Kirshbaum argues that more meaningful—and successful—efforts enabling people to sell their own excess energy production, are likely to emerge at scale in places like Nigeria, where infrastructure is unstable, and people own the assets generating power. "By using something like a local transformer," he argues, "people [can] transact and buy and sell that power, or allow the meters, or the devices themselves to partner" and transact.[25]

In the not-too-distant future, an individual's assets could autonomously purchase supplies, monetize themselves, and enable their owners to profit from them. In the process, systems will leapfrog some physical infrastructure development while empowering users to find novel ways to share and exchange value.
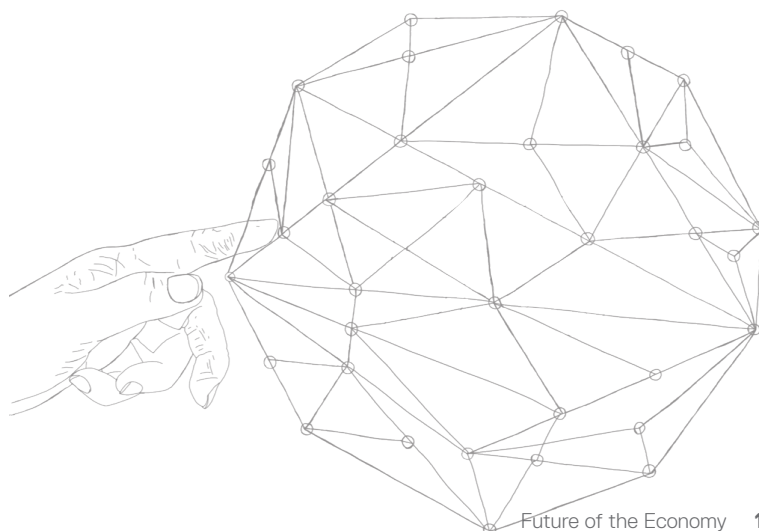
There are still many hurdles to overcome to achieve a friction-free economy by 2030. The greatest opportunities will come from breaking down silos and approaching both challenges and opportunities with broader collaborations in mind. Making the most of the opportunities of 2030 will depend on individuals and organizations navigating tricky, often unsolvable questions. By engaging with these difficult dilemmas now, business and civic leaders can work together to offset some of the issues. Below are some dilemmas that will require ongoing navigation.

Security threats

Emerging technologies have the capacity to drive human progress, and in the wrong hands, dismantle it. For instance, artificial intelligence has the potential to transform industry for the better. But the technology can also be used by adversaries to exploit security gaps across billions of connected devices and react faster in the face of resistance—enabling criminals to double the number of data breaches and identity thefts every 15 months.

⚙ SIGNAL OF CHANGE

IoT devices come with a degree of risk. That risk is particularly profound in healthcare. As connected medical devices are integrated with our bodies, the opportunity to put patient lives at risk increases.

Zingbox is working to ensure the security of connected medical devices. It uses AI to monitor network traffic across IoT devices and identify security threats. Zingbox's goal is not just to secure IoT devices but also enable the Internet of Trusted Things—to ensure that networked devices, as they proliferate and become increasingly complex, remain safe and secure.

Data privacy

Related to heightened security concerns, a friction-free economy will require a new approach to data privacy that maximizes benefits to users while minimizing feelings—real or imagined—of the invasiveness of new technologies. For instance, many of the advantages of autonomous commerce depend on products that can create detailed, real-time records of where, when, and how a user engages with a product. While this kind of information can be used in the cloud—and increasingly locally—to provide better performance, users will need to sacrifice personal information and privacy in the process. In this environment, organizations will need to more clearly spell out the benefits of holding and tracking customer data, while taking proper measures to stress-test their systems, assess risk in real-time, and contain/minimize the damage.

⚲ SUPPORTING DATA

4,600 business leaders around the world rank security and data privacy concerns as the most pressing barrier to successful digital transformation. Seventy-four percent of responses went on to label privacy as an urgent societal concern, followed by security (73%).[26]

Human-machine interactions

Likewise, the emerging friction-free economy will create new kinds of dilemmas about interacting with intelligent machines as they carry out increasingly varied roles in our economy. These kinds of questions will take technologists well beyond the realm of familiar security and interaction design. The emergence of semi-autonomous cars is a case in point. There are many unchartered nuances that will need to be accounted for when designing for human and machine interactions. A recent Uber patent is an example of this. When filing the patent for a self-driving car that replaces a human driver with a hologram, Uber noted that the hologram would make eye contact with a pedestrian—much like a human driver would—as a way to tacitly signal that it is okay to cross the street.[28] The ramifications of getting this wrong are significant, and potentially fatal.

SUPPORTING DATA

AI sparks a myriad of regulatory questions, ranging from trying to reduce discriminatory biases in training data sets used to shape how machines make decisions, to increased limits over the level of autonomy we might grant to intelligent machines. Forty-four percent of business leaders surveyed by Dell Technologies think that there should be greater regulation over the ways in which AI can be used going forward.[29]

Trust and transparency

Individuals and organizations routinely and intentionally create frictions to prevent exposing themselves to risk. From simple office badges that ensure only employees can enter, to more complex technical barriers about accessing data. If we remove these frictions, we could increase the risk, or perception of risk. Given already heightened trust issues—the situation could become explosive. Organizations will need to restore confidence by combining strong authentication with a transparent culture.

SUPPORTING DATA

Among leaders surveyed by Dell Technologies, three in ten don't trust their own organization to look after employee data, and a third don't trust their own company to safeguard customer data. Almost half (49%) believe their organization will struggle to prove that it is trustworthy within the next five years.[30]

Governance

Blockchain technologies can help restore trust by enabling more secure conditions for sharing data. However, some of blockchain's advantages can also be exploited and misused. Lane Casserly uses the example of governance: "Blockchain technology has the potential to quash the use of banks, which would give dictatorships the ability to leverage a national digital currency to gain more control and ownership within regimes. Creating a national digital currency in a dictatorship would fully centralize ownership of all wealth created within the bounds of certain property lines, including full ownership of all data generated from the interactions of citizens and visiting tourists."[31]

Chouguley shares a similar concern about who has the power to exert control over others. With advances in AI and machine learning, we could plausibly be living in a "world where software will dominate human thinking, and we're effectively shaped and cultivated by computer programs to think and behave alike." He further posits, "Maybe society will turn into one homogenous group of thinkers and free thought would be curtailed."[32] As with any major technology, it is up to us to use these technologies for good and earn trust in the process.

Job creation and continuous education

Perhaps the biggest question that we have in a friction-free economy is around the future of work. With the rise of AI, many have been speculating that increasing automation of tasks could lead to job losses. Our previous forecasts have indicated that while some job loss may ensue in particular fields, such as manufacturing, emerging technologies will also create new opportunities. New jobs that don't exist today will begin to emerge. However, continuous education and lifelong learning will be critical for workers to participate in future economies. In addition to retraining programs, workers can turn toward entrepreneurship and start their own businesses. Our experts believe there will be opportunities in the arts, creating new ventures, improving the lives of other humans.[33]

Climate change and resources

While the shifts toward a friction-free economy pave the way for new efficiencies throughout the economy, they also point toward new kinds of climate and resource risks. For example, while people might have increasingly sophisticated abilities to produce complex goods, the inputs—rare earths—are not always distributed (and even when they are, often require mining and environmental degradation to access). As the ability to manufacture goods increases, this could create additional pressures to produce more raw materials—at a faster pace—further damaging local environments.

That said, reducing emissions will require a range of investments in new kinds of green infrastructure that are designed to be more efficient and sustainable. A friction-free economy could enable more people to participate in profitable, climate-positive activities like building green infrastructure.

It's critical to engage with such dilemmas in the friction-free economy now, so we can better identify and promote the kinds of human-machine partnerships that will create value in shared and meaningful ways in the future.

CONCLUSION

In much the same way that cell phones and social media have eliminated many of the frictions involved with communication, technical advances over the next decade will open up opportunities to reduce and even eliminate some of the most painful and persistent frictions in our economy. From new ways of making and buying commodities to fairer ways to serve unbanked populations, the opportunities in the friction-free economy are substantial.

But these opportunities aren't inevitabilities—and advances toward the friction-free economy will be exploratory in nature. In part, how these shifts play out will depend on how we respond to the dilemmas highlighted above. For example, continued declines in trust could result in consumers, companies, and governments putting up bigger barriers and introducing additional frictions into the economy—if they think those barriers are critical for security.

Variations—including industry variations, regulatory differences, and consumer preferences—will play a role in how these shifts unfold and manifest themselves in the economy of 2030. We should anticipate uneven progress and expect that some industries and geographies will accelerate efforts to remove frictions while in other contexts, progress will remain relatively slow.

Laying the foundations of the friction-free economy will depend upon a combination of technical understanding, innovative leadership, and a sense of vision and determination to encourage an ecosystem of innovation. Leaders who engage with these possibilities today could be reshaping the economy of 2030 for the greater good.

ENDNOTES

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31   Chouguley.

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