

The GraceKennedy Foundation Lecture 2018

TECH CHARGE
SMART HOMES, SMART BUSINESSES,
SMART NATIONS



Parris Lyew-Ayee, Jr.

GraceKennedy Foundation

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GraceKennedy Foundation

The GraceKennedy Foundation was established in 1982, in celebration of the company's 60th anniversary. The Foundation provides assistance in three areas: education, the environment, and health and well-being. This is accomplished primarily through the provision of grants, tertiary scholarships, diaspora activities, the funding of two Professorial Chairs at The University of the West Indies and the Annual Lecture Series.

Since 1989, the GraceKennedy Foundation has used its lecture series to engage the Jamaican public, both locally and in the Diaspora, to promote discussion and debate on relevant topics affecting Jamaican society. For those who cannot be physically present, the lecture is streamed live to GraceKennedy's YouTube channel. In addition, copies of the lecture book are distributed to schools and public libraries across the island, and the e-book is available free of cost at www.gracekennedy.com in the hope that the lecture's reach will extend beyond those present at its delivery.

Technology is pervasive in modern life. At the individual level we are tied to our smart phones, tablets, laptops and PCs as we rely on them for communication, information and entertainment; at the organizational and national levels we rely on technology to improve operational efficiency and service delivery. Technology is the subject of this year's GraceKennedy Foundation Lecture - "Tech Charge - Smart Homes, Smart Businesses, Smart Nations" - to be delivered by one of Jamaica's foremost information technology professionals, Dr. Parris Lyew-Ayee.

The lecture will explore the impact of technology on today's society as it continues to influence the patterns of modern life. A neutral vehicle, technology advances our quality of life in immeasurable ways while, at the same time, in the hands of unscrupulous individuals, it poses great threats to our financial

and personal security. The lecture will demonstrate clearly that, for better or worse, technology is now and will continue to be, deeply embedded in every aspect of our lives.

We are confident that this lecture will continue in the tradition of previous lectures and become an invaluable resource for all who seek a deeper understanding of significant national issues. The Foundation, as always, welcomes and looks forward to your comments.

Caroline Mahfood
Secretary /Executive Director
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Copies of the Lectures are available online at www.gracekennedy.com or from the GraceKennedy Foundation, 64 Harbour Street, Kingston.

The GraceKennedy Foundation Lecture 2018
Tech Charge – Smart Homes, Smart Businesses,
Smart Nations

Parris Lyew-Ayee, Jr. writes with a style that shows his indisputable genius. With exacting detail and extensive research, he creates for us a *brave new world*, for which we feel compelled to take responsibility. With clarity of prose, he shocks us with the portrayal of technology's potential risks, while reassuring us of the power of the human species and its will to survive. He presents us with a daunting challenge, a future that we must embrace and make our own.

My first encounter with Parris was twelve years ago at St. George's College. I had only heard of, not met the brilliant young scholar who, at age 23, had recently completed doctoral studies at Oxford University.

"I've begun a project for developing spatial mapping of the campus."

"That's marvellous, Dr. Ayee. You understand, though, we would be short of funds to support such a venture."

"I prefer if you call me, Parris, and not to worry, this would be a gift for our *alma mater*."

For those who know him, he is just as humble and kind-hearted today. Now Director of Mona Geoinformatics Institute (MGI) and Senior Lecturer at The University of the West Indies, Parris's specialities include Geographic Information Systems, Geomorphology, Natural Hazards Analysis, Crime Analysis, Business Intelligence Mapping, GPS and Environmental Systems. We are fortunate to have Parris share with us his scholarship through this publication, to teach us, entertain us and dare us to accept the future, to *tech charge* of emergent technologies.

Parris demonstrates an understanding not only of future technologies but also of the complexities of human behaviour.

Not for one moment does he trivialize or simplify the problem; he realizes that no one solution can be the answer to the risks of a fast-growing technology. He urges us to be open and willing to embrace different opinions, perspectives and priorities. In fact, we get a sense that it is the extent to which we take charge that will make the difference. He does not allow us to be complacent about the future. He forces us to come face to face with real dangers, to understand the detrimental effects humans have had on the environment. He impresses upon us the unmistakable responsibility we have to act, for the sake of averting our own extinction, which we ourselves may be causing. These shock effects jolt the reader and drive home the immediacy and impact of his message.

Parris engages the reader. He acknowledges that emergent technologies in the form of big data and artificial intelligence evoke anxieties, ranging from loss of privacy to the nightmare of killer machines popularized by Hollywood. This identification with our own commonplace fears is what helps us to allay them. We come to realize that for the survival of individuals and businesses alike, we must use technology as a strategic tool to take charge and create opportunities for a better world.

He teaches us. Parris challenges our thinking beyond the familiar notions of the Industrial Revolution to understanding new terminologies. He explains that we have progressed through phases of the assembly line, computer animation and now, beyond, to a fourth phase called cyber-physical systems. We have entered a new planetary period, the Anthropocene, a stage in our evolution whereby we have effected change at a speed beyond nature's ability to absorb these developments, which include proliferation of waste, the use of nuclear technology and an accelerated world population.

He invites us to imagine a world where we live side-by-side with creatures of artificial intelligence, not dissimilar to the utopias and dystopias created by fiction writers. AI (artificial intelligence) machines can now perceive their environments,

learn from them and solve problems. They will become an integral part of our lives. He surprises us with the statistic that within twenty years, an estimated 50 percent of jobs in America will be supplanted by robots. Parris is not afraid to spell out the hazards to mankind of AI technology, the looming spectres of World War III and annihilation of the human race. These notions bewilder us, forcing us to realize that action is needed. We must not only grasp the enormity of the revolution but also use this knowledge to spur ourselves on to finding solutions.

He gives us courage to embrace the opportunities to be gained from these advances. Businesses must adopt new technologies as they strive for innovation and productivity in a competitive landscape. The leading corporations in the USA are all technology-based: Apple, Google, Microsoft and Amazon. We can learn from these giants and prepare the way for the creation of new types of jobs as old ones become obsolete. Businesses will become smart by joining the smart-tech revolution.

Parris immerses us in the coming world of smart technology. He stretches our imaginations beyond familiar smart devices like our phones to dream of smart homes, businesses, cities and even nations. He introduces a whole different view of urban living and the structure of commerce. Cities and nations will deploy hundreds of electronic sensors connected wirelessly to each other, feeding real-time information to control stations. Smart technology will weave us inextricably together with people and organizations around the globe.

So that we do not panic at the prospect of the loss of our freedoms and individuality, he reminds us of the social and economic benefits of this future global state. These developments have the potential for improved public administration, physical and natural environment, and better standards of living.

Are we convinced? The reality is that we cannot arrest the onset of this revolution. We must figure it out and find remedies for our own nation, Jamaica. What will it take to modernize the gathering and flow of data? How will Jamaicans benefit? How

can we use technology as a tool to fight crime, to improve health services, to raise the standard of living for the average Jamaican? He entertains answers to these critical questions.

In this lecture, Parris Lyew-Ayee shows himself to be a technology futurist by providing a clear vision of a tomorrow powered by technology. He explains ways in which it affects our personal lives, he challenges businesses to adopt new, innovative approaches and, by extrapolation, creates futuristic scenarios of homes, cities and nations.

Parris is more than qualified to paint a picture of a future world for us. He operates a commercial research and development company that specializes in geospatial information systems, services and solutions. He is the recipient of several awards including: 50-Under-50 Leaders Shaping Jamaica (PSOJ); FIA (International Automobile Federation) America's Mobility; International Hakka Achievement (Toronto); UWI Press Outstanding Publishing Proposal, Environmental Studies; Book Industry Association of Jamaica, Best Reference Book (2013); Prime Minister's Youth Award; and the Governor-General's Youth Award for Excellence. He has also earned the UK Commonwealth and Jamaica Exhibition scholarships. This expertise has not gone unnoticed in the local and international community. He is an Eisenhower Fellow and Director of many boards in Jamaica including GraceKennedy Ltd., the Bureau of Standards, eMedia Interactive, and he is Chairman of the Water Resources Authority and the National Works Agency.

We congratulate and thank Parris Lyew-Ayee, Jr., for sharing with GraceKennedy Foundation his expertise on future technologies. He gives us the big picture by showing us how we can reframe our understanding of the world.

His message proves the adage true: "to conquer fear is the beginning of wisdom". With a stroke of genius and the magic of the printed word, he drives us to comprehend the complexities of change. He shows us what awaits us in the fourth revolution,

whether we like it or not and, most important, challenges us as individuals and businesses to find the answers.

Fred W. Kennedy
Chair, GraceKennedy Foundation
February 2018

Acknowledgements

I would like to express my appreciation to the GraceKennedy Foundation for inviting me to deliver this year's Lecture and allowing me to share my experiences and perspectives on the nature of technology in modern society, with practical examples from my research. I would like to specifically note my appreciation of the support from the Foundation's Executive Director, Mrs. Caroline Mahfood, its former Chairman and my former boss, Professor Elsa Leo-Rhynie, and its current Chairman, Dr. Fred Kennedy. I am also grateful to the other members of the Foundation's team and partners.

I am grateful to my fellow Board Directors at GraceKennedy Ltd., particularly Group CEO Don Wehby, and Group Chairman and my former boss, Professor Gordon Shirley, who advised me early on in this exercise. All of my colleague Directors have been wonderfully supportive of me in the five years that I've been with the GK family but I would like to note the particular support of Douglas Orane, who has served as a mentor and guide for my journey so far. There have also been so many members of the wider GraceKennedy organization who have played a very important part in my journey leading up to this presentation including, in no particular order, Simon Roberts, Toni Spence and Caryn Spencer, who have given me practical examples and case studies to work with big data in a big company.

At the outset of this project I asked that young people be included throughout the process. Ryan Scott, a Visual Communications Major at The Edna Manley College of the Visual and Performing Arts and the 2017/18 GraceKennedy Scholar at that institution, designed the lecture book and invitations. His classmate, Sean Tyrell, a merit scholar with the Foundation, filmed and edited the video for the live presentation.

Many of the examples I've used in this presentation are the products of the teamwork of every single one of my colleagues

at my second home, the Mona GeoInformatics Institute (MGI), over the past thirteen years. In particular, I would like to mention the 3D king, Alexander Grennell; the GPS guru, Luke Buchanan; and Jovan Roper and Tobi Burnett who directly assisted with my presentation. The MGI Board, in particular its Chairman Earl Jarrett and (my current boss) Principal of The UWI Mona Campus, Professor Archibald McDonald, have given tremendous support to the organization over the years, and endorsed the vision of the company of being a premier research institution that engages in practical and applied solutions emanating from The University of the West Indies. This has led to fearless and radical approaches to problems and direct engagement. I am not ashamed to say that we are world-class, and that is because of the collective efforts of those around me at MGI.

Finally, no one has to suffer more or put up with more grief from me, than my family - my parents, grandparents, and brother. In their tolerance of my pursuit of my interests, which align with practical objectives that can be measured by national or regional impacts, my greatest asset and resource is my very conservative Roman Catholic and Chinese family. I am grateful for the opportunities I have been given to succeed and for the very strong moral centre instilled in me. The alignment of my personal values with my professional life is the reason why I am very comfortable being at GraceKennedy, and why I am honoured to deliver this lecture this year.



Parris Lyew-Ayee, Jr.

THE LECTURE



Chapter 1



TECHNOLOGY TRANSITIONS

Introduction

Modern society is defined by technology and is increasingly dependent on this to move and function. From lifestyle choices to doing business and conducting administrative affairs, technology forms the basis for both individual interactions and transactions, and societal operations. Businesses operate to build and deliver technology as well as to use technology for their own activities. Public services, on national or local scales, depend on technology, from mundane email communications to service delivery such as tax collection and policing.

Moore's Law - the observation that the number of transistors in a dense, integrated circuit doubles approximately every two years - is increasingly apt, as new services using evolving technology themselves evolve, and entirely new industries are generated. This makes for exciting opportunities for modern societies - including new ways to make money, increase efficiency, and improve quality of life at a personal and societal level - but also terrifies a not-insubstantial portion of the population. People fear impacts such as loss of jobs that machines will take away, automation of once-manual tasks, World War III, and the dominion of humans by machines. There are also concerns about technological ethics and privacy, and risks to businesses and individuals alike.

The likely reality is that it will not be as bad as people fear, nor as good as people hope. Humans are notoriously complex and individually-minded; totalitarian states throughout history have had to spend an enormous amount of resources to control their populations. Different opinions, perspectives and priorities mean that there will never be a single solution to any problem or need, and the plethora of technological options that exist testify

to this. Even as many of these options coalesce into common platform products, whether physical or digital, these are used in many different ways for different purposes.

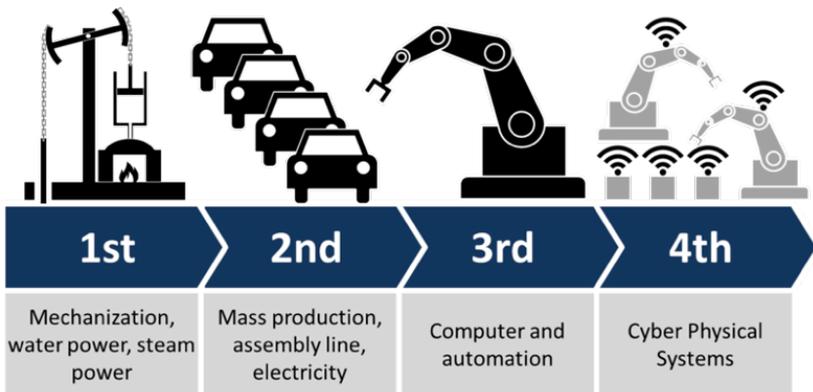
This presentation explores the realities that exist in the technological world from a user perspective, with a particular emphasis on the business and geopolitical aspects. Technology is increasingly creating a borderless world irrespective of geography. Cultural exchanges occur freely as countries consume each other's cultural exports in the form of television, movies or music. Job opportunities are created as high-speed Internet allows for offshore outsourcing, and loss of jobs to outsourcing or automation creates opportunities for entirely new careers to develop. But threats exist, from stolen identities and credit card details to the hacking of military secrets and tampering with foreign elections. The degree to which a society allows itself to be driven by, and affected by, technology, is a testament to its level of sophistication.

Enter the Anthropocene Period

Human history forms a very small part of the entire 14-billion-year history of the planet, as recorded throughout geologic time. Yet humans have had a significant and consequential impact, enough that an entirely new term has been coined for the current planetary period: the *Anthropocene*. This is defined by the fact that humans have attained the ability to effect change to the planet beyond nature's ability to absorb such change, ranging from the generation of waste and emissions to nuclear technology and net population growth. The ability to both wage war and develop new technologies that consume resources and alter the balance of nature means that there is an outsize impact of humans on the environment and technology, defined as practical applications of knowledge amassed by humans, has been the tool.

From the evolution of modern *Homo sapiens*, which ushered in the Stone Age, tools have defined the Ages, from the Bronze Age to the Iron Age. Civilization followed in tandem with these innovations, each rising and falling by the hands of the same technologies that helped form them. It was not until the beginning of the Industrial Revolution in the eighteenth century, the putative start of the Anthropocene Epoch, that humans began to chart a different path for themselves. This path initiated a seismic shift in society, from a largely agrarian environment to an urban and industrialized one, to the point where, for the first time in human history, across the globe, more people live in cities and urban environments today than in rural areas.

Since the first Industrial Revolution, humans have seen three other industrial revolutions (see Figure 1), moving away from steam- and water-powered production systems towards mass production and the assembly line in the early twentieth century, then towards computer-based systems and automation in the middle to latter stages of the past century, and now towards connected cyber-physical systems in the first quarter of the twenty-first century.



- Figure 1 -
The Four Industrial Revolutions
By Christoph Roser at AllAboutLean.com under the free
[CC-BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/) license, 2015

Views from the Past

It is useful to see how influential people from the past viewed the future in their own time. Many of these views have come from business leaders and scientists and technologists, who have a direct role in influencing the way the future turns out. Some of these enlightened people may have engineered the future themselves (for example, Steve Jobs, Bill Gates and Elon Musk), and some got it both right and wrong. Thomas Edison stated in 1889 that, “fooling around with alternating current is just a waste of time. No one will use it, ever,” no doubt in the midst of his epic feud with Nikola Tesla at the dawn of the age of electricity. Ken Olsen, the founder of Digital Equipment Corporation (and named in 1986 by *Fortune* magazine as “America’s most successful entrepreneur”), commented in 1977 that, “there is no reason anyone would want a computer in their home.” The founder of 3Com, Robert Metcalfe, mused, “I predict the internet will soon go spectacularly supernova, and in 1996, catastrophically collapse.”

World’s Fairs of the past offered tantalizing views of the future, perhaps none more so than those fairs held in the middle of the twentieth century at the dawn of the rocket age, and where the automobile and aeroplane were becoming mainstream. Individually-owned flying machines and climate-controlled domes over cities would be normal by 1999, claimed a futurist in 1966 (Figure 2).



- Figure 2 -
An Imagined Future World (1999)
Source: Fred Freeman - *Life in 1999*, 1966.

Pop Culture

Perhaps nothing influences contemporary views of the future more than pop culture references – movies, television shows, novels – that represent different futures based on prevailing political climates, technological advancement, or simple wishful thinking. Some of these present utopian futures where the future is decidedly better than the present, with technology playing a significant part in improving individual lives, work, and even entire societies. Others present very dark and dystopian futures, where machines dominate humans or where rulers govern the lives of everyone, and where privacy has been sacrificed for public safety or the purported well-being of all.

One of the first popular science fiction writers that focussed on visions of the future based on contemporary technological

advancements was the nineteenth-century English novelist H.G. Wells, dubbed the “Shakespeare of science fiction”. In fact, Wells is credited with having developed the term “time machine” after the successful publication of his novel of the same name in 1897. Other novels that seemed prescient include *The War of the Worlds* (1898; space travel) and *The First Men on the Moon* (1901; the Apollo moon landings). In fact, there is a crater on the moon named after Wells.

Dark visions of the future have sold millions of movie tickets over the years. They have also negatively influenced our views of high-tech systems, perhaps none more so than artificial intelligence and robotics. Movies like *I, Robot*, itself based on a series of short stories by Isaac Asimov between 1940 and 1950, show a future where robots serve humanity based on a series of laws and where a conspiracy to enslave humans is uncovered. The *Terminator* franchise, now in its fourth decade, shows artificially intelligent robots from the future engaged in battles with humans over the fate of the planet. And the *Matrix* movies also show a very dark future where humans have already been enslaved by machines, with an all-out battle by scrappy individuals determined to free them and defeat the robots by direct engagement in the artificial environmental construct designed to placate humans. Meanwhile, the movie *Minority Report* shows a not-too-distant future, and examines issues related to privacy and public security and how these collide when manipulated for ill intentions.

Perhaps no other pop culture phenomenon presents a more utopian future vision than Gene Roddenberry’s *Star Trek* series. Originating in the 1960s as a network television show, it has now spawned twelve movies and five spinoff series as of 2018, and presents a future, roughly 200-300 years from now, where humans have achieved world peace, interstellar faster-than-light travel, and made contact, for better or for worse, with several alien civilizations. One of the most remarkable elements of the

Star Trek series is how seemingly accurate their predictions were of the future, and how many of these have become reality roughly fifty years since the start of the original series. Mobile phones, wearable technologies, tablet devices and virtual reality headsets were all shown in *Star Trek*, being used very much as they are today. While some may refer to molecular transporters or warp travel as perhaps the ultimate aspirational *Star Trek* visions of the future, its view of the future where humans are conflict-free with each other, working in harmony and working with alien cultures and civilizations, speaks as much as a political allegory for the politically charged times in which the series ran – civil rights in the 1960s, the fall of communism in the early 1990s – as it is a work of science fiction.

Business and Technology

Half a century ago, manufacturing and oil companies dominated business in the USA; today, conglomerates occupy the top spots, with a retail company, Walmart, atop the current listings. Internationally today, state corporations like Sinopec from China, international manufacturers like Volkswagen and Toyota, and the oil company Royal Dutch Shell are all top ten global companies by revenue. The entire business landscape has changed, and while Apple is the only pure technology company in the latest listing, both within the USA and globally, ranked by revenue, it would be a mistake to think that it is the only technology company in that listing. Today, almost every large company is, in essence, a technology company. Back offices, manufacturing lines, research and development, and product offerings all depend on technology. Oil companies use cutting edge technologies for exploration and extraction of resources, with the efficiencies afforded by technology directly responsible for the current state of oil prices. Car companies are increasingly developing hybrid and self-driving systems, all requiring enormous amounts of technology and research (see Table 1).

Table 1:
Top US Companies, 1955 and 2016

1955 Revenues			2016 Revenues		
Rank	Company	(\$ million)	Rank	Company	(\$ billion)
1	General Motors	9,823.5	1	Walmart	485.8
2	Exxon Mobil	5,661.4	2	Berkshire Hathaway	223.6
3	U.S. Steel	3,250.4	3	Apple	215.6
4	General Electric	2,959.1	4	Exxon Mobil	205
5	Esmark	2,510.8	5	McKesson	192.4
6	Chrysler	2,071.6	6	Unitedhealth	184.8
7	Armour	2,056.1	7	CVS	177.5
8	Gulf Oil	1,705.3	8	General Motors	166.4
9	Mobil	1,703.6	9	AT&T	163.8
10	DuPont	1,687.7	10	Ford	151.8

Compiled from: Mark Perry, "Fortune 500 firms 1955 v. 2016..." December 2016.
<http://www.aei.org/publication/fortune-500-firms-1955-v-2016-only-12-remain-thanks-to-the-creative-destruction-that-fuels-economic-prosperity/>

Health care and pharmaceutical companies use reams of big data for their research analytics and distribution of their products. Major holding companies, like Berkshire Hathaway, themselves own many large businesses, including many technology start-ups and unicorns.

Other metrics, however, reveal the dominance of technology companies today. Discounting the previous statement that practically all big companies today are technology companies, in terms of innovation, influence, positive global impact, and where people would like to work, pure technology companies dominate, with companies like Apple, Google (Alphabet), Microsoft and Amazon making the top ten in all categories (Table 2).

Table 2:
Top Companies, Various Metrics, 2016

MOST INNOVATIVE	MOST INFLUENTIAL	MOST POSITIVE GLOBAL IMPACT	MOST LIKE TO WORK
1. Apple	1. JP Morgan Chase & Co.	1. Microsoft	1. Walt Disney
2. Alphabet (Google)	2. Apple	2. Alphabet (Google)	2. Alphabet (Google)
3. Intel	3. Walmart	3. Amazon	3. Amazon
4. Amazon	4. Microsoft	4. Apple	4. Apple
5. Microsoft	5. Amazon	5. Walt Disney	5. Twenty-First Century Fox
6. 3M	6. Exxon Mobil	6. Exxon Mobil	6. Delta Airlines
7. Cisco Systems	7. General Motors	7. Johnson & Johnson	7. Microsoft
8. Boeing	8. Goldman Sachs Group	8. Walmart	8. Nike
9. Dow Chemical	9. Bank of America Corp.	9. General Electric	9. Boeing
10. Oracle	10. Alphabet (Google)	10. Intel	10. Lockheed Martin

Tech companies are in bold in the chart above

Source: Survey by SurveyMonkey and Fortune, June 7, 2016

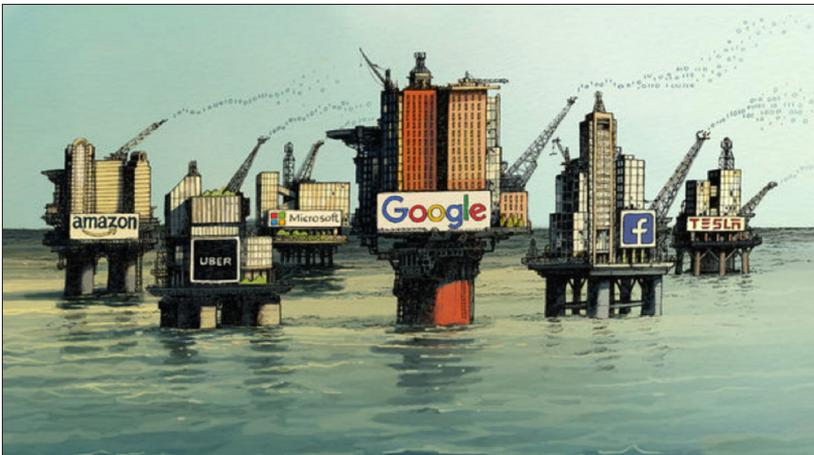
Chapter 2



BIG DATA AND ARTIFICIAL INTELLIGENCE

Big Data

Every day, 2.5 quintillion (18 zeros) bytes of data are generated. This is largely due to an enormous increase in the use of cheap sensors that collect data, as well as many different platforms for the creation of new and original data (such as social media and online activities), and different means of storing them. McKinsey Global Institute, in 2011, in fact, described this phenomenon as the “next frontier for innovation, competition and productivity,” and predicted how the rise of data from a myriad of sources – from business-generated data to multimedia, the Internet of Things (to be discussed later), and especially social media – will create unprecedented opportunity for businesses going forward (Figure 3).



- Figure 3 -
The New Oil

Source: “The world’s most valuable resource is no longer oil, but data”,
(The Economist, May 2017)

The Institute noted that there are a few main areas where big data will have noted impacts: health care, manufacturing, retail, the public sector, and personal services. Retail, for example, could see a 60 percent increase in operational margins with the application of big data, while the public sector can generate more than \$300 million in value through efficiency gains from utilizing big data. In terms of manufacturing, McKinsey states that big data is as important as labour and capital. Big data can also reduce US health care expenditure by 8 percent and this will only improve over time, with the continuous evolution of technologies and more data being brought online.

Big data would create value in five main ways:

- Big data would unlock value by making information transparent and usable at a higher frequency.
- As more data become available digitally, organizations can collect more accurate and detailed information that can benefit inventory management and human resources management, among other functions, and would allow for efficiency improvements, boosts in performance and better management decisions.
- Big data would also allow for a narrower segmentation of customers, for the creation of more tailor-made products and services. It would no longer be enough for customers to be defined as young or old, or male or female, and big data can disaggregate information at a more granular level.
- Sophisticated analytical tools that can process big data, more than big data itself, would allow for substantially improved decision-making at all levels.
- Big data can allow for improvement in the development of next-generation products and services, providing for

more accurate guidance in assessing the viabilities of new innovations in getting these to market, and reducing often costly errors associated with product releases and false starts.

What this all means is that there will be entirely new opportunities. According to the McKinsey report, by 2018 the USA will have a shortage of up to 190,000 people with deep analytical skills and 1.5 million managers and analysts that can do something with this data and make decisions. These are brand new, high-value jobs which perhaps best illustrate the potential for technology to create wholly new opportunities for people, and not simply displace people and jobs. We will explore that in the next section.

Big data generation is dependent on a very large sample of the population providing reams of information, capturing behaviour patterns, preferences and activities over time, often continuously. However, it would be incorrect to assume that this is only the purview of governments. While governments' security infrastructure (intelligence, surveillance, and so on) as well as financial systems (for taxation and licensing, for example) often tends to large amounts of data on the population, it is within private companies that real big data potential may be realized. Amazon controls over 75 percent of all e-book sales, while Google is responsible for 89 percent of all online searches. Google and Apple control 99 percent of all mobile operating systems, Apple and Microsoft 95 percent of all desktop operating systems, and Facebook has 95 percent of all young people using at least one of its products (according to the *Wall Street Journal*, January 16, 2018). These are used to generate revenue by selling this information to third parties for business development, product utilization, market intelligence and the like, though these companies have come under increasing government antitrust scrutiny given their dominance. Nevertheless, it is big data,

crowd-sourced in real-time, or harvested from existing records, digital or otherwise, that will become the fuel for all significant technological development moving forward.

Artificial Intelligence

“It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world.”

Vladimir Putin, 2017

Artificial intelligence (AI), as opposed to natural intelligence found in humans and animals, refers to machines that can perceive their environment and take actions that involve learning and problem-solving. AI has evoked many images of world domination by machines, as mentioned earlier, and has already been applied in different iterations. Iterations include speech recognition; autonomous cars (see earlier); complex data interpretation involving natural language processing, search algorithms, and image and video analyses; as well as use in complex strategy games like chess. With big data availability comes the need for efficient analysis. Coupled with increases in computing power, AI is a necessary tool in the modern age of technology.

There have been huge philosophical debates on the nature of AI and the future of humanity that have pitted titans of both science and technology on both sides of the argument. Stephen Hawking, of all people, theorized that AI could “spell the end of the human race,” and is joined by Microsoft’s Bill Gates, and Space-X and Tesla’s Elon Musk, who are concerned about the possibility that AI could evolve beyond human control. On the other hand, Facebook’s Mark Zuckerberg has come out in favour of AI, challenging “naysayers,” particularly Musk, as being “irresponsible”. Zuckerberg believes that, ultimately, humans who build machines will always be superior to the machines.

But Musk's concerns extended into global geopolitics and converge with Putin's statement. Musk tweeted his belief that "competition for AI superiority at national levels [is the] most likely cause for WW3," noting also the role of China alongside the European Union, Japan, Russia and the USA in the vanguard of AI research at the moment. In fact, the *Washington Post* in 2016 noted that China now led the USA in AI research, although the USA most likely leads in tangible output. The possibility of an AI arms race between world powers would undoubtedly lead to a technological boom period and many opportunities for civilian spin-offs and benefits but would not likely assuage the fears of those concerned about AI and the future of the human race.

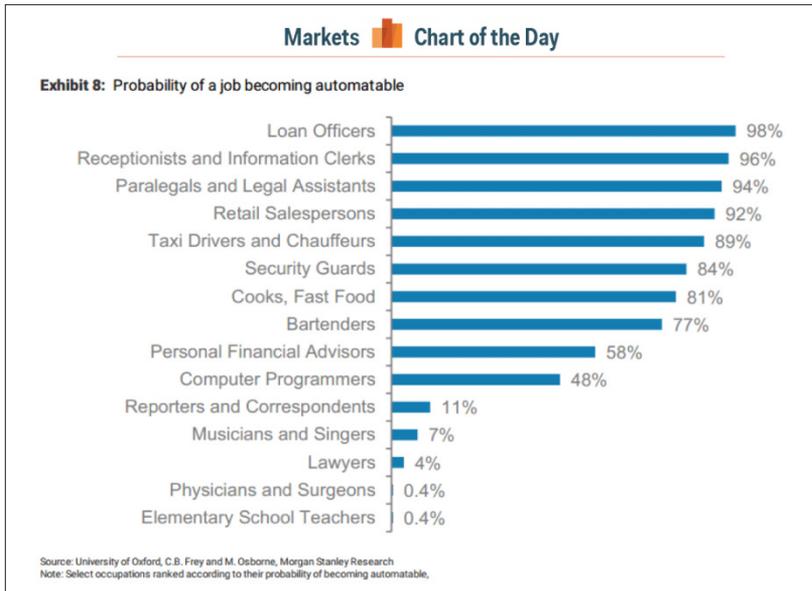
Concerns extend beyond World War III and the end of humanity. In 2016, Morgan Stanley commented that almost half of US jobs would be replaced by robots in twenty years. These included the probability that 98 percent of loan officers, 96 percent of receptionists, 94 percent of paralegals, and 92 percent of retail salespersons would lose their jobs (Figure 4).

AI and automation can affect many different existing jobs, from office workers to service workers like taxi drivers, waiters (robot waiters currently serve food in China and Japan) and security guards (roving robot guards currently patrol neighbourhoods in San Francisco against vagrants). Extremely high-skilled professionals such as surgeons and lawyers may be secured from AI disruption, as are those in the creative industries like music and other entertainment professions.

For balance, however, we should note the many jobs that employed masses of people which are now completely defunct, like switchboard operators and streetlamp lighters whose jobs were, no doubt, disrupted by the advent of new technologies. Likewise, many jobs that are in vogue today did not exist a decade or two ago, such as app developer, research data miner, and social media consultant. As such, so-called threats to jobs represent an opportunity for people to increase their levels

of training to disrupter-proof professional levels, or to create entirely new industries where jobs will be there for the taking.

McKinsey & Company, in a 2016 report, also noted that even within some professions, not all elements are automatable. For example, they noted that jobs that involve predictable physical work, like assembly-line welding, and food preparation or packaging, have a 78 percent technical feasibility of automation, while unpredictable physical work, like construction or outdoor livestock production, have a 25 percent feasibility. Again, jobs that require managing people are the least automatable and, therefore, the most secure from AI or semi-AI disruption.



- Figure 4 -

Probability of a Job Becoming Automatable.

Source: "Half of US jobs could be taken by robots in the next 20 years — here's how likely it is that yours will be one of them" - Business Insider

For now, though, AI has become disembodied to the general population as personal digital assistants such as Apple's Siri, Amazon's Echo, Microsoft's Cortana, and Google Home tap into their makers' vast archive of big data and network connectivities

(not to mention our own phonebooks and email records) to give us information on the weather, movie times, and random trivia factoids.

Chapter 3



SMART APPLICATIONS

Smart Devices

Time was when phones made and received calls (and were tethered to walls by wires), people drove motor vehicles from Point A to Point B, door locks were manually controlled by keys or levers, lights turned on with a physical switch, and blood pressures were read at doctors' offices. Even as different technologies began to coalesce in common devices (like cameras in phones), these were not technically 'smart' until they began to connect to other devices and networks via Bluetooth, WiFi, near-field communication (NFC), and 3G. These enabled other devices to connect or be connected to smart devices, and allowed browsers on these smart devices to connect to the World Wide Web.

Motor vehicles are undergoing a particular smart revolution at present, where the arms race into new hybrid, electric and other alternative fuel systems (for example, hydrogen) by car companies (Toyota's Prius, Nissan's Leaf, Chevrolet's Volt) has opened a new frontier in autonomous vehicle development by a mix of dedicated car companies (Mercedes Benz, Ford) and *bona fide* technology companies like Google and Apple. Perhaps no other company is more at the forefront of this combined research than Tesla, whose various vehicles (which now include a semi-truck) have bleeding-edge technology in both fuel and autonomous driving systems. Such smart vehicles will afford benefits ranging from safety systems to efficient driving and improved fuel economies. They will connect to GPS satellites to know where they are, self-drive using a combination of GPS, an array of cameras around the vehicle, and sensors like radar that can read the surrounding environment in real-time, connected to the vehicle management system (braking, acceleration).

Wearables collect real-time information on users' biometric properties (for example, heart rate, blood pressure, distance travelled); so, too, did devices such as the now-defunct Google Glass, Samsung Gear and Apple Watch. However, the largest usage is in the health and fitness category. Use of wearables has become an important component of health care provision, where real-time information as well as a historical record of activity can be fed to medical service providers, which can help with diagnosis and determination of treatment. They are also integral in professional sports monitoring. PricewaterhouseCoopers, in a 2014 Wearable Future Report, noted that 20 percent of Americans own a wearable, a figure that has most certainly increased since then. Other applications include military usage for better battlefield information and equipment usage and control.

It is estimated that this so-called Internet of Things (a term devised by an employee of Procter and Gamble, not a tech firm) will be comprised of over 30 billion objects by 2020, with an estimated global market value of \$7.1 trillion.

Smart Homes

Smart home devices, because of their falling prices and increasing availability, are more and more being integrated into our daily lives. Connected systems link smart phones to smart devices in homes via the Internet and allow for:

- Lighting, home security systems, refrigerators, washing machines, air conditioning systems and other devices to be connected
- More efficient electricity consumption (by turning on or off devices when needed, or by optimizing their usage)
- Persistent security coverage (where sensors, cameras and alarms can alert homeowners to anything from home

intrusion to fire threats at any time, whether they are at home or not)

- Improved home entertainment options (with voice-activated programming options, lighting, and audio-visual options)

Smart Businesses

The business of smart devices, that is, the manufacturing, distribution and retail of smart devices, is different from businesses that utilize smart devices for a more efficient operation that improves profitability while reducing cost. Any modern, efficient business has to adopt smart business technologies as integral components of its business model in order to remain competitive and relevant. The key element driving this decision is the nature of the customer, who is increasingly demanding cheaper goods and services more quickly and would quickly turn to a more nimble competitor and/or destroy a brand's hard-earned reputation with a viral social media post.

Big data-fuelled decisions still have to be applied to a business process, whether this is cultivation, manufacturing, banking or marketing. Software like those developed by SAP, the world's largest business software company, can manage reams of data for manufacturing and distribution companies, as well as businesses in the finance, specialized (aerospace, defence), service (media, telecommunications, sports) and consumer (fashion, retail) industries, managing everything from inventory to human resources.

Smart businesses can know precisely the amount of inventory in their warehouses, how long the goods have been there, when and where those products were made (traceability is an important requirement of many regulators for consumer products today), and how to move items from warehouses to store shelves. Retail stores themselves can better manage their own inventory and supply logistics to manage just-in-time versus just-in-case concerns about inventory management.

Farms can use smart sensors and devices to understand everything from weather patterns and other environmental data (soil quality, irrigation schedules), to harvesting and processing of crops. This aspect is something to which many climate change advocates have dedicated effort and funding. Within the production and processing environment, everything from managing storage environments (to prevent spoilage) to efficient handling of crops and produce and their subsequent packaging and the rate of a production line, can all be managed in a smart system, with or without automation.

These connect to integrated shipping and logistics industries which handle the movement of goods across the world, with multi-modal systems that move cargo via sea, air and land, by truck or rail, through ports and warehouses, until they reach their final destinations. Aided by efficient port and customs handling systems that can interface with cargo containers and allow for rapid processing, the entire business supply chain is made more efficient, which will allow for reduced costs and increased sales volumes.

In the financial environment, regulations often force businesses to adopt smart practices to prevent fraud and other criminal acts, and requirements such as Know Your Customer and Know Your Employees force financial entities to use big data and cross-reference these against many other data sets, internal and external, and to generate alerts based on probability and predictive analytics using various tools.

Businesses like Amazon and Alibaba epitomize smart business and, in doing so, have altered how businesses operate. These entities could not have operated before smart systems came into being, given the wide-ranging components needed to make the companies work - from connecting different businesses into an online retail environment to fulfilling orders from far-flung suppliers using myriad shipping options, and processing online payments (and ensuring customer data

security). Amazon's decision that it would develop its own airline, Prime Air, launched in 2017 and develop its first set of brick-and-mortar stores, as well as its purchase of supermarket chain Whole Foods in 2017, sent ripples across existing businesses along those lines. This will directly affect the business models of established freight companies like FedEx and UPS). Amazon's recent launch of its Amazon Go stores, devoid of cash registers, is an extreme experiment that many retailers are undoubtedly watching very closely. Like individual jobs and AI, entire businesses and sectors can now be affected by smart systems and, like jobs, these create opportunities for businesses to innovate and increase their product offerings in order to evolve as inevitable technologically-fuelled change happens.

Smart Cities

Urban Histories

The first so-called urban revolution occurred around 6,000 years ago when, in a few regions of the ancient civilized world, agricultural innovations made it possible for communities to produce a surplus of their products that could support a population living in urban centres, who did not have to grow their own food – rulers and their courts and armies, priests and merchants. The hinterland population depended on the towns to provide them with things they did not produce for themselves, and market centres developed. The next urban revolution did not come until the advent of the first Industrial Revolution around the eighteenth century when innovations in manufacturing, especially of textiles, iron and steel, led to the growth of cities taking advantage of their locations vis-à-vis raw materials, labour resources and markets. By the late nineteenth to early twentieth centuries, cities had also grown into centres of commerce, regionally, nationally and internationally, while maintaining their economic bases, especially in manufacturing.

Cities developed as centres, also, for financial and educational services.

From the early twentieth century, urban geographers in the USA developed typologies of cities essentially based on arbitrary (though empirical) classification of their labour forces engaged in a number of key economic activities (Mayer & Kohn, 1965). So a city could be classified as a manufacturing centre (like Pittsburgh, Pennsylvania or Detroit, Michigan), commercial centre (like St. Louis, Missouri), an administrative centre (like Washington, DC), or an educational centre (like New Haven, Connecticut). However, many of the best-known cities often ended up in a class called “Diversified” simply because they had economies which had all of these functions but not enough of their labour force in just one function to fall within the numerical cutoff for that function. The best example of this is New York City, which is known as a city with significant portions of its economy linked to manufacturing, the retail and wholesale trade, entertainment, transportation, tourism and recreation, and education.

By the 1980s a new term emerged: the transactional city (Gottmann, 1983), defined as based on services provided – financial, commercial, educational – but at a higher level than in the past. Such cities became important as technology developed (and continues to develop – remember the fax machine?), making it possible for all sorts of transactions based now on computers and the Internet to link persons and organizations across the globe. The world’s most important stock exchanges are now global, and operating in different time zones means connections can be 24-hour even if the actual exchanges are not open for business at the time. Many persons may acquire a college education or some form of specialized training without ever attending a physical campus, even in a country half-way across the world.

This epitomizes what is happening to cities around the world – a deep metamorphosis in urban form and function

caused by linked socioeconomic and technological changes. The basis of this metamorphosis is the shift from national labour forces based on agriculture and manufacturing to economies composed largely of workers who specialize in transactions, in the production and exchange of intangibles such as information, data, knowledge, and decision-making. This metamorphosis is a sharp break with the recent past and it will force an equally sharp change from the way we have customarily thought about cities and their functions.

Modern cities are now, above all, hosting environments that provide infrastructure and support services for transactional activities. In the past, religion, politics, commerce, entertainment and law were the traditional transactional functions that were part of urbanism – in fact, they may have been the driving force for urbanization. Today, the most important and rapidly growing transactional activities that cities host are information services, which have become the basis of an ongoing urban renaissance.

Approaching Smart Cities

Enter the term “smart city” – the end product of the impact of all this interconnectedness on urban form and function in the twenty-first century. Just as the advent of the private automobile led to the spread of cities into suburbs and the rise of commuter populations, the development of vast suburban shopping malls, a decentralization of people and activities and consequent urban blight, smart cities may signal a revival of cities as centres of the new and developing technologies. Such technologies may either draw people back to cities or enable them to be the focal points of the corporate organizations at the hub of hundreds or even thousands of people working at their computers and other smart devices in their homes far away, even in other countries.

Cities such as Amsterdam, Barcelona and Madrid are examples of old cities that are retrofitting themselves as smart cities. These cities have deployed a wide sensor network to deal with issues of traffic congestion, public transportation

and parking as well as utilities management – for energy conservation, water usage and garbage collection. More recent cities making the change to smart cities include Milton Keynes in the UK and Songdo in South Korea. The former is a planned development, built fairly recently (in the 1960s), with a distinctly different layout than that of traditional British cities, while the latter is a brand new as-yet-unfinished development, purpose-built to be a smart city. These areas, being more recent developments, have layouts more conducive to modern societies, designed in the electricity and automobile age.

Parts of Toronto have been slated to become a smart city. Being a development by Google (Alphabet), this is the first large-scale private sector development of a smart city. A 12-acre area along Toronto’s waterfront is to be developed by the Alphabet innovation unit Sidewalk Labs “from the internet up,” and they hope that this will “bridge the digital divide between rich and poor”.

While there are hundreds of smart cities, existing or planned, around the world, Singapore has declared its intention to become the world’s first smart *nation* (Figure 5). This is a government initiative that will build on existing infrastructure, pairing this with a technologically-savvy population and highly-efficient, results-oriented government systems. Announced by the Prime Minister in 2014, the government believes this will spur a wholly different form of citizen participation, where citizens can contribute and share in the determination of solutions that affect everyone. The US\$2.4 billion project will also involve the private sector in a major role, including start-ups and innovations creation. While this is indeed an ambitious undertaking, it should be noted that Singapore’s small size (Singapore’s total physical size is roughly the same as the wider Kingston Metropolitan Region) allows for this to be undertaken in a manner that a much larger country could not, to say nothing of Singapore’s vaunted reputation for getting things done.



- Figure 5 -

The downtown central business district of Singapore. What used to be their waterfront has been dammed up and is now a working reservoir that collects rainwater runoff and direct rainfall and settles these before treatment and use as domestic water supply, all sensor-managed. Roads and cars also have sensors; the night crowds in the picture at the bottom are waiting for the nightly laser show off the hotel (three towers with the surfboard on top) into a fountain in the water, all timed to music.

Source: The author

The benefits of smart cities are similar, and these depend on the availability and deployment of hundreds of sensors that are all connected to each other and feeding control stations real-time

information. The system also needs to be open, where external users can access these systems with their various devices to gain information on traffic or public transportation, as well as receive alerts and other information over a public network. The system must also be scalable, where the smart city solves individual and collective problems and needs at the same time. It must be able to receive and use information, including from those accessing the system for information, and process and distribute this information.

All of this is intended to provide great societal benefits. Such ubiquitous connections will yield results ranging from a more efficient city economy to:

- An engaged population that is both feeding the network and consuming information from it
- Better public administration
- An improved physical and natural environment
- A better standard of living for the city population

Tangible benefits, such as better traffic management and public transportation solve multiple problems simultaneously: a more free-flowing traffic network reduces vehicular emissions and fuel consumption by reducing idle times in traffic; reduces losses in worker productivity from sitting in traffic, and promotes a more efficient use of the transportation network by deploying city assets when needed most and reducing these when not needed. Smart cities can also better manage energy consumption by having smart meters regulate usage of electricity in times of peak demand, as well as the reallocation of resources when needed the most. This includes many of the items already used within smart homes but scaled out to a much larger area. The same applies to other areas of utilities management including water, sewage, and garbage collection,

where routine tasks - monitoring and inspections, and other scheduled activities such as garbage collection - can be assisted by sensors mounted on utility infrastructure, which can advise on areas requiring attention, thus reducing the manual need to conduct these tasks, either on a routine or an emergency basis.

The benefits of a smart city also include improvements to security infrastructure. Closed-circuit cameras are not new technologies but in smart cities, these can be connected to other sensor infrastructure to assist normal policing monitoring activities, threat detection and interception, and investigation of crimes. These systems also serve as deterrents to crime. Technology once deployed at large-scale public events like the Super Bowl in the USA is now deployed in cities as counter-terrorism equipment. These include radiation sensors and biometric scanners, including facial recognition systems, which can process millions of people on a daily basis. These have been used recently in several mass-casualty events.

One of the important components of security and emergency management - mass evacuation - is easily managed by smart city infrastructure. Digital signage and notice boards, each with general or location-specific information, can present information to the public, advising of the proper course of action. The application of this for disaster management is very obvious where, as conditions change from the pre-, during- and post-disaster phases, an orderly movement of people is important to avoid the exacerbation of the disaster.

Notwithstanding all the above, in 2017 Amit Garg noted three counter-intuitive trends in smart cities. First, cheap sensors were not enough. These need to do what they were intended to do consistently, and the end results need to be meaningful. This not only requires the necessary infrastructure but also dedicated maintenance. Once in place, it is not enough to have a network of connected sensors working properly with an adequate maintenance budget. City management needs to ensure that there is proper staffing in place, with the necessary

(non-technological) resources to address problems and issues the smart city network would identify. It does not make much sense for a smart city network to be able to detect problems in a sewage or garbage collection infrastructure if there are no resources to address the problem. Real-time systems that can self-adjust, like smart traffic lights and electricity meters, also have upstream input and downstream impacts that may require manual attention to fully address a situation.

Second, Garg noted that incremental improvements were better than drastic change. This is an important consideration where existing cities are being retrofitted to become smart cities, especially in very old cities. The changes themselves may be radically different from what these cities were designed to be. In order for smart cities to accomplish what they are intended to do, societies need to already have a culture of innovation and change and drastic overhauls may become costly backfires. Third, there is no reason to scale out to an extreme extent. Doing one city at a time can achieve objectives intended, and scaling out too much may overwhelm city management (and budgets). This is an important consideration.

It should be noted that, from an urban planning perspective, the word city has specific meaning and, for the most part, what is being called a smart city is really a *part* of a much larger metropolis. City centres or dedicated areas earmarked to become smart cities are not themselves the *entire* city. These are areas that can most benefit from technological improvements to traffic management and public transportation and the provision of city services among other things, but may not extend to the entire city, which may be comprised of less diversified areas that do not require large amounts of services, such as residential neighbourhoods or dedicated industrial areas.

Risks and Ethical Considerations

All of the terabytes of information (per person) that are feeding sensor networks, concerning everything from individual preferences of television and Internet browsing to heart rates, preferred routes to work, shopping habits and family histories, to say nothing about credit card and bank account numbers, invariably contain significant risks and concerns about privacy. Data breaches such as those that affected US-based companies Equifax (the largest data breach in history – so far), Sony, Target, Home Depot, Staples, and Yahoo! are some examples of high-profile data breaches that have exposed personal information of everyday citizens, as opposed to data breaches that involve classified military information such as what happened with Edward Snowden. As people willingly provide personal information in the interest of convenience and cheap (free) access to services, as well as information they may unknowingly or inadvertently give (from phishing attacks, for example), such breaches can result in significant inconvenience, at best, to many people.

Smart cities, however, as a function of their larger scale and connectedness components, present a different level of risk concerns, some of which have nothing to do with technology. By definition, smart cities, in a cyber-realm, will have to proceed according to certain digital rules, and may not accommodate the usual chaotic nature that accompanies organic urban development, which may see alternating series of growth, blight and regentrification, different design aesthetics typical of the period of development, and the incorporation of many ideas – structural, political, creative – of their respective eras.

However, it is typically the issues of privacy that concern most people about smart cities: constant surveillance by unblinking CCTV cameras, ubiquitous and persistent WiFi feeds relaying individual locations and activities, and (often) distrust of public authorities charged with managing the data and the ability of such public authorities to manipulate the data.

There is also concern that the dependence of certain smart cities on smart infrastructure may render them vulnerable to targeted attacks that may cripple an entire urban area. The possibility of a rogue state or non-state actor hacking a city's electricity grid and paralyzing the place exists with connected systems, as does the potential impact of a high-altitude electromagnetic pulse detonation over a city. Similarly, natural hazard impacts can cripple cities too dependent on technological systems to operate independently. In modern societies, in the aftermath of disaster impacts from hurricanes or earthquakes, the availability of electricity, not water, is the most important consideration. In addition to this, severed telecommunications connections, whether they are broken fibre lines or downed cellular towers, can severely disrupt any modern city's ability to function, much less any smart city. This is the current and ongoing situation in Puerto Rico and its capital San Juan, following the impact of Hurricane Maria there in 2017. It was also the experience in Port-au-Prince, Haiti, in the aftermath of the 2010 earthquake there. In both cases, not only were livelihoods and normal city operations disrupted but relief operations were also hampered, and relief workers had to bring in their own power supplies to operate; priority was given to restoring the local power grids.

Chapter 4



LESSONS FOR JAMAICA

As Jamaica progresses further into the twenty-first century, there have been distinct steps towards a more technologically-integrated society and efforts made in both the public and private sectors towards this. A growth strategy involving business process outsourcing (BPO) inherently requires Internet connectivity and high-speed broadband services in order to operate, while an increasing number of government services are offering online channels for access by the general population. Meanwhile, the private sector has also developed an increasingly sophisticated suite of products that leverage the new high-tech paradigm we are living in, with a wide array from multimedia, entertainment and telecommunications options to banking services and personal security.

Fibre-optic cables are widespread in the Kingston Metropolitan Area and other urban centres, and are expanding further. The National Works Agency (NWA) has developed an Intelligent Transport System that uses its own dedicated fibre line to connect traffic lights to closed-circuit television cameras for monitoring traffic flows. The Agency has allowed other agencies to access both the feed and fibre itself for the purposes of intra-governmental communications, as well as for their own operational needs. National security operators like the Jamaica Defence Force and the Jamaica Constabulary Force have access to the NWA's fibre for security purposes.

No other initiative, however, captures the ethos of this presentation more than the plan by the Jamaica Public Service to create a Smart City Concept in New Kingston. The Government of Jamaica mandated the JPS in 2015 to convert street lights across Jamaica to LED types, resulting in 110,000 street lights being converted and having intelligent control

systems. Improvements will include the ability for the LED lights to dim according to ambient lighting conditions (especially at dusk or dawn, when full illumination may not be necessary), as well as the ability to report maintenance issues with each setup, all connected to a central control system. This is the single largest energy efficiency initiative in Jamaica. This will also allow for other technologies to be used with the upgraded infrastructure including video surveillance, traffic management, public parking sensors, public WiFi and digital signage.

The pilot area for this initiative will be in New Kingston, the capital city's second central business district (CBD), with a variety of activities ranging from retail businesses and office spaces to entertainment venues and residential areas, incorporating both public- and private-sector interests. As in most CBDs, there are distinctly different daytime and night-time activity patterns both in terms of traffic and energy consumption, as businesses and offices close in the evenings but other activities such as entertainment and dining options, come alive. There are also variations in vertical spaces; CBDs typically have a higher building density, with several high-rise structures. Lower floors may be retail spaces, while upper floors may be offices. These have different energy requirements and can be addressed by having smart meters. Free public WiFi can benefit the general population but also serve to connect public transportation with traffic lights, and allow for people to know arrival times of buses and also flow traffic to allow for bus schedules to be kept and emergency service vehicles to move when necessary. Figure 6 shows the 3D concept model of the smart city, an important component in visualizing and thereby selling the concept to stakeholders and regulators alike.



- Figure 6 -
3D wire frame model of New Kingston,
used for the concept of the Smart City Pilot
Source: Mona GeoInformatics Institute, 2016

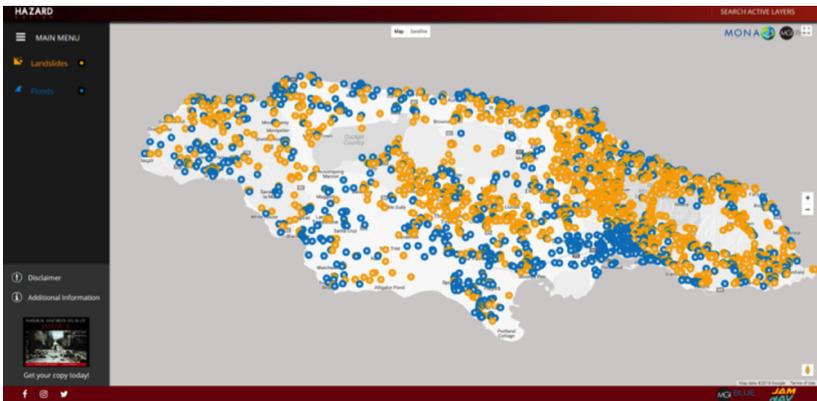
This is a transformative initiative. However, as Garg (2017) stated, it alone is not enough. There are important societal properties that will need to be addressed, away from the physical hardware initiatives that the JPS will be installing. Many individual institutions may have implemented standard operating procedures concerning everything from data collection to processing of information. Banking and financial services are perhaps the best examples of this in Jamaica, with compliance regulations – especially the Know-Your-Customer and Know-Your-Employee regulations, as well as the nature of international banking – very strictly enforcing the way these businesses operate. Telecommunications companies are also very good at this in Jamaica.

However, smart societies need this discipline to be extended throughout the country at a fundamental level, where data are not just collected for the sake of collection and seen as the end-product of a standard operating procedure. Instead, data entry operators need to see themselves as feeders into a larger

system of analytics where input information, whether collected manually or through digital sensors, is passed through to other players in the wider system, whether they are human analysts or artificially intelligent systems. In many cases in Jamaica, reams of data are collected – traffic tickets, reported crimes, hospital records, among other data – that are not processed together to establish linkages and relationships, not to mention allow for predictive analytics for events not-yet-happened. Too often we are given, as a nation, very elementary statistics reporting crime, road fatalities, or some other measure having either gone up or down by a particular percentage. This is rudimentary statistics, incongruent with what is possible with the tools we already have, much less any smart or intelligent system we aspire to possess. How this information is operationalized will depend on knowing where certain events are occurring, and actions needed to address specific incidents at specific times with specific resources. Data reporting, especially in the public sector and media, is almost always backwards looking, reviewing past statistics, instead of projecting the information forward.

For all the work being done on introducing technological systems that will generate data in Jamaica, from customs and immigration to tax collection, health services and security, these will be creating a new set of baseline data, whose real value will only be realized after years of data collection using this or future technologies. Digitization of past records has also begun in some agencies and will need to be integrated with the new incoming data. Current efforts at the Mona GeoInformatics Institute (MGI) are aimed at addressing data collection in data-poor environments and unlocking value from data already collected, formally or not, from past reports and records. These include crowd-sourcing real estate information and used car sales from public advertisements (to determine both the value and variability of the market over space and time), to trawling digital media archives for records on landslides and floods

(3,526 and 2,666, respectively, as of the end of December 2017) since the nineteenth century (see Figure 7), long before official records were kept by government agencies. These are useful when looking at frequency of occurrence, validating models, and for identifying areas prone to either activity when considering developments. Similar models using indicator data are being developed for traffic and income data for Jamaica.



- Figure 7 -
Online web map of all floods and landslides
in Jamaica since the 19th century

Jamaica's recent episode with the Chikungunya virus saw the whole country affected in some form - if people did not get the virus, there was a high chance that they knew someone who did. The virus devastated productivity as people reported sick, resulting in delayed court cases, reduced workforce output and school absenteeism. Some people died from complications from the disease. There were even travel advisories about Jamaica posted on the matter. For all of this, though, the official Ministry of Health figure for the outbreak was 5,180, less than 0.2 percent of the population of Jamaica. Meanwhile, more than 40,000 people from public schools alone across Jamaica - students and teachers alike - reported as absent with virus symptoms. While

the vast majority of affected Jamaicans did not go to clinics to get tested for the virus, the impact remained and, in this case, official data did not portray the full impact. This is similar to the current situation in Puerto Rico post Hurricane Maria, where the official death toll was reported at sixty-four in December 2017, yet journalists and others suspect this figure could be twenty times higher.

Other examples of where commonly reported figures do not present a full picture of social realities are with road traffic crashes and crime. Invariably, the figures that government officials and the media focus on are crash fatalities and murders. Fatal crashes amount to just 3 percent of all motor vehicle collisions annually (Lyew-Ayee, 2012) and major crimes (murders and shootings), as reported to the police, represent between 20 percent and 25 percent of all violent injuries reported to hospitals. In fact, a recent cost-of-care study conducted by McCartney, et al. (2017) showed that the total cost of injuries to Jamaica is around \$12.6 billion per annum, taking into consideration violent injuries, road traffic crashes and suicide attempts. In all these cases, actual deaths from these occurrences accounted for the least costs to the Jamaican health care system; it is treating immediately-non-fatal casualties that generates direct costs of \$5.4 billion per year. This includes emergency room, supplies and staff costs, and indirect costs of \$7.2 billion (from loss of income and impact on family life, for example, but not costs associated with deferred elective surgeries and other secondary impacts on the health care system). Table 3 shows the summary of the findings.

Table 3
 Cost of Care in Jamaica.
 Source: McCartney, et al., 2017

Estimated Annual Direct Medical Costs				
<i>FOR VIOLENCE RELATED INJURIES (VRI) AND ROAD TRAFFIC CRASHES (RTC) FOR JAMAICAN HOSPITALS: JANUARY TO DECEMBER 2014</i>				
HOSPITALS	Item	COST (J\$'000)		
		No. of Cases	Mean	Total
7 STUDY HOSPITALS	VRI	12,989	175	2,268,642
	RTC	6,737	115	774,755
OTHERS	VRI	11,646	115	1,350,084
JAMAICAN HOSPITALS	RTC	5,716	115	657,349
TOTAL ALL	VRI	24,635	147	3,618,726
JAMAICAN HOSPITAL	RTC	12,708	113	1,432,104

Estimated Cost of Injuries in Jamaica, 2014 (J\$)				
Injuries	No. of Cases	Direct Medical Costs	Indirect Costs	Total
VRI	25,000	3.6 Billion	5.0 Billion	8.6 Billion
RTC	13,000	1.4 Billion	1.8 Billion	3.2 Billion
Suicide and Attempted Suicide	500	0.35 Billion	0.4 Billion	0.8 Billion
TOTAL		5.4 Billion**	7.2 Billion	12.6 Billion

*Figure round to nearest '000. Indirect costs include productivity losses, disability
 ** The direct medical cost of injuries excluding compensation of staff was \$4.6 billion*

However, with the focus on fatalities rather than the complete data available, as generated by the complete data ecosystem available to society from the police, hospitals, ministries and policymakers, as well as researchers, the full picture is being missed. Addressing this would allow for a far better allocation of resources to tackling problems of crime and violence as well as dealing with the carnage on the roads, rather than a purely reactive approach. Further, using complete data would allow for greater operational efficiencies within the health and security institutions, as well as maximizing returns on investments in technologies at these places.

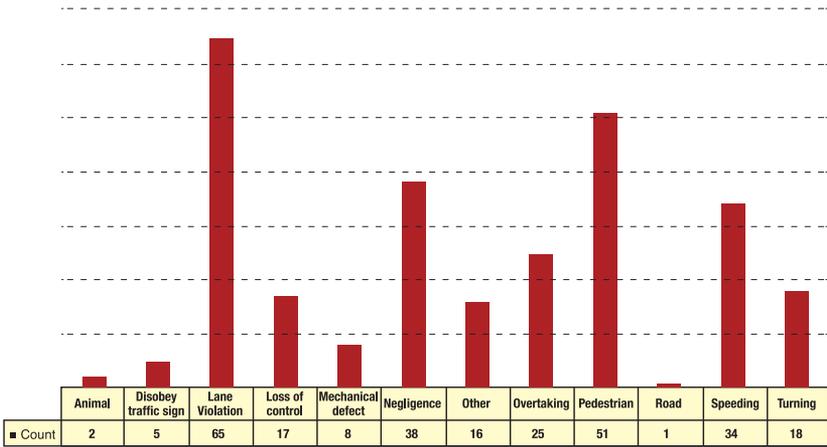
To illustrate this point even further, ongoing research at MGI in looking at the dynamics of road safety in Jamaica go beyond

statistics on outcomes (fatal crash incidents, casualties) and look at data related to road engineering and infrastructure. Current speed limits (50 km/h in built-up areas; 80 km/h in rural areas) appear to be anachronistic with the nature of vehicles, road design, and most important, risk (see Figure 8). Different roads carry different levels of risk depending on traffic, construction and maintenance, the number of intersections on these roads, the number of infrastructural elements (schools, workplaces, shopping centres), slope, and road curvature. Data for 2017 have shown that the majority of fatal crashes occurred along straight, flat roads with very few elements nearby. Crashes are occurring in rural areas, which have an inherently different risk profile than urban areas. From this information, fatal crash hot spots can be predicted, not just on the basis of outcomes but also on physical realities.

A blinkered approach to data results in analyses being based on under-reported data, which makes arriving at effective solutions difficult. Policies ranging from anti-crime operations to public health campaigns may be initiated reactively or based on anecdotal rather than empirical information, or be based on a limited sample of data, analyses of which may be biased or inherently compromised. Final official data on road fatalities for 2017 have shown that speeding is the fourth leading cause of crashes in Jamaica by a good margin (see Figure 9), yet there remains a challenge in addressing other causes of fatal crashes. It is also worthy of note that there were no explicit references to impaired driving (from drugs or alcohol), or from cellular phone use. Independent data sources as well as independent checks and balances by trained analysts can convert the raw data into information and effective knowledge. In addition to this, data from additional sources - a hallmark of smart systems - is critical, whether for direct input into analyses or for context and validation. This remains a major challenge for Jamaica.



- Figure 8 -
Marcus Garvey Drive (top) and Cassava Piece Road (bottom) in Kingston.
Both are 50 km/h roads but have fundamentally
different designs, usage and risks



- Figure 9 -
Causes of Fatal Crashes in Jamaica, 2017

Still, given the nature of the challenges, options and alternatives have emerged from the resources of the private sector, which is as much a stakeholder in Jamaica’s challenges as anyone else. On matters of road safety, the JN Foundation has partnered with the International Automobile Federation, MGI, and the National Road Safety Council in determining actual crash hot spots (not just for fatal crashes) across the island, and has placed markers for these at key locations, as shown in Figure 10. The private sector needs to continue to play a major role in bringing a technological mindset to the governance and operations of the wider society.



- Figure 10 -
Crash hot spot billboard, located at an actual crash hot spot

Academic institutions play a critical role in maximizing the benefit of technology for the country. This will not only come from training persons in computing or digital technologies at our universities, but will also include training in everything ranging from business and management (especially in the new businesses of social media marketing and financial technologies), to vocational training to fill new jobs displaced by machines which are able to do old jobs quicker, cheaper, and persistently.

However, this training needs to extend to the primary schools onwards, where teachers and students alike, both at least familiar with technologies through exposure, begin to inculcate important values and ethics surrounding technology usage, in preparation for the imminent arrival of smart homes and cities across Jamaica. This is critical for two reasons. As the next generation is brought up in an environment in which

technology is no longer a novelty but is as normal and familiar as the motorcar and electricity, they are able to slot right into active usage of the technology and apply this with a comfort and ease that is not necessarily the case today. The other reason, however, extends further. It will be this next generation that will build upon the gains from the original implementation of these systems within Jamaican society, developing specific applications and tools unique to a Jamaican situation or problem, and ultimately exporting these as a natural by-product of our technological evolution. This is the current case with China where, less than a generation ago, they lagged behind the rest of the world in information communications technology (ICT) development but were able to learn from other countries and companies and innovate solutions based on their practical needs and experiences which they are now applying and exporting to the rest of the world.

It is worthwhile to note that of the twenty-five top-paying jobs in the USA (Ward, 2016), seven are directly in the ICT sector, with an additional three in the data science category (Data Scientist, at #16; Data Architect, at #20; and Analytics Manager, at #24). An additional eight categories are in either the hard sciences (medical or pharmaceutical fields and research and development) or applied mathematics (actuary, finance, tax). Only two, Creative Director and Design Manager, are in the creative arts fields; the rest are in the business management or legal professions.

While it is not necessary in the world that is emerging as a result of the fourth industrial revolution for technology users to themselves understand how computers were made, it is still eminently useful to be familiar (and comfortable) with all components of science, technology, engineering and mathematics, especially the latter. Data analysts are needed to go beyond the standard descriptive statistics and first-order analyses that can be derived from big data. Digital creative arts apply technology in many truly innovative ways but these are all fundamentally underpinned by STEM concepts. Sound mixers

and digital effects artists can create magic with their output but will forever be constrained by what the software and technologies can do. The difference between Hollywood special effects from the 1950s and now can be directly measured by the increases in computing power and capabilities since then, harnessed by capable scientists, especially mathematicians, able to compute literally at light speed using computers, the movement of dinosaurs, the effects of lighting on space ships, and bringing worlds long lost back to life. Combining Jamaicans' innate (and disrupter-proof) creativity with the emerging possibilities in technology, especially in AI, will create a future rich with high-value possibilities here.

Jamaica has already officially launched a STEM strategy for education, with several schools designated as STEM academies. As a result, there have been moves in the right direction to orient the country in a direction consistent with a globalized world and its demands for workers, products and services. Jamaica's Vision 2030 already includes an ICT strategy that seeks to chart the way into the future for the country. This addresses government-led approaches, albeit with contributions from the private sector and academia. There have been considerable achievements already towards getting many of the bureaucratic systems to adopt technology for activities ranging from tax collection and customs to the Tablets in Schools programme. The wider Jamaican society is already seeing fundamental changes in access to technology through ubiquitous usage of cellular phones, especially smartphones. The World Economic Forum's Global Competitiveness Report for 2014-2015 ranked Jamaica 43rd out of 144 countries in terms of availability of the latest technologies – not terrific but certainly far from terrible. Jamaica will need to continue to evolve a true technological culture – and its different derivative data products – that goes beyond seeing technology as peripheral tools and novelties but rather, as interwoven into individual lives and collective societies, of the rural and urban, and the rich and poor.

Conclusions



Technology is neither bad nor good. It is, by definition, a tool that is developed and wielded by humans. Even though machines may create machines, ultimately, they were designed and coded originally by humans.

Undoubtedly, technology has changed billions of lives and is singularly responsible for the current state of human civilization, for better or for worse. Young people, with their inquisitiveness and relative facility for trying and adopting new things, are the greatest users and beneficiaries. Today, however, regulators are concerned about exposure of children to certain types of media content, as citizen viewing migrates to non-traditional platforms of delivery. And as the fourth Industrial Revolution – the age of cyber-physical connectedness – gets under way, young people have a crucial role: they are often the creators of the technologies they use. They no longer need teams of wiser and older engineers to develop new systems and products for them. They simply ride the waves of existing technologies, reading the tea leaves of social trends and, coming up with entirely new ways to communicate, buy, sell, travel and do business, develop lucrative products we never knew we needed but now find that we cannot live without.

Challenges remain, from the benign (interpersonal attitudes, antisocial behaviours, obesity and other public health concerns) to the decidedly malignant (cyber-bullying, scamming, terrorism) and everything in between, including propagating ignorance through fake news. It is important to remember that, for all its capabilities, technology will remain a tool, able to be wielded for good and bad intentions. Greater social intervention programmes that instill proper values in people, especially the young, will be of paramount importance. Such programmes do not need to even be technology-based but could still be conveyed through the technologies that young people utilize.

The greatest inter-generational challenge the world faces is climate change and those most vulnerable, bar none, are the young people who stand to inherit the planet. At the same time, technology also presents opportunities to fix the environment. So-called clean technologies offer billions of US dollars in opportunities which, through innovation, can yield low or zero emissions from energy production, more efficient use of packaging and recycling and a smaller environmental footprint, even as the world's population is slated to reach 10 billion by mid-century. This is the business case for supporting climate change investments and innovation – not just saving the planet for the planet's sake. In fact, clean technology, along with biotechnology, is forecast to be the next significant wave of innovation after the previous waves of innovation – steam and railways (1830-1875); steel, electricity and heavy engineering (1875-1920); oil, automobiles and mass production (1910-1975); information and telecommunications (1971-present) – that accompanied the previous four industrial revolutions (Stern, 2015).

The transformative influences that technology provides for both individual upliftment and societal change cannot be denied but it will be the non-technological elements that will be crucial in determining the extent to which change will occur, for better or for worse. If technology alone can change the world as we know it, then the machines have already taken over.

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