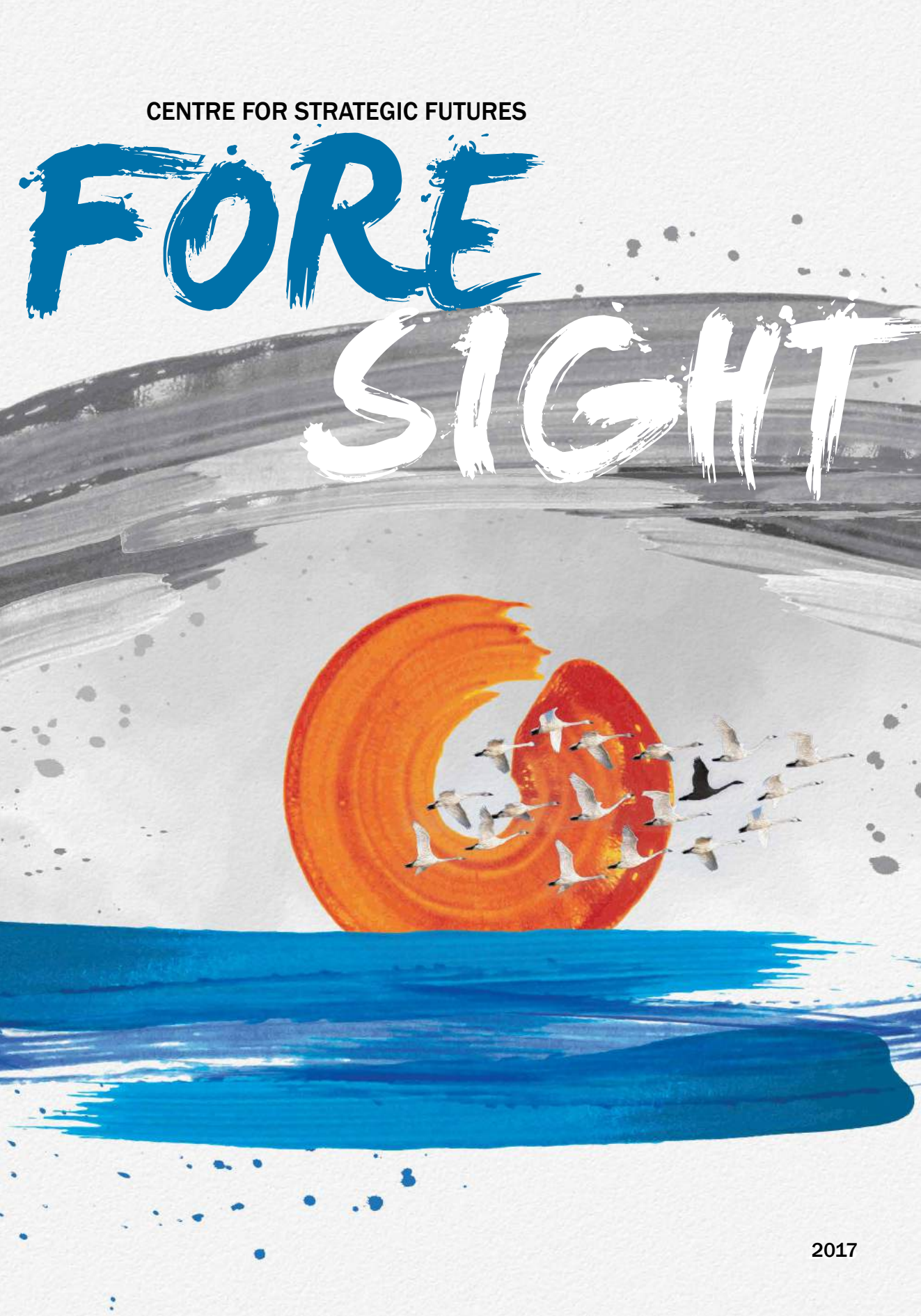
CENTRE FOR STRATEGIC FUTURES

FORE SIGHT



2017

About the Centre for Strategic Futures

The Centre for Strategic Futures (CSF) was established in early 2009. Since 1 July 2015, it has been part of the Strategy Group in the Prime Minister's Office. This situates it at the heart of the government, with the ability to reach across agency stovepipes.

The Centre is very much like a think tank within government, with the freedom to focus on issues of strategic importance even if they were not perceived to be immediately urgent.

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Foreword

This year marks 20 years of scenario planning in the Singapore government, beginning with our first set of national scenarios in 1997. Since then, we have created a further five sets of national scenarios and trained thousands of public servants in "the gentle art of re-perceiving", as the father of scenario planning at Shell, Pierre Wack, eloquently described it. I have personally been involved in this journey since the first set of scenarios, and it is an opportune time to reflect on what we have learnt along the way.

We have come to recognise that the pace of change is accelerating, and interdependencies grow in complex ways. Disruptive technologies such as artificial intelligence, robotics and additive manufacturing are upending current economic structures, while increasing global connectivity is changing the face and texture of social connections. Cyberspace is rapidly altering the nature of cooperation and conflict. We are also facing political and social upheaval in the global environment—the UK's vote for Brexit and the US Presidential election are but some examples—the causes and implications of which are as yet unclear. The team at the Centre for Strategic Futures (CSF) has spent some time exploring such connections among these changes over the last two years and their findings are contained in this volume.

As the complexity of the global system grows, we must develop new capabilities not only to survive, but thrive—to be, to borrow Nassim Taleb's now famous term, antifragile. Strategic foresight continues to help Singapore evolve to meet the wicked problems of the future which require us to reach across silos and adopt an interdisciplinary approach. In recognition of this, CSF is now housed in the Strategy Group, which was set up in 2015 as part of the Prime Minister's Office. It embeds a long-term lens in the Strategy Group, which is responsible for identifying whole-of-government priorities early, strengthening coordination across ministries and agencies to address these priorities, and translating them into policy plans.

We have often viewed Singapore's size and lack of natural resources as constraints. But in this complex environment, our compact size and small population allows us to take a systems approach to issues. Constraints can be turned into opportunities if we are prepared to be bold, imaginative and innovative in our search for new solutions.

Peter Ong
Head, Civil Service

Welcome Note

We live in curious times. Indeed, a Martian observer of Earth would have found the past two years a thrilling ride. In 2015, the US joined the world in a deal to address climate change and concluded negotiations for a trade agreement with 11 countries known as the Trans-Pacific Partnership. However, barely two years later, Washington abruptly withdrew from both. In 2016, a Google-led artificial intelligence (AI) system fascinated us with its triumph over the world's second-best Go player, while the WannaCry ransomware attack in 2017 painfully exposed our growing reliance on technology. The stomach-churning twists and turns within the last two years have confounded many and have certainly influenced our research agenda.

The impact of technology, particularly the digital revolution, has been a major research theme, where we explored the potential futures which could emerge. Catalysed by digital connectivity, the sharing economy could reinvigorate communities. Work could become increasingly location-independent as people tap web-based platforms, as well as augmented and virtual reality technologies, to work and collaborate remotely. The impact of the digital revolution and its confluence with other technologies, such as the life sciences and agriculture, will also be a fascinating space to watch.

The difficulty of predicting how societies behave and respond to changes has grown apparent in the past two years—pollsters, for instance, have been proven wrong on multiple occasions. For those of us undertaking foresight work, it underscores the point that as we strive to keep abreast of scientific breakthroughs and technological advances, their social and governance implications cannot be neglected. Whether it is a low-work economy as the Fourth Industrial Revolution displaces workers and alters the nature of work, or ethical dilemmas around the behaviour of AI systems, we may soon be confronting a future radically different from today. It will be more important than ever that we anticipate and prepare for them.

Scenario planning has helped us to explore changes in the operating environment and remains a key part of our futures toolkit. Nevertheless, the accelerating rate of change makes it imperative that we complement it with a more modular and timely approach to pick up emerging signals, to explore and generate awareness of their strategic impact. We share some of the issues that we have picked up in the new "Emerging Strategic Issues" section of this edition of *Foresight*.

In this volatile and surprising world, the demand for foresight is greater than ever. The work of foresight is never a solitary endeavour and we are grateful to the network of thinkers, futurists and leaders who have shared their insights with us. As you peruse this edition of *Foresight*, we welcome your thoughts and comments on the issues that we touch on. We would love to hear your take on the curious times we live in.

Joan Moh
Head, Centre for Strategic Futures

2015-2016 Highlights

By Leon Kong

The mission of the Centre for Strategic Futures (CSF) is to position the Singapore Government to navigate emerging strategic challenges and harness potential opportunities. We experiment with and apply a range of foresight tools to research and analyse issues of strategic importance to Singapore. Through our work, we seek to support and enable better decision-making, and develop a collective instinct and capacity for strategic thinking across the government. This article provides a summary of CSF's work in 2015–2016.

Foresight is the ability to consider and plan for the future. For CSF, our foresight practice has a strong focus on exploring multiple possible futures which may not be top-of-mind for decision-makers in the Singapore Government. Our ability to play this role has been strengthened with CSF's move from being housed under the Public Service Division to the Strategy Group under the Prime Minister's Office, which was set up in July 2015 to strengthen whole-of-government planning and execution, and tackle long-term, cross-cutting issues. This move has allowed CSF to more closely link and translate foresight into strategy and decision-making—because we have a clearer sense of the Government's policy priorities and are better able to incorporate longer-term uncertainties into government strategy discussions.

There is, of course, a tension inherent in foresight work. CSF's work needs to walk the tightrope between challenging agencies' current operating paradigms and being accepted as relevant by these agencies. Nevertheless, as we continuously calibrate that balance, we believe that our sharpened focus on the foresight-to-strategy process, or what we term "F2S", has helped our futures work create greater impact.

- Whole-of-government scenario planning is a key function played by CSF. In recent efforts, the CSF team has developed new ways of bringing interim research products, even prior to the scenarios themselves, towards policy discussions. The deck of Driving Forces 2035 cards, which we published in late 2016 even as we were drafting the scenarios, were the culmination of an inter-agency foresight effort involving more than 80 public officers across government to look at forces that would shape Singapore's future operating context. We have also taken pains to innovate in the way scenarios could be communicated, experimenting with a 10-minute video drama depicting what life might be like in each of these three scenarios, and an immersive scenario game. Our reflections on this can be found in the article *Communicating Scenarios: The Gentle Art of Inception* in this volume.
- To enhance our ability to cope with institutional surprises, we further systematised our Emerging Strategic Issues (ESI) process, which seeks to pick up weak signals on the horizon. Prior ESI exercises were conducted every few years, with our last round being in 2012. In that exercise, we shortlisted issues that agencies collectively assessed would have a significant impact on Singapore, but that the Government was less prepared for. Since then, we have started identifying ESIs on an ongoing basis and engaging agencies on the ESIs—to shortlist issues that have the most strategic impact for deeper research. Pages 66-70 contain a selection of the ESIs that we have picked up.

- Deeper dives into selected topics have had resonance within government, drawing greater agency attention to emerging issues. To give but two examples, one deep dive explored the possibility of establishing rules for outer space as a new commons, and another explored the potential for the supply of food to peak in the future, and the opportunities and threats in such a scenario. Articles about our research in these areas can be found in this volume of *Foresight* (see pages 30-35 and page 68).

ENGAGEMENTS AND COLLABORATIONS

The practice of foresight entails the seeking out and systematic interrogation of uncertainties. This requires exposure to diverse and fresh perspectives to counter inherent cognitive biases. As such, CSF not only harnesses and draws together ideas from within government, but actively seeks them without.

Foresight Conference

The biennial Singapore Foresight Week, which is the flagship event for the foresight community in Singapore, was held in 2015. CSF's Foresight Conference was held as part of the week's events, on the theme of "Global Cities: Flows, Space and Flux". This topic allowed us to examine the outsized influence global cities in particular had on the flows of people, capital, resources, knowledge and innovation, in light of the trends of urbanisation and immigration around the world.

With valuable help from our Distinguished International Fellow and chief facilitator Dick O'Neill, the event brought together an eclectic and multi-disciplinary group of thinkers, including:

- Thomas Malone, Founding Director, MIT Centre for Collective Intelligence, whose research focuses on how work can be organised in new ways exploiting the possibilities of information technology
- Sander van der Leeuw, Distinguished Sustainability Scientist, Julie Ann Wrigley Global Institute of Sustainability at Arizona State University, an anthropologist whose research interests include complex systems theory and archaeology
- Vinay Gupta, Global Resilience Guru, one of the world's leading thinkers on managing global system risks including poverty, development, and environmental crises
- Peter Schwartz, experienced futurist and technologist with Salesforce, and another of CSF's Distinguished International Fellows
- Tyler Cowen, Professor of Economics, George Mason University, who has written extensively on the economics of culture

In the discussion of global cities, the idea of virtual cities or communities as another form of organisation in the future captured the attention of participants. This led to the question of how new online platforms for interaction might lead to new paradigms of organising labour. As another thread of this tapestry, if labour could be almost entirely de-linked from geographical location, would this lead to the widening of the "gig" economy? What social challenges might this pose? How would this change the competition among global cities to attract high-skilled labour? The sharing economy was also a topic of much discussion, and the potential to harness value from this development piqued the interest of policy-makers.[1]

Focussed engagements

Beyond the Foresight Conference, CSF regularly engages with original thought-leaders in different fields, linking them with policy-makers in different parts of government to explore issues of mutual interest more deeply, and inject fresh perspectives.

- **Professor Mariana Mazzucato**, author of *The Entrepreneurial State*, visited in July 2015 for a round of robust conversations with agencies involved in setting Singapore's S$19 billion research, innovation and enterprise strategy for 2016 – 2020. Her visit yielded rich discussions on the role of the state in driving innovation, best practices in encouraging innovation, socialising risks and rewards from innovation, and shaping the public discourse about the role of the state in innovation.

- During a week-long visit in early 2016, sharing economy expert **April Rinne** conducted workshops for policy-makers and engaged with entrepreneurs to deepen the collective understanding of the sharing economy. A wide range of topics were explored, including regulatory challenges, the social value that could be unlocked through the sharing economy and emerging trends in this space, such as new ownership models. CSF's interview with April Rinne on some of the newer aspects of the sharing economy is included in this volume of *Foresight*.
- **Dr Catherine Fieschi**, Executive Director of London-based think tank Counterpoint also made several visits to Singapore hosted by CSF and the Civil Service College. She shared her rich expertise on narratives, social cohesion and national identity with many agencies in the Singapore Government. CSF's own exploration of narrative frames and experimentation with an ethnographic approach towards understanding how Singaporeans think and speak about the future has also benefitted greatly from her observations around cultural anxiety, class and populism in Europe.

Among many others, some of the experts that we spoke with and are deeply grateful towards for their generous sharing of insights include Professor Itzik Ben Israel, Chairperson of the Israel Space Agency, Parag Khanna, author of *Connectography: Mapping the Future of Global Civilization*, and Professor Huw Price and his team at the Centre for the Study of Existential Risk. With our continued attention to complexity science and how it can inform policy and foresight, we also benefitted from interactions with Professor Yaneer Bar-Yam, complexity expert and Founding President of the New England Complex Systems Institute, as well as Professor Geoffrey West and Professor Luis Bettencourt from the Santa Fe Institute. We have also interacted with foresight practitioners in other governments and think tanks, including those of Oman, the UAE, Japan, Korea, the US, UK, Finland and the Netherlands, and are appreciative of their continued candid sharing of their challenges and innovations.

Expanding Networks

CSF recognises that diversity in thought goes well beyond that of academic discipline or area of expertise; perspectives are shaped by culture and national context. As such, CSF actively seeks out connections from a range of countries abroad.

Our travels in the last two years brought us not only to developed countries, but also to developing ones. Notably, we strengthened and expanded our networks in the two largest countries and among the fastest growing economies in the world: China and India. There, we uncovered and explored perspectives less discussed or understood by the intellectual currents of the English-speaking and Western world, such as R&D trends in the Chinese-speaking world, and alternatives to export-led growth that are being contemplated by segments of Indian society. We also participated in workshops and events with other foresight institutions sharing similar interests: Finland's Social Innovation Fund Sitra and Japan's National Institute of Science and Technology Policy (NISTEP).

> *"The ecosystem of futurists has grown across government, and consequently, CSF's role has also expanded from being a trainer to convenor of the foresight community of practice."*

CAPABILITY BUILDING

CSF continues to play a capability development role for the futures ecosystem within the Singapore government. We run the Futurecraft suite of courses at the Civil Service College, which equips futures officers with methods and approaches for futures work. With other teams in the futures ecosystem now experimenting with new approaches, we have begun to incorporate more practitioner-led sharing, where futurists from other units also share their experiences and takeaways from projects they have undertaken.

The ecosystem of futurists has grown across government, and consequently, CSF's role has also expanded from being a trainer to convenor of the foresight community of practice. We engage the rest of government on emerging issues by convening topical discussions. This serves to sensitise policy-makers to longer-term issues and importantly, to the concerns of their colleagues in different agencies, thereby catalysing a whole-of-government conversation. Some of the themes for our roundtable discussions in the past two years include:

- **Virtual Singapore and the Human Cloud**. With advances in digital connectivity and new modalities of interaction such as Virtual Reality (VR) / Augmented Reality (AR), CSF brought participants from government, academia and the private sector together for several discussions on the implications of these technologies. One discussion looked at the "Human Cloud", or the growth of location-independent high-skilled knowledge work, and its impact on the global labour economy.
- **The Perfect Storm**. Framed against the then-upcoming 2016 US Presidential Election and the shock of Brexit, this expansive discussion explored the short to medium-term consequences of a "Perfect Storm" scenario: a confluence of global political and economic trends that, taken together, could have significant impact, both positive and negative, on Singapore.

> *"As foresight practitioners, our role is not to predict the future, but to prepare decision-makers so that we shape the future we will come to own."*

- **Climate Change**. Seeking to deepen the systems-level view of climate change, this roundtable focused on its second and third order impacts, their implications for Singapore, and possible responses. It was an opportunity to connect the dots, ranging from how the international climate change agenda might evolve, to the impact of volatile weather on food and water security, and emerging public health threats. What emerged was a reiteration that building social resilience was a critical strategy that would be needed to navigate the risks and opportunities ahead.

AND THE FUTURE?

In our next edition of *Foresight*, when we look back, we foresee reviewing another eventful, if not harried, two years. It has never been clearer how much the world is in flux, and consequently, the range of its possible futures. As foresight practitioners, our role is not to predict the future, but to prepare decision-makers so that we shape the future we will come to own.

NOTES:

1 Highlights of the Foresight Conference discussions in 2015 are available at http://www.csf.gov.sg/docs/default-source/default-document-library/foresight-conference-2015-proceedings.pdf.

Society at Risk

Hunting Black Swans and Taming Black Elephants

Adapted from a speech by Peter Ho, Senior Advisor, Centre for Strategic Futures, at the Para Limes Conference on "Disrupted Balance—Societies at Risk" *on 5 December 2016, in Singapore*

DISRUPTION IS A CERTAINTY

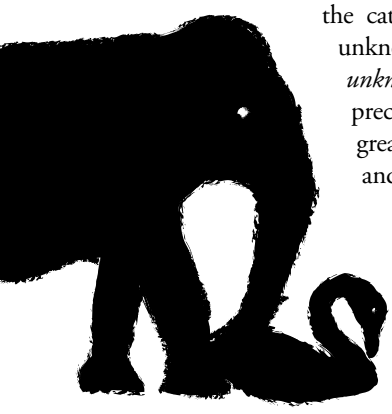
Disruptions are disturbances to the normal flow of life—a cyber-attack, a new virus, a violent storm, civil unrest or economic turbulence. They happen because we live in an interconnected world. What happens in one part of the world can affect other parts of the world—the so-called butterfly effect which postulates that the flap of a butterfly's wings in Brazil can set off a tornado in Texas. The core concept is that small changes in initial conditions can have large effects.

Globalisation, the internet and urbanisation increase, accelerate and intensify these connections. Events and actions in different parts interact with each other in complex ways, to produce effects that are emergent, and often surprising and disruptive. As connections intensify, the frequency of disruptions will increase and the amplitude of their impact will grow.

As Singapore's founding Prime Minister, the late Mr Lee Kuan Yew said, "The past was not preordained, nor is the future. There are as many unexpected problems ahead as there were in the past."[1]

BLACK SWANS AND BLACK ELEPHANTS

Some of these unexpected problems, or disruptions, will be of the *black swan* variety: rare, hard-to-predict events with a large impact. Many disruptions—natural disasters, pandemics, even financial crises and political upheavals—do not fall into the category of black swans or Donald Rumsfeld's unknown unknowns. Instead, they are either *known knowns*, or *known unknowns*. Yet people and governments often fail to take precautions against these issues because they tend to give greater weight to present costs and benefits, than future risks and opportunities.



This leads me to a new member of the menagerie, the *black elephant*. It is a cross between a *black swan* and the proverbial *elephant in the room*.[2] The black elephant is a problem that is actually visible to everyone, but no one wants to deal with it, and so they pretend it is not there.

> *"People and governments often fail to take precautions against these issues because they tend to give greater weight to present costs and benefits, than future risks and opportunities."*

When it blows up as a problem, they all feign surprise and shock, behaving as if it were a black swan.

One example is the 2013 small Ebola outbreak in Guinea which ballooned into an international health emergency in 2014. Over 10,000 people died, and the economic cost to the affected nations in West Africa was estimated to be in the range of billions of dollars.[3] But it could have been nipped in the bud if the appropriate actions had been taken at the start.

Unfortunately, the tendency of the human mind is to underestimate both sudden crises, as well as slow burn issues. The result is organisational hesitation: until events reach crisis proportions, no one takes any action.

RESILIENCE AND ANTI-FRAGILITY

Building resilience can help societies to be ever ready for such disruptions. Judith Rodin, the former president of the Rockefeller Foundation who launched the 100 Resilient Cities initiative, provides a good definition: "Resilience is the capacity of any entity—an individual, a community, an organization or a natural system—to prepare for disruptions, to recover from shocks and stresses, and then to adapt and grow from a disruptive experience."[4] Nicholas Nassim Taleb argues that if fragile things break when exposed to stress, then something that is the opposite of fragile would not just hold together when put under pressure. Instead, it would actually get stronger.[5] He calls this the quality of "antifragility". Indeed, resilience goes beyond bouncing back and growing from *only* crises. To quote Rodin, it is also about "achieving significant transformation that yields benefits even when disruptions are not occurring."

THE CASE OF SARS IN SINGAPORE

On 25 February 2003, the SARS virus entered Singapore through three women who had returned from Hong Kong with symptoms of atypical pneumonia.[6] They had contracted what became known as the Severe Acute Respiratory Syndrome, or SARS, which is thought to have emerged in Guangdong Province sometime in November 2002.

The virus then spread with frightening speed through the hospital system.[7] It confounded our medical authorities. They did not know how the virus spread, and why it spread so aggressively. The fatality rate was shocking. Then-Prime Minister Goh Chok Tong told the BBC in April 2003 that this was a "crisis of fear".[8] Overnight, visitor arrivals plunged and the entire tourism industry came to a grinding halt. SARS severely disrupted the Singapore economy, in the second quarter of that year. By the time the SARS crisis was declared over in Singapore, 33 people had died out of the 238 reported cases.

> *"SARS was a black swan for Singapore. There will be more of such crises. When the normal flow of life is disrupted, societies will need resilience to cope."*

SARS was a *black swan* for Singapore. There will be more of such crises. When the normal flow of life is disrupted, societies will need resilience to cope.

A RESILIENT RESPONSE TO SARS

Singapore's response to SARS was a resilient one. One of the most critical early decisions was to designate SARS a national crisis, and not just a public health problem. This meant that all the resources of the government and nation could be harnessed in a whole-of-government approach to tackle the *wicked problem* of SARS. The SAF and Police put entire divisions at the disposal of the health authorities.[9] Within weeks, MINDEF's Defence Science & Technology Agency (DSTA) and DSO National Laboratories developed a contact tracing system, as well as the now world-famous infrared fever screening system. These innovations came to epitomise the can-do and inventive attitude in Singapore during the crisis.

> *"Governments, like any large hierarchical organisation, tend to optimise at the departmental level."*

WHOLE-OF-GOVERNMENT AND WHOLE-OF-NATION

The whole-of-government approach adopted for SARS had a compelling logic. People from different organisations, both *within* and *outside* government, came together to pool their knowledge in order to discover potential solutions for dealing with the deadly SARS outbreak, and to combine their resources to meet the demands of the crisis.

While the whole-of-government approach may be an imperative, it is not easily achieved. Governments, like any large hierarchical organisation, tend to optimise at the departmental level rather than at the whole-of-government level. Whole-of-government responses to contingencies must be practised, otherwise the "muscle" of the government machinery becomes flabby and atrophies from lack of use. That is why periodically in Singapore, there are exercises on the ground involving not just the authorities and uniformed groups, but even members of the public.

EFFICIENCY VS RESILIENCE

Singapore's response to SARS could not have been achieved if the government had been organised with an obsessive focus on efficiency and optimisation. Taleb—the statistician and risk analyst who popularised the term "black swan"—notes that when disruptions occur in overly-optimised systems, "errors compound, multiply, swell, with an effect that only goes in one direction—the wrong direction."[10]

To deal with disruptions, governments must go beyond an emphasis on efficiency. Lean systems that focus exclusively on efficiency are unlikely to have sufficient resources to deal with unexpected shocks and volatility. As Taleb notes, "Redundancy is ambiguous because it seems like a waste if nothing unusual happens. Except that something unusual happens—usually."[11]

> *"One important idea is for resilient governments to have a small but dedicated group of people to think about the future systematically, who will identify contingencies to be planned for, and emerging risks over the horizon to be managed."*

If disruption is inevitable, how can we develop a system that is resilient to such shocks? One important idea is for resilient governments to have a small but dedicated group of people to think about the future systematically, who will identify contingencies to be planned for, and emerging risks over the horizon to be managed. The skill sets needed are different from those required to deal with short-term volatility and crisis. This group should be allocated the bandwidth to focus on the long term without getting bogged down in day-to-day routine. By improving the ability to anticipate such shocks, governments might reduce their frequency and impact. *[See Text Box 1]*

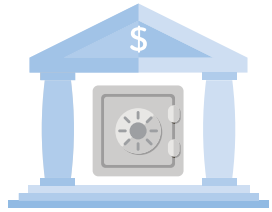
Text Box 1: How Singapore Builds Capacity to Anticipate and Cope with Change

SkillsFuture is an example of how Singapore tries to "future-proof" the workforce by establishing a norm of lifelong learning, and by creating the infrastructure to make quality continual education possible. Because it is not always possible to predict manpower trends accurately, having a system in place to encourage upgrading, and a culture that encourages lifelong learning, will help Singapore and Singaporeans ease through changes and uncertainties in the employment landscape. It is part of a larger effort to ensure that Singapore remains resilient in the face of uncertainty and future shock.

Another part of the answer is the availability of reserves, whether natural resources or other kinds of national reserves built from prudent planning. These are insurance for contingencies. The SAF and its supporting organisations like DSTA and DSO are reserves of the nation. Without that "fat" in the system, it is doubtful that Singapore would have been able to respond to the SARS crisis as effectively as it did. *[See Text Box 2]*

Text Box 2: Different Kinds of Buffers

Singapore's government has also ample national reserves from the savings and surpluses of the government budget. During the 2007–2008 global financial crisis, the Singapore government for the first time drew on the national reserves in the form of a S$20.5 billion Resilience Package.* This was primarily aimed at preserving and enhancing business competitiveness as well as promoting job retention, during a period of great uncertainty. A key aspect involved encouraging firms not to retrench workers, but to support retraining programmes, as well as temporary part-time arrangements. Once the world economy began to recover, Singaporean firms were able to respond with alacrity and speed to "catch the winds" of global economic recovery.



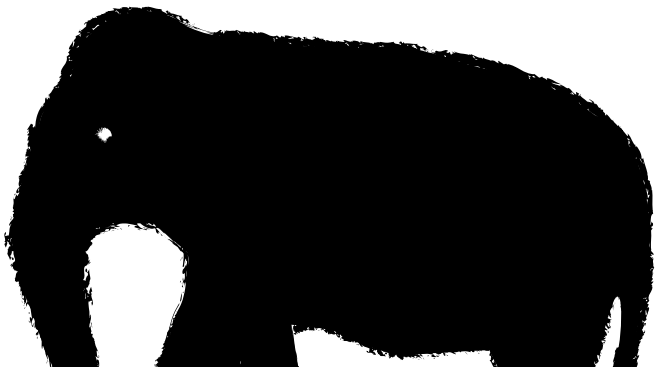
*"Budget 2009: Resilience Package", Ministry of Finance, Singapore, 5 February 2009, accessed 12 April 2017, http://www.singaporebudget.gov.sg/budget_2009/resilience.html

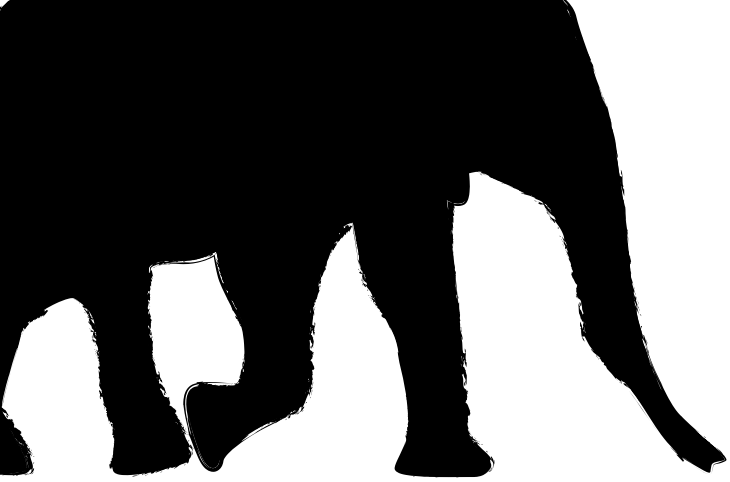
OVERSHOOTING VS UNDERSHOOTING

During the SARS crisis in Singapore, the authorities did many unprecedented things, including contact tracing, temperature screening, and home quarantine.[12] Electronic monitoring bracelets were issued in order to enforce quarantine orders. A security company, Certis CISCO, was deployed to keep track of people quarantined at home. Initially, these measures were denounced in the western press as "draconian". But later on, many of these measures were quietly adopted by other cities afflicted by SARS. Being prepared to take such aggressive measures was a key part of an effective response to the SARS crisis.

In the April 2003 BBC interview, then-PM Goh said, "I'm being realistic because we do not quite know how this will develop…If it becomes a pandemic, then that's going to be a big problem for us…I'd rather be proactive and be a little overreacting so that we get people who are to quarantine themselves to stay at home. The whole idea is to prevent the spread of the infection."[13] In other words, when dealing with serious disruptions where there is a lot of uncertainty, it is often better to *overshoot* rather than *undershoot*.

> ***"Singaporean leaders told people not only what they knew, but also what they did not know. They shared their concerns. They avoided providing false assurances."***





TRUST

Another issue was also at play: fear. Even in financial crises, as in 2008 after Lehman Brothers collapsed, fear can go viral. As Franklin Roosevelt said during the Great Depression, "The only thing we have to fear is fear itself."

The dissemination of trusted information is one way of managing fear. During the SARS outbreak, Singapore's approach was a textbook example of full transparency. The government gave the World Health Organisation (WHO) unfettered access to information.[14] Every afternoon during the crisis, all the data and information collated from the previous 24 hours was presented at a conference chaired by the Director of Medical Services. WHO observers attended it. They had access to the same raw data as Ministry of Health (MOH) officials. The government also laid bare the uncertainties and risks during SARS.[15] Singaporean leaders told people not only what they knew, but also what they did not know. They shared their concerns. They avoided providing false assurances.

This transparency built on underlying trust, not just of the people in the government, but also of the government in the people. Singaporeans trusted the government for its effectiveness and integrity. The government trusted Singaporeans to deal with the uncertainty as the SARS outbreak unfolded. This two-way trust, between the government and the people, formed a deeper source of national resilience in Singapore during SARS.

FEAR AND THE MERS OUTBREAK IN SOUTH KOREA

South Korea had a different experience during the outbreak of the Middle East Respiratory Syndrome (MERS) virus there. On 20 May 2015, South Korea reported its first imported case of MERS.[16] By the time Seoul declared that outbreak over, nearly 17,000 people had been quarantined, 186 people had been infected and 36 people died. Thousands of schools had been closed. Although the outbreak was eventually brought under control, the government was criticised for its slow response to the outbreak, and for stoking fears by failing to effectively communicate public health risks. In early June 2015, the Korea Centers for Disease Control & Prevention (KCDC) closed its Twitter account to the public, only to re-open it the following day.[17] As the *Korea Times* put it in an editorial, "adding to mounting public concerns was a lack of information—the exact area affected, the list of hospitals, the first patient and those infected by him—leading to the spread of groundless rumours and swelling [of] unfounded fears in a vicious circle."[18]

THE BLACK ELEPHANT OF TERRORISM

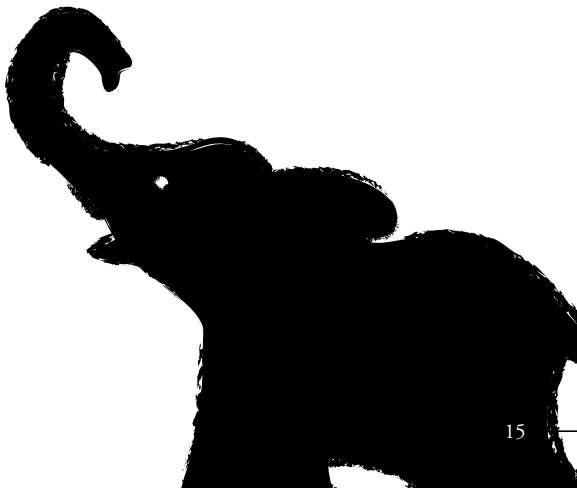
Terrorism is another black elephant. France is no stranger to terrorism inspired by a wide range of causes: Corsican nationalism, French nationalism, the Palestinian cause and lingering effects from Algeria's fight to gain independence from France in the 1950s–60s. With the rise of radical Islam and the emergence of the Islamic State, the problem has intensified. In recent years, France experienced the January 2015 attack on the offices of *Charlie Hebdo*, the satirical newsweekly. 17 people were killed.[19] In November 2015, the rampage of shootings and suicide bombings in Paris killed 130 people.[20] On Bastille Day in 2016, a 19-tonne truck rammed into crowds in Nice, killing 86 people.[21]

The French have shown remarkable resilience, even defiance, in the face of these attacks. Soon after the *Charlie Hebdo* shooting, "*Je suis Charlie*" became a powerful rallying cry. It symbolised support for the freedom of speech and freedom of the press. It was used as a hashtag on Twitter, and within two days, it had become one of the most popular news hashtags in Twitter history.[22]

Yet underneath the symbolic rhetoric, the fabric of society itself may be tearing. In the month after the *Charlie Hebdo* attack, there were at least 160 attacks on Muslim people and the Muslim community. This was more than the total number of attacks in 2014.[23]

To be sure, these tensions did not develop only after the attacks. In October 2005, two French youths of Malian and Tunisian descent were electrocuted as they fled the police in a Paris suburb. Nearly three weeks of riots followed, causing €200 million worth of damage and injuring 126 policemen and firemen.[24] Longer-term issues are at play here: social and economic exclusion, racial discrimination, and the capacity of the secular state to integrate cultural and ethnic diversity.

This has not been lost on the political actors in France. During his campaign for the 2017 presidential elections, Nicolas Sarkozy, a former president, vowed to ban the wearing of the veil in public and to take up the war against *burkinis* with new zeal.[25] Speaking after the Nice attacks, Marine Le Pen, leader of the National Front, said, "The war against the scourge of Islamic fundamentalism has not begun. It is urgent now to declare it."[26] In having to face down the black elephant of terrorism, the question is whether France's response is merely reactive, or whether it exhibits both resilience and antifragility.



TERRORISM IN SINGAPORE

Singapore has had its own brushes with terrorism. One was the 1974 hijack of Laju Ferry by members of the Japanese Red Army and the Popular Front for the Liberation of Palestine.[27] In December 2001, Singapore announced the detention of 13 members of the hitherto unknown Jemaah Islamiyah (or JI) terrorist network, dedicated to the establishment of a pan-Islamic caliphate in Southeast Asia. Since then, more than 66 people have been detained under the Internal Security Act for terror-related activities.[28]

Singapore has also beefed up security at soft targets. After JI was discovered, one urgent matter was to beef up the protection of Jurong Island, a vast petrochemical complex that had been designed for safety, but not for high-level security.[29] The new security measures not only dramatically strengthened the security of Jurong Island, but also became a selling point to investors. I would argue that it was an *antifragile* response.

> *"The cornerstone of Singapore's counter-terrorism strategy is a community response plan."*

Besides these concrete measures, the government has also taken care to ensure that the Muslim community remains integrated into the broader society, rather than give cause for alienation. The cornerstone of Singapore's counter-terrorism strategy is a community response plan. This enhances community vigilance, community cohesion and community resilience.[30] Singapore has built networks of community leaders and influencers by forming the Inter-Racial and Religious Confidence Circles (IRCCs). These leaders have helped strengthen the understanding and ties between different races and religions. Muslim leaders not only speak out against those who distort Islam, but also use the media, mosque and madrasah to assert mainstream Islamic values.

Singapore is also one of only six countries with structured programmes to rehabilitate and reintegrate terror detainees into society.[31] The Religious Rehabilitation Group (RRG) was set up in 2003 after the JI terror plots were thwarted. RRG counsellors, all of them trained religious scholars and teachers, have helped terror detainees understand how they had been misguided by radical ideologues.[32] Every released terror-related detainee in Singapore has undergone counselling as part of rehabilitation. The counselling sessions also extend to the family members of detainees. Most detainees have settled back with their families, found jobs and integrated back into Singapore society.

Just as trust between the government and citizens in Singapore predated SARS, strengthening the social fabric has been a key strategy since independence. Where migrants may concentrate around the *banlieues* of Paris, Singapore encourages social mixing. It uses quotas to avoid the build-up of racial enclaves in public housing estates. It has introduced a raft of policies to ensure that growth is inclusive: investments in public education, grants for skills training and tax credits for the working poor.

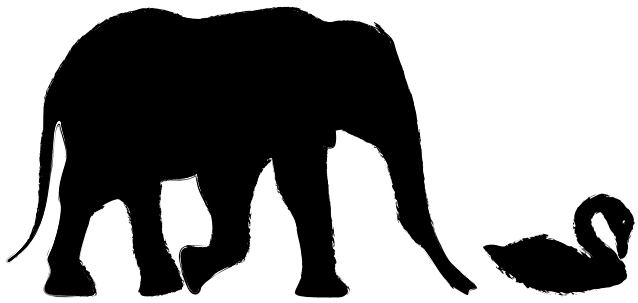
Strengthening the social fabric also means building antifragility through simulations. Simulations hone citizens' and agencies' instincts around how to respond in crises, and build the confidence that we can overcome crises. This psychological strengthening is part of what Singapore calls *Total Defence*. The most recent initiative in this vein is *SGSecure*—a national movement to sensitise, train and mobilise the community to play a part to prevent and deal with a terrorist attack. In 2016, a counter-terrorism exercise, dubbed Heartbeat, was held at the performing arts centre, the Esplanade, as part of the *SGSecure* initiative.[33]

"Just as trust between the government and citizens in Singapore predated SARS, strengthening the social fabric has been a key strategy since independence."

CONCLUSION

Terrorism and disease outbreaks involve diffusion—of ideologies and pathogens. Both are black elephants—risks for which societies typically put off preparations, or avoid talking about altogether. Measures to build resilience before such crises occur include having a dedicated capacity to think about emerging risks, and having redundancies and reserves in a system instead of only prioritising efficiency. During such crises, societies must have the adaptability to work across silos. Governments also need to engage the community for a whole-of-society response, build trust through transparent communication, and be prepared to overshoot in response to crises. These softer aspects are just as important as specific measures like quarantining; the underlying layer of trust and cohesion is what societies need to build in times of peace, even as they learn to hunt down black swans and tame the black elephants that will surely visit societies and countries from time to time.

We may not be able to pre-emptively hunt down all the animals in the menagerie of risk, but we can at least learn to live with them. This will produce better governance and better societies for all.



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Foresight Research Agenda

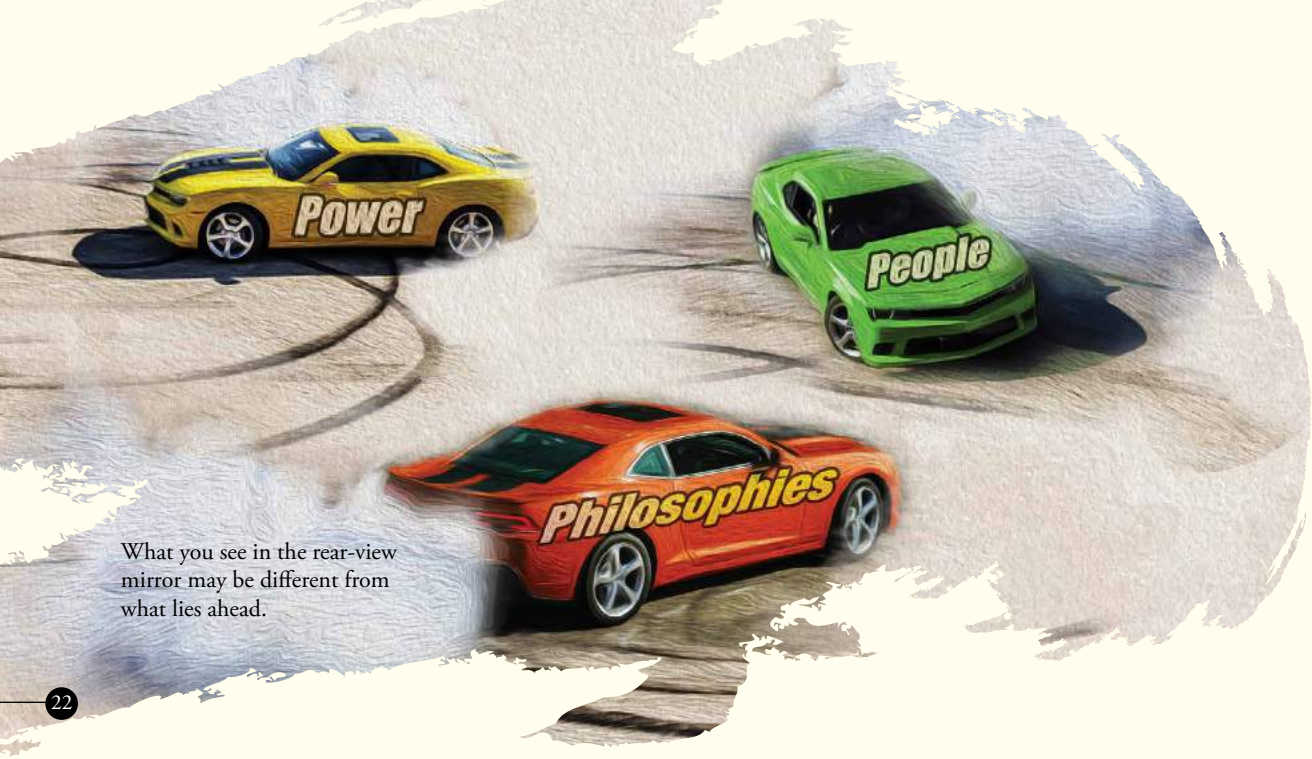
Power, People and Philosophies

By Jared Poon and Derrick Cham

The twentieth-century philosopher and mathematician, Bertrand Russell, told a story about a turkey who was fed on its first day at the farm. Intrigued by whether this would continue, the turkey collected data across a wide range of circumstances—rainy days and sunny days, whether it was the farmer or her husband who did the feeding, and so on. Finally, having amassed a robust dataset, the turkey felt confident that it would be fed every morning. Come Christmas Eve, however, it was killed and roasted.[1]

We are much like that turkey. And that is not a bad thing. Inductive reasoning of the sort the turkey used, where we work on the assumption that the future will be like the past, is a pillar of science. But it is good to be prepared for futures which are not like the past. Sometimes, projections fail. Sometimes, trends bend.

In 2015, CSF convened 80 public officers from the Singapore government to map the forces which might have an impact on the future of Singapore.[2] In an effort to avoid the fate of Russell's turkey, we focused on where the future might not resemble the past, identifying potential inflexions and locating where they may lie. In this article, we sketch various possible inflexions: in power, in how people interact with technological change, and in organising principles.



What you see in the rear-view mirror may be different from what lies ahead.

POWER

As Harvard University political scientist Joseph Nye has pointed out, power in geopolitics will shift from West to East. And in business and society, power will shift from the centre to the margins, in both the West and East. While shifts in power occurred in the past, we need to watch the particulars of the upcoming shifts: the return of the East as leaders in science and technology, not just as major economies; and the empowerment of marginal actors, such as social minorities and new platform businesses, who may grow into influential actors and even take on lead roles one day.

> *"It is good to be prepared for futures which are not like the past. Sometimes, projections fail. Sometimes, trends bend."*

The East will come to prominence in areas beyond economic and military strength, and into leadership in science and technology (S&T). China has become the second-largest economy in the world. Its geopolitical influence is growing through institutions, such as the Asian Infrastructure Investment Bank, as well as through military modernisation.[3] While these changes are well-known, China is now also aggressively pursuing S&T. President Xi Jinping described it as the "main battlefield of the economy" and innovation as the "engine of growth". China has lived up to these statements. Research and development (R&D) spending has risen from US$41 billion in 2000 to US$377 billion in 2015.[4] Their ambitions are grand. They plan to land astronauts on the moon in the next 15-20 years, build deep-sea platforms and sequence millions of genomes.[5] India, another rising nation in the East, has over 1,000 R&D centres and over 4,000 tech start-ups.[6] It has also taken on major projects, like launching 104 nano-satellites in a single rocket.[7] While China has a head-start over India—its R&D spending was equivalent to 1.8% of GDP in 2011 compared with 0.8% in India—the point is that both are developing their S&T capabilities.[8] Together, China's and India's rise to greater S&T prominence adds another dimension to the shift of power from West to East.

In business and society, power will shift from established centres to the margins, but will be unevenly distributed. It will flow to particular actors or groups of actors—new centres at the margins. For example, Bitcoin is a giant in the growing cryptocurrency space, and Kickstarter a new centre in the nascent crowdfunding space. We see the unevenness on the social side as well. Well-educated women of majority races in the West have arguably benefitted more from women's suffrage than minority women. Gay men have arguably benefitted much more from LGBT equal rights movements than trans-men and trans-women.[9]

However, the centres at the margins might gain influence and eventually rival the established centres of today. Just a few years ago, platform economy corporations, such as Airbnb and Uber, were marginal forces. Now, they have accumulated enormous power, sometimes at the expense of homeowners and drivers respectively, and have arguably become new centres in their own right. For example, Uber, once the outsider upstart, now earns more from business travellers in the US than traditional taxis and rental cars combined.[10] As they facilitate tens of millions of rides per week, Uber and other ride-sharing corporations have become a critical part of the infrastructure of some cities. Their newfound centricity could ironically cause them to lose much of the outsider's verve and dynamism, as governments consider regulating them in the same vein as traditional companies, mandating that they share a similar classification and that their freelancers be considered employees.

These power shifts in business, society and geopolitics will rely on the exploitation of a different set of resources, in the same way that oil emerged as a key resource in the twentieth century, shaping the course of economies and nations. In future, new resources, many perhaps lying latent and untapped today, will form the basis of power. For example, blockchain technologies like Bitcoin allow us to spin computing power into money; idle computing power, once worthless, has become a resource. Other things, currently unusable or inaccessible, might likewise become valuable resources: asteroids in outer space, the deep ocean, personal behavioural or biological information, and our attention. Even entire swathes of the earth may transform in value and usefulness, as existing cold regions grow warmer due to climate change and become more suitable for agriculture. Will Canada or Russia become the new breadbaskets of the world? What are the new resources beyond the ones mentioned, and which actors will rise to sudden and unexpected prominence?

PEOPLE

There is an implicit narrative about how the future will look: the big advances will be in "hard" disciplines like digital technology or material science.[11] After all, some of our most spectacular successes in recent history, from space travel to the internet to smartphones, have been founded on work in these hard disciplines. This, it is said, is why education in the STEM fields is of utmost importance, because those will be the jobs of the future. The common vision of the future is of gleaming computers and sterile glass and steel constructions. But perhaps we are at an inflexion point, and rumblings of this change are already starting to become visible.

> ***"While shifts in power occurred in the past, we need to watch the particulars of the upcoming shifts: the return of the East as leaders in science and technology, not just as major economies; and the empowerment of marginal actors, such as social minorities and new platform businesses, who may grow into influential actors and even take on lead roles one day."***

Perhaps the future might be far more *people*-centric than the past suggests, because what we think of as "technology" is becoming more and more integrated with our lives. As it does so, the relationship between technology and people deepens in three ways.

First, technology will have to understand people. Integration into our lives means that machines

> *"Perhaps the future might be far more people-centric than the past suggests, because what we think of as 'technology' is becoming more and more integrated with our lives."*

must be sensitive to how people behave and what they care about. It might have been enough for a car to be fast and powerful. An autonomous vehicle, however, needs to also understand when other drivers might slow down, when pedestrians might hesitate, and whether to swerve into a tree to avoid a gaggle of children crossing the street. It might have been enough for robots which assemble furniture to be strong and reliable. Caregiving robots, like the ones being developed jointly by Japan's RIKEN Brain Science Institute and rubber maker Sumitomo Riko, need also to understand human anatomy. And they need to be able to perform power-intensive tasks without inflicting pain.[12] Chat-bots, whether for entertainment or customer support, will need to learn enough to understand their interlocutors, but not too much. Microsoft's experimental chat-bot Tay, designed to learn how to speak like a millennial, had to be shut down because it learned too well from toxic elements of the internet community. It started tweeting horrifyingly racist and misogynistic comments within a day of her first contact with people outside the lab.[13]

Second, technology will have to be understood by people. Integration into our lives means that machines cannot be too alien—people resist genetically-modified foods in part because they do not understand them.[14] Conversely, as people understand a technology, they will often find it less alien, more acceptable. Indeed, technologies will have to be acceptable to, and accepted by, humans, with all our neuroses, irrationalities and obsessions.

Sometimes that means that the technology will have to cater to our preference for the familiar. Technologies are sometimes designed to replicate elements of previous designs. For example, folders on computers resemble real-life folders, while many phones and electronic cameras make a shutter-click sound when a photograph is taken, despite not having shutters. This is a design concept called skeuomorphism.

Sometimes that means that the technology has to be attractive—Apple made billions off the aesthetics of their phones and the user-friendliness of their user interface, not their superior technology.

And sometimes, that means that the technology has be sensitive to cultural variation. In the mid-1990s, BMW had to recall their 5 Series cars—they had installed a voice in these cars which could act as a GPS, but male German drivers were apparently unwilling to take directions from the female voice, because it was a "woman". [15]

Third, technology will help us understand people better. Several trends are converging to make it the case that there are unprecedented amounts of social data available for analysis. The "Quantified Self" movements take the form of people recording their caloric intake and blood sugar online or wearing Fitbits to track their exercise habits and sleep cycles. Millions of people log on regularly to virtual worlds like World of Warcraft or 天涯明月刀 (Moonlight Blade); all their behaviour, from how much time they spend with which other players, to how often they die from falling off high places, is meticulously tracked.[16] Platforms like Google, Tencent and Amazon track spending patterns, internet use patterns, and patterns of social networks. All this data is increasingly amenable to analysis as computing power increases and mathematical tools become more sophisticated.

There is a feedback loop between these various

relationships between technology and people. As technology helps us (that is, academics, governments and corporations) understand people better, we will in turn design technology that can better understand people, and be better understood. This encourages greater adoption and integration of these technologies into ever-deeper parts of our lives, in turn allowing us access to data that further improve our understanding of people. This lets us design technology that can even better understand people, and so on, in a virtuous loop.

If the future will in fact be so people-centric, then perhaps it will not be as alien as we fear, full of dystopian chrome and cold fluorescents. We might expect a big wave of advances in the intersection between technology and human behaviour. In such a future, which groups, which corporations, and which nations have the necessary mix of computer scientists, ethicists, linguists and anthropologists to make their mark?

"If the future will in fact be so people-centric, then perhaps it will not be as alien as we fear, full of dystopian chrome and cold fluorescents."

PHILOSOPHIES

It is hard to deny that the past few centuries have been Western centuries—the economic power and military might of the US and Europe were, and still are, unparalleled. Some of the philosophies characteristic of the modern West—globalisation, free trade capitalism and liberal democracy—have become the *de facto* organising principles of the world.

These three organising principles have advanced science, raised the standards of living of hundreds of millions, and freed many from tyranny, oppression, sickness and poverty.[17] While some hope that these principles will gain further traction, it is growing apparent that they may be threatened by the consequences they are producing.[18] Even as adherence to these philosophies have benefited many, some appear to have benefitted far, far more than others.

This inequality, along with growing awareness of it, has in recent years blossomed and borne strange fruit. The votes for Brexit in the UK and for President Donald Trump in the US were arguably expressions of a deep anger at the elite few who have hogged the rewards of progress.

Near-future advances in technology might stoke this anger by widening the gap between the elite and the rest. These advances might do so by making some tech-entrepreneurs astronomically wealthy, leaving others to scurry about in a gig-economy servicing them. But they might widen the gap in another way: while today's gap is mostly just a gap in wealth, technological advances could result in systemic gaps in the quality of personal traits such as intelligence, or ambition, or empathy. To see this, consider three truths about technology:

First, most, if not all, technology has always been about making us better at doing the things we do. For instance, writing makes us better at remembering things, cars make us better at getting from place to place and computers make us better at computation.

Second, technology will advance. Put together with the first truth, this means that technology is likely to *get better at making us better*. Writing made us better at remembering things. But augmented reality (AR) and artificial intelligence (AI) virtual assistants could help us record everything, make connections with old pieces of knowledge and external information, parse it according to our

personal interests, and retrieve it when relevant. Where writing performs as rudimentary exosomatic memory, it does well primarily by *encoding* information. AR and AI virtual assistants could perform not just the encoding of the information, but also the organising, the parsing, the connection, and the timely prompts for retrieval.

Third, there will be inequality of access. The rich and powerful will have easier, better, perhaps exclusive access to new technologies, whether it is new AI-assistants to organise their lives, new gene-editing programmes for their children, or new drugs for their health.

turbulence, the "China model" appears to offer political stability. Political philosopher Daniel Bell argues that the rise of China and Beijing's resolve to tackle longer-term challenges, for example, make the Chinese model of political meritocracy more attractive. This involves rigorous selection of top leaders based on performance over decades, at provincial and national levels, and on virtue.[19] Oman and the UAE are Gulf states ruled by monarchies whose legal systems extensively incorporate Sharia law. Yet they are widely reputed for high levels of modernisation and thriving economies. Others seek to smooth the rough edges of liberal democracy and free-market capitalism:

> ***"While today's gap is mostly just a gap in wealth, technological advances could result in systemic gaps in the quality of personal traits such as intelligence, or ambition, or empathy."***

Unless one of these three truths changes, the rich and powerful will get not just richer and more powerful, but also better all around. They will have access to technologies that are increasingly good at improving themselves as humans, making them smarter, healthier, more focused, more energetic, more charismatic, possibly more empathetic and more morally sensitive. And the poor will have much less access. In a world like this, the rich might begin to actually deserve and merit their wealth and privilege as better and more competent people overall—a true aristocratic class. What shape would the despair and existential rage of the non-elite take, when the distance between them and the elite becomes altogether impossible to cross?

But alternative organising principles are emerging. As the UK and US enter a period of political

inequality and marginalisation. Sitra, the Finnish Innovation Fund, for example, is developing a "New Democracy" to bolster inclusion—by providing more information to citizens so they can take part in decision-making.[20]

There are even more experimental attempts to redefine what progress itself means. The World Happiness Report, for example, attempts to measure various indicators of well-being, rather than just GDP.[21] While rich countries such as Norway and Denmark rank highly, even Bhutan, a poorer nation, has focused on happiness since 1972. It even incorporated the idea of Gross National Happiness in its Constitution in 2008.[22] And while the separation of state from religion has been a norm in the West, attempts are emerging to integrate religion with the state around the world.

We see this example in the culture wars between the left and the right in the US, as well as in the growth of Islamist leaders, political parties or policies in countries such as Turkey, Indonesia and Brunei.[23]

Which way the world will turn is uncertain. In developed Western countries, which of the organising principles of globalism, capitalism, and democracy will be the next scapegoat for deepening inequality? As alternatives to these organising principles appear on the scene, what will these countries do? In emerging economies like the African or Southeast Asian nations, where will they lean: towards globalisation, free trade capitalism and liberal democracy, or in new Chinese, Scandinavian, or Bhutanese directions?

WHAT THIS ALL MEANS

What we have tried to share are some of the inflexion points we potentially face. Some show up as shifts in power, some as shifts in the place of people in technological change, and some as shifts in the organising principles and philosophies of our societies. As we take a step back, we see that the future looks grim—inequalities threaten at every turn, resentment builds up everywhere, and existential threats abound. Yet, at the same time, the future looks bright—extreme poverty is falling, societies are more inclusive now than ever before, and technology holds promise to solve some of our hardest problems. It is uncertain if things are getting worse or if things are getting better, but one thing's for sure—to quote Bob Dylan, the times, they are a-changin'.[24]

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The Next Frontier in Power and Commerce: Outer Space

By Joanne Wong

Outer space has emerged as a new strategic arena. Competition among countries to project power through space is intensifying as technological advances and growing commercial interests make outer space more accessible. These advances hold the promise of resource exploitation and territorial claims for human settlements. There are early parallels between what is happening in space and what happened in the seas in the colonial era. While these parallels hint that developments in space might be disorderly, they also suggest how nations could work together in the next frontier—through global rules for the global commons.

SPACE POWER EMERGING AS THE NEW SEA POWER

Just as British sea power contributed to the rise of the British Empire in the 1800s, major powers are acting on the basis that space power will contribute to global influence this century.[1] In 2001, the US's Space Warfare Centre conducted the first in the Schriever war-game series. The scenario, set in an imagined future of 2017, depicted a large country threatening its smaller neighbour.[2] The exercise was designed to explore the requirements for space control, explore ways to counter advanced adversary space capabilities, and evaluate the enemy's ability to deny the US and its allies' space capabilities.

Apart from the US and Russia, which developed its Global Navigation Satellite System (GLONASS) during the Cold War era, other large nations are increasingly involved in space power projection.[3]

"Just as British sea power contributed to the rise of the British Empire in the 1800s, major powers are acting on the basis that space power will contribute to global influence this century."

Outer space is emerging as the next frontier for human activity, whether for economic development, power projection or even human settlement.

For example, the European Space Agency is currently developing the Galileo global navigation satellite system so that European states would not have to rely on the US military-operated Global Positioning System (GPS) or the Russian GLONASS.[4] The first two operational Galileo satellites were launched from Europe's Spaceport in October 2011, and subsequent launches took place from October 2012 to November 2016.[5] China has been developing the Beidou satellite navigation system since 1994. Beidou started providing coverage in China in 2000 and has since expanded to cover the Asia Pacific region, with plans to provide global coverage by 2020 through a constellation of 35 satellites.[6] China will build and launch the Hai Yang 3 (HY3) maritime monitoring satellite network in 2019.[7]

The big powers, moreover, are developing anti-satellite (ASAT) warfare capabilities.[8] In 2007, China conducted an ASAT weapons test, destroying one of its own defunct weather satellites.[9] It has conducted similar tests of nominal "missile defence" technology in 2010, 2013 and 2014. In 2008's Operation Burnt Frost, the US destroyed one of its own malfunctioning satellites using missile defence technology. India and Russia are also competing in this area. India is developing a missile defence system, which potentially offers ASAT capability, and conducted a test in 2014.

Apart from the great powers, an increasing number of countries are also investing in space systems and their downstream applications. 58 countries invested in space technologies in 2013, up from 37 in 2003. 22 other countries planned to do so as of 2013.[10] Although no explicit military application has been claimed, more than 90% of space technology is dual-use, meaning the vast majority of space technologies have a military application.[11] In January 2016, for example, India announced it would set up a satellite tracking and imaging centre in Vietnam to provide Hanoi access to signals from Indian observation satellites for civilian purposes.[12] However, observers say the move has military significance with regard to Vietnam's territorial disputes with China in the South China Sea.

TECHNOLOGICAL ADVANCES AND COMMERCIAL INTEREST: MAKING OUTER SPACE ACCESSIBLE

One of the drivers for the emergence of space as a strategic arena is technological advances. Just as chartered companies of the colonial era such as the Dutch East India Company sailed the world to explore and trade, space corporations may play a similar role. Today, private corporations collaborate and compete with national space agencies and this dynamic has already driven developments in space tourism, microgravity medicine, microgravity manufacturing and low-earth orbit satellite technology.[13] Following the Obama Administration's call for increased partnership and reliance on private aerospace companies, players such as SpaceX, Boeing, Blue Origin, and Virgin Galactic have contracted with the National Aeronautics and Space Administration (NASA) to supply the International Space Station and provide sub-orbital flight services, and with the Defense Advanced Research Projects Agency (DARPA) to design and build space planes.[14] An intensification of the public-private dynamic around space technology can be expected to accelerate the development and drive down costs of space technologies.

"An intensification of the public-private dynamic around space technology can be expected to accelerate the development and drive down costs of space technologies."

Space launches are already getting significantly cheaper. SpaceX has reduced the cost of space launches to about US$600 to US$1,200 per pound to launch a satellite into low-earth orbit, after its chief executive officer, Elon Musk, said in 2004 it would "very achievable" to cut the cost to US$500 per pound.[15] This compares to a cost of about US$6,000 per pound on the Delta IV Heavy operated by the United Launch Alliance, which held the monopoly on military space launches between 2006 and 2016.[16] Industry experts project that below a price point of US$1,000, there will be broader demand for satellite launches.[17] As improved manufacturing capabilities and computing power reduce the weight of new satellites, launch prices over the next ten years are expected to continue to drop.[18]

Just as the sailing ship and steam ship contributed to the age of maritime exploration, advances that quicken space travel will likely contribute to outer space exploration and development. There have been promising efforts to drastically reduce the transit time for space travel. A NASA team has been experimenting with electromagnetic (EM) drive technology which, if viable, could reduce transit time to Mars to 10 weeks.[19] Another novel technology in development is the photonic propulsion engine, which would use earth-based lasers to propel a spacecraft equipped with a photon sail. The underlying physics of this system are less controversial, and in theory, such a system could direct a probe to Mars in as little as three days.[20] With significant reductions in cost and transit time for space travel, outer space may become much more accessible to small states, more corporations and individuals. Developments in outer space are likely to increase exponentially.

SPACE MINERALS AND SOLAR POWER AS THE NEW GOLD, SPICE AND TEA

Just as demand for bullion, tea and spices drove the development of colonies across the seas, demand for rare minerals and other resources looks set to drive space development. Space-based solar power is a promising source of renewable energy as it would capture solar power much more efficiently than terrestrial solar cells and provide round-the-clock energy as the sun never sets in space. The main hurdle in developing space-based solar power lies in the mechanism for transmitting the energy from space to earth, but there has been significant progress in this area. The Japan Aerospace Exploration Agency (JAXA) has been testing systems for transmitting energy from space-based solar panels to earth.[21] In a test of the technology, Mitsubishi Heavy Industries sent 10 kW of power over microwaves to a receiver about 500 metres away.[22] China has also announced plans to build a space-based solar power station in the coming decade.[23]

Minerals on asteroids and celestial bodies like the Moon are another valuable resource. Luxembourg is planning to develop an asteroid mining industry, in collaboration with commercial partners from the US and Europe.[24] In late 2016, it introduced a bill concerning the rights of mining firms to extract resources from near-Earth objects (NEOs) such as the 12,000 asteroids between the orbits of Earth and Mars.[25] Asteroids are potentially richer in valuable metals like platinum than the Earth's crust. Asteroid-mining firm Planetary Resources estimates that a single platinum-rich 30 metre-long asteroid could contain platinum worth around US$25 billion to US$50 billion at today's prices.[26]

SPACE SETTLEMENTS AS NEW COLONIES

Just as growing access, commercial interest and competition pertaining to the seas contributed to colonisation in the 17th to 19th centuries, these factors could also lead to human space settlements being established much earlier than most assume. Since late 2015, the Head of the European Space Agency has championed the idea of a manned moon base.[27] Around the same time, NASA said it planned to have humans orbit Mars as early as the 2030s, a step towards possibly landing and living there.[28] Among NASA's intermediate plans is the development of Deep Space Habitat concepts—space habitats that would allow a crew to live and work safely on missions beyond low earth orbit for up to 1,100 days.[29] The first space colonies will extend the scope of geopolitics to space, and could result in significant geopolitical shifts over the long term. After all, colonialism has resulted in such shifts—the US, the world superpower of the past 50 years, started off as a British colony.

> *"The first space colonies will extend the scope of geopolitics to space, and could result in significant geopolitical shifts over the long term."*

WHAT'S NEXT FOR SPACE?

In the colonial era, the sea was an arena of conflict between states. Competition over the seas was initially governed by the "freedom of the seas" doctrine, which limited national rights and jurisdiction over the oceans to a narrow belt of sea surrounding a nation's coastline, leaving the rest of the seas to the law of the jungle.[30] After World War II, states sought to extend jurisdiction beyond the narrow of belt of sea under the freedom of the seas doctrine—whether to harvest fisheries, extract natural resources or protect the seas from pollution. To address these issues, talks about global rules governing the seas started in the 1970s under the

auspices of the United Nations and culminated in the UN Convention on the Law of the Sea (UNCLOS).[31]

The parallels with modern maritime history suggest that unruly competition may emerge as space grows into a new source of resources and an arena of commercial and geopolitical competition. Yet, current regulatory frameworks on space as a global commons are inadequate on the issue of space sovereignty. The Outer Space Treaty of 1967 (OST) prevents brazen territorial claims by states, but recognises the authority of private actors to claim territory, and therefore their installations and vehicles retain the sovereignty of their sponsoring nation(s).[32] Many clauses in the OST have never been tested in court.[33] In 2015, for example, the US passed the Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act which gives US citizens and companies property rights over resources they obtain from asteroids—a stance that some legal experts say may violate the OST.[34] Yet the case of the seas still suggests hope that nations will come together to strengthen the global rules governing space as a peaceful global commons, as they once did for the seas, so that all states can continue to access this increasingly important domain.

“The case of the seas still suggests hope that nations will come together to strengthen the global rules governing space as a peaceful global commons, as they once did for the seas, so that all states can continue to access this increasingly important domain.”

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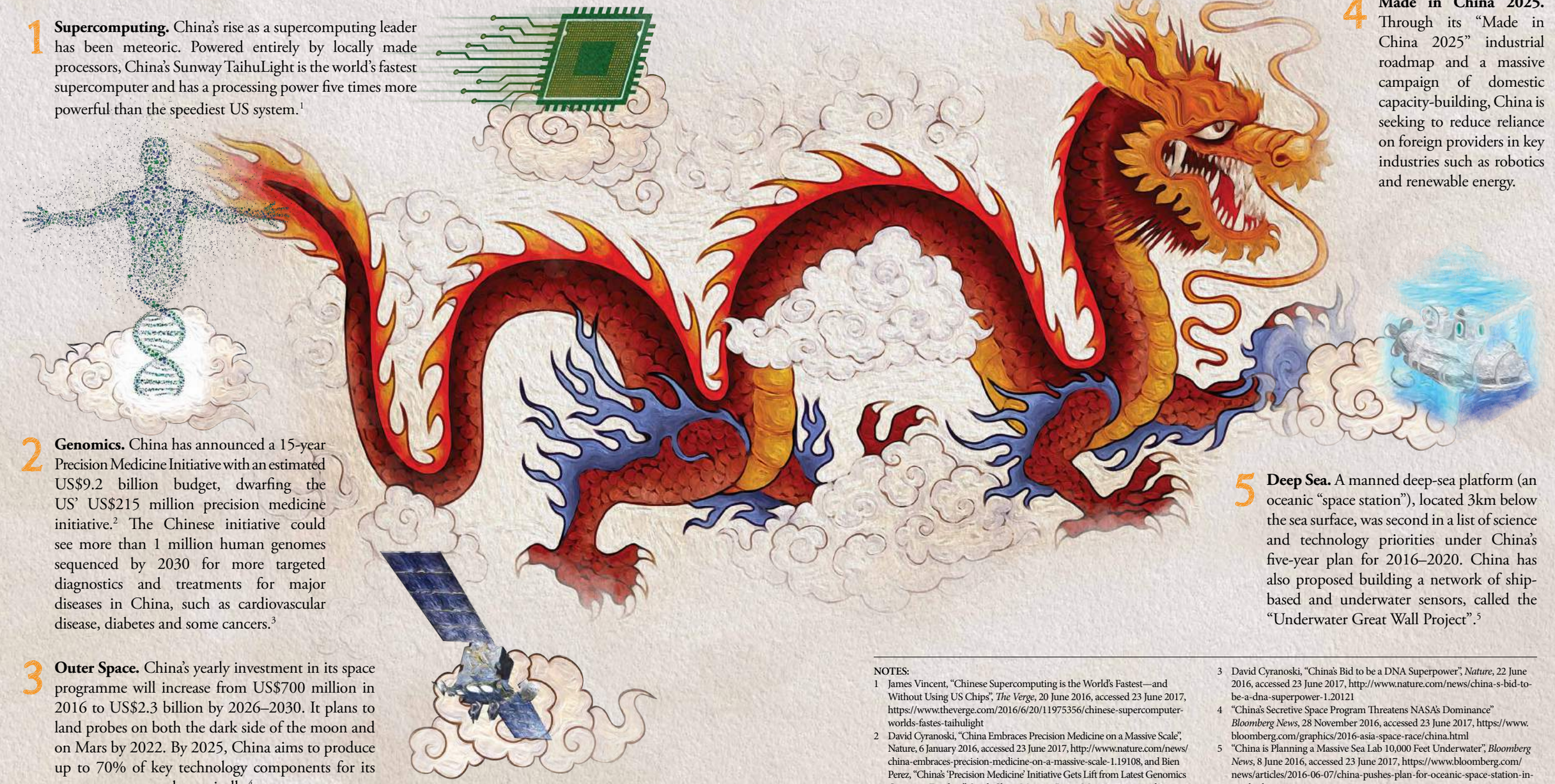
China's Rise as a Technological Superpower

By Chan Chi Ling

China's capacity and ambitions for research and development (R&D) have grown considerably over recent years. China's assets range from national science programmes and sustained R&D investments, to its large cohorts of scientists and huge domestic market. These have helped China catch up technologically, and even take the lead in some areas. Even though it still lags traditional R&D powerhouses in some areas, the technological centre of gravity could shift east in time, with China becoming more dominant in global R&D.

1 **Supercomputing.** China's rise as a supercomputing leader has been meteoric. Powered entirely by locally made processors, China's Sunway TaihuLight is the world's fastest supercomputer and has a processing power five times more powerful than the speediest US system.[1]



2 **Genomics.** China has announced a 15-year Precision Medicine Initiative with an estimated US$9.2 billion budget, dwarfing the US' US$215 million precision medicine initiative.[2] The Chinese initiative could see more than 1 million human genomes sequenced by 2030 for more targeted diagnostics and treatments for major diseases in China, such as cardiovascular disease, diabetes and some cancers.[3]

3 **Outer Space.** China's yearly investment in its space programme will increase from US$700 million in 2016 to US$2.3 billion by 2026–2030. It plans to land probes on both the dark side of the moon and on Mars by 2022. By 2025, China aims to produce up to 70% of key technology components for its space programme domestically.[4]

4 **Made in China 2025.** Through its "Made in China 2025" industrial roadmap and a massive campaign of domestic capacity-building, China is seeking to reduce reliance on foreign providers in key industries such as robotics and renewable energy.

5 **Deep Sea.** A manned deep-sea platform (an oceanic "space station"), located 3km below the sea surface, was second in a list of science and technology priorities under China's five-year plan for 2016–2020. China has also proposed building a network of ship-based and underwater sensors, called the "Underwater Great Wall Project".[5]

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4 "China's Secretive Space Program Threatens NASA's Dominance" *Bloomberg News*, 28 November 2016, accessed 23 June 2017, https://www.bloomberg.com/graphics/2016-asia-space-race/china.html

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India's Take-Off?

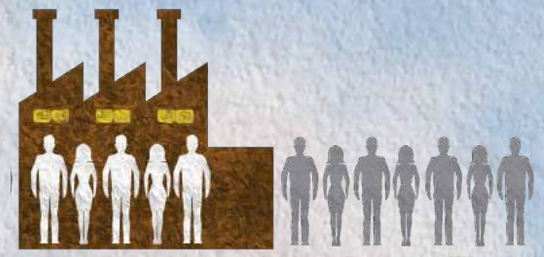
By Leon Kong

At US$2 trillion in value, India's economy is one of the world's great engines of growth.[1] It stands poised to reap a demographic dividend: around half of India's 1.2 billion people are under the age of 26, and by 2020, India is forecast to be the youngest country in the world.[2] Crucially, PM Narendra Modi has embarked on structural reforms (such as demonetisation, goods and services tax reform) that could lay the foundation for long-term growth. India's future may yet arrive.

THE CHALLENGE

India needs to create around 10–12 million jobs per year to absorb its youth bulge, but is only creating around 5 million per year.[3]

India may not be able to grow through export-led manufacturing the same way East Asian tigers have. There is a widespread view that automation, deglobalisation, and China's dominance in manufacturing have closed the path of export-led manufacturing as a driver of job growth in India.



AADHAAR'S POTENTIAL

Tackling structural deficiencies would spur growth significantly. Among other things, these deficiencies include a highly informal economy comprising more than 80% of the workforce.[4]

India's digital infrastructure aims to bring informal workers into the formal sector, allowing them to be taxed, receive benefits, and access microcredit that would in turn fuel consumption. This digital infrastructure comprises three layers:

- **Jan Dhan**—a financial inclusion scheme to ensure access to financial services for the masses
- **Aadhaar**—a massive biometric authentication system to provide a unique identity to each individual
- **Mobile services**—a requisite for Jan Dhan and Aadhaar to be effective

Aadhaar enrolment has grown spectacularly—99% of all adults enrolled.[5]

Challenges remain, however. Using Aadhaar for identification requires an internet connection, but this is often patchy. Smartphone penetration remains low at around 30%.[6] Additionally, legislative hurdles remain as constitutional challenges to Aadhaar are pending hearing from a Constitution Bench.[7]

TECH DIPLOMACY?

An intriguing speculative future is one where Aadhaar proves to be a consequential tool in India's diplomatic arsenal. Could India one day leverage its digital stack to construct an India-centric regional information infrastructure by introducing Aadhaar to neighbouring countries?

NOTES:

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2 "India's Demographic Dividend", *Thomson Reuters*, 7 July 2016, accessed 1 June 2017, https://blogs.thomsonreuters.com/answerson/indias-demographic-dividend/

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4 Abhishek Waghmare, "Demonetisation Will Hit Farmers, Informal Workers; Long-term Outlook Positive", *Hindustan Times*,15 November 2016, accessed 1 June 2017, www.hindustantimes.com/india-news/demonetisation-will-hit-farmers-informal-workers-long-term-outlook-positive/story-ghWMZfVuXnsvkiPWC4iKM.html

5 Mahendra Singh, "99% of Indians Over 18 Now Have Aadhaar Cards", *The Times of India*, 28 January 2017, accessed 1 June 2017, www.timesofindia.indiatimes.com/india/99-of-indians-over-18-now-have-aadhaar/articleshow/56820818.cms

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7 "Govt Cannot Belittle SC Order, Say Petitioners Challenging Decision to Make Aadhaar Mandatory", *Huffington Post India*, 4 May 2017, accessed 1 June 2017, www.huffingtonpost.in/2017/05/04/govt-cannot-belittle-sc-order-holding-aadhaar-voluntary_a_22069306/

The Human Cloud in the Future of Work

By Derrick Cham

While the risk of job displacement due to advances in artificial intelligence and robotics preoccupies many commentators, another pressing problem deserves attention: the mismatch between workers' skills and available work. If only employers and workers could connect across the barrier of geographical distance, perhaps this mismatch could ease. Could the "human cloud"—a global pool of skilled workers working remotely for employers and clients—be a solution?

The human cloud will enable workers, based physically in different places, to collaborate on research and development, as if they were in the same room.

A STUBBORN DISCONNECT BETWEEN PEOPLE AND WORK

A 2016 survey of 42,300 multinational employers by human resource consulting firm ManpowerGroup found that 40% could not find the necessary talent to fill available jobs. This figure marked an increase from 30% in 2009 to its highest level in eight years.[1] In particular, higher-end talent like programmers and big data analysts were harder to obtain.

The skills gap is largely caused by having too few workers with the right skills, but it is also worsened by skilled workers being less willing and able to move. It is challenging to uproot, leave friends and family to move to another city for a job. There are uncertainties and risks, such as the risk that new jurisdictions may not recognise one's credentials.

A contributing factor could be the growth of households where both spouses are working, which would make it harder for a household to move if only one spouse is offered work in a new city.[2] Looking beyond, an upswing in populist sentiments, especially in advanced economies, may also lead to immigration curbs; after all, President Donald Trump's election in the US and the vote in the UK to leave the EU were in part fuelled by anti-immigration sentiments. Such immigration curbs will make it harder for talent to flow across borders where they are needed, and further exacerbate skills gaps.

THE HUMAN CLOUD AND THE SHORTENING OF DISTANCE

Skills mismatches are therefore related to the cost of distance. To some extent, technologies, such as email and video-chat, and newer collaboration tools, such as Slack (a cloud-based platform that supports team communication, document sharing and more), have cut transaction and coordination costs over distance. These tools replicate the functions of a physical office by providing a digital platform for communication, collaboration and coordination. Remote work allows employees or freelancers to perform work—and employers to access talent—from a wider range of locations.

This trend will grow further, easing skills mismatches, with the arrival of online talent platforms—digital marketplaces that help match individuals and work opportunities.[3]

"A 2016 survey of 42,300 multinational employers by human resource consulting firm ManpowerGroup found that 40% could not find the necessary talent to fill available jobs."

These platforms create a global labour market, unlimited by geography or borders, for a wide range of services. Some, such as Upwork, are online marketplaces for worldwide buyers and sellers of skills to bargain and come to a deal on their own. Others use online marketplaces to manage projects. Konsus, for example, breaks down a client project into tasks and identifies freelancers around the world to take on the tasks. Others, such as Kaggle, provide a platform for organisations to pose their problem statements to a global pool of data scientists and statisticians, who compete to provide the best solution.

These platforms give employers access to a more diverse pool of skilled workers, helping start-ups and small companies that cannot afford permanent designers or accountants access their skills nonetheless. Large companies also benefit by tapping on contingent workers during crunch times.

The workers on the human cloud gain flexibility, the ability to market their services worldwide and more work.

More employers and workers are using the human cloud. According to Gallup, the number of people in the US working remotely four or five days a week rose from 24% to 31% between 2012 and 2016.[4] Revenue generated by the human cloud, which includes online staffing, online services and other firms, doubled in 2016 to between US$47 billion and US$51 billion.[5] This trend is set to continue. In a recent survey of global business leaders at the Global Leadership Summit, organised by the London Business School, 34% said more than half of their companies' full-time workforce would be working remotely by 2020.[6]

> *"At one extreme, some companies do not have an office at all, operating entirely with remote workers. There were 125 such companies globally in 2016, nearly quintupling from 26 in 2014."*

At one extreme, some companies do not have an office at all, operating entirely with remote workers. There were 125 such companies globally in 2016, nearly quintupling from 26 in 2014.[7] US$1 billion start-up Automattic, the company behind the popular Wordpress blogging site, has roughly 550 employees across more than 50 countries and no physical offices.[8] They give employees a stipend to set up their home offices, from which meetings and even job interviews are conducted. These examples are not limited to tech start-ups, but also companies amenable to remote arrangements in accounting, health, law, travel and other industries.[9]

THE COMING COLLAPSE OF DISTANCE?

In the future, more kinds of work will be possible on the human cloud. High-touch work—those needing personal face-to-face interaction—will increasingly be performed online and over distance, due to technological advances.

Virtual, augmented and mixed reality (VR, AR and MR) technologies promise to deliver the benefits of co-location *without physical co-location*, raising the possibility that companies can export services that could only be delivered domestically in the past.[10] For example, faster data transmission rates coupled with robotics, enable services, such as surgery, to be performed remotely.[11] Even services that depend highly on physical touch could be delivered virtually through VR and haptic (touch) sensors. Researchers from the University of Texas at Dallas School of Engineering and Computer Science have created a physiotherapy telemedicine system. When the physiotherapist "manipulates" the patient's virtual avatar, haptic sensors pick up the sensation and allow them to be replicated; the patient feels the action through a haptic suit even though both are in different places. In 2015, the technology was piloted for physiotherapy use by war veterans, and in 2017, it was presented to members of the US Congress.[12] These encouraging signals point to a future where even specialised high-touch services may become tradable.[13]

Collaboration that once required frequent face time will also become more feasible remotely. One example is the Ford Immersive Vehicle Environment (FIVE) Lab used by automaker Ford in Dearborn, Michigan. Engineers log into the FIVE Lab from Ford centres in the US, China, India, Germany, Brazil and other countries. In the virtual lab, they discuss and test various aspects of digital vehicle prototypes, such as materials, colours, packaging

> *"High-touch work—those needing personal face-to-face interaction—will increasingly be performed online and over distance, due to technological advances."*

and ergonomics—as if they were in the same physical space. Given the productivity gains and cost savings, Ford has doubled its use of FIVE every year since 2013.[14]

FURTHER TRANSFORMATIONS?

While it is early days and uncertainties abound, the human cloud could trigger three further changes in the areas of competition and education certification.

First, as remote-working technologies advance, economies and companies will begin to compete over the human cloud. The ability of economies and companies to harness the human cloud will grant an edge in finding skilled workers, especially if immigration curbs and population ageing in rich economies make it harder to import and train workers. It will also give companies an edge in reaching new markets, for example, by exporting high-touch services through the human cloud. Competition for the best and brightest "virtual" talent will heat up, just as economies and companies compete to draw talent to where their needs are today.

Second, platforms will compete not just over front-end marketplaces, but also the back-end infrastructure to support a range of services needed by the human cloud. These include e-identity, e-payments, business registration, taxation and others. Estonia's novel "e-residency" programme, for example, allows non-Estonians to use Estonian government digital services, such as paying taxes and signing contracts digitally (which are legally binding in the European Union). Estonia is targeting the growing market of digital nomads—individuals who leverage technology to work remotely and live a nomadic lifestyle—who want the convenience of living as part of the human cloud without having to face costly administrative hurdles.[15]

Third, if platforms that disaggregate and distribute work to the human cloud expand, micro-credentialing may grow popular, as workers and

> *"In the virtual lab, they discuss and test various aspects of digital vehicle prototypes, such as materials, colours, packaging and ergonomics—as if they were in the same physical space."*

employers will seek accreditation for skills to perform specific tasks. Secure distributed ledgers, such as blockchain, could be used to store micro-credentials and allow employers to check their authenticity. New micro-credentialing institutions may even develop, just as institutions, such as the Cambridge International Examinations or International Baccalaureate, have already become the trusted brands in pre-university education qualifications today.

CLOUD OR CLOUDY?

In "Preparing for a New Era of Work", McKinsey Global Institute argued that the world was seeing intense global competition for high-skilled knowledge work.[16] To survive in an era of slow growth and narrowing margins, economies and companies will need to use labour more effectively. The human cloud can help companies with this. But it places responsibility on individuals to chart their own careers, companies to change how they work to tap into the human cloud and nations to rethink how to manage the movement of people.

NOTES:

1 Manpower Group, "2016-2017 Talent Shortage Survey", 2016, accessed 19 June 2017, http://manpowergroup.com/talent-shortage-2016

2 Among married-couple families, 53% had earnings from both the wife and husband in 2011, up from 44% in 1967. The percentage of married-couple families, where both husband and wife had earnings peaked, in the 1990s. See US Bureau of Labor Statistics, "Working Wives in Married-Couple Families, 1967–2011", *The Economics Daily*, May 2014, accessed 27 June 2017, https://www.bls.gov/opub/ted/2014/ted_20140602.htm

3 These marketplaces facilitate a variety of working arrangements, including incorporated freelancers and other small business owners without employees, independent contractors, full-time employees who moonlight, and those who participate on contingent work platforms.

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8 Julie Bort, "$1 billion Startup Automattic is Closing its San Francisco Office and Having Everyone Work from Home", *Business Insider*, 12 June 2017, accessed 19 June 2017, http://www.businessinsider.sg/automattic-closes-san-francisco-office-to-let-everyone-work-remotely-2017-6/?r=US&IR=T#LCV5FEyGg02JpzqP.97

9 Shin, "At These 125 Companies"

10 The various technologies differ in terms of how much of the "real" world is experienced through the devices. Augmented Reality has the most, with digital information and objects overlaid onto the view of real world objects. Virtual Reality has the least, and completely immerses the user in a digital environment. Mixed Reality is a middle ground between both VR and AR.

11 Carlos Danger, "The Doctor is in: Remote Surgery in the Digital Age", *Technology and Operations Management*, Harvard Business School, 18 November 2016, accessed 20 June 2017, https://rctom.hbs.org/submission/the-doctor-is-in-remote-surgery-in-the-digital-age/

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15 "E-Residency—New Digital Nation", *E-Residency*, accessed 23 June 2017, https://e-resident.gov.ee/

16 Susan Lund et al, "Preparing for a New Era of Work", *McKinsey Quarterly*, November 2012, accessed 28 June 2017, http://www.mckinsey.com/business-functions/organization/our-insights/preparing-for-a-new-era-of-work

Growing Healthy in a Sluggish World

An Interview with David Skilling

CSF worked with Dr David Skilling in 2016 to examine how Singapore can grow more dynamic and resilient as an economy, given concerns about sluggish global growth and the implications for Singapore.

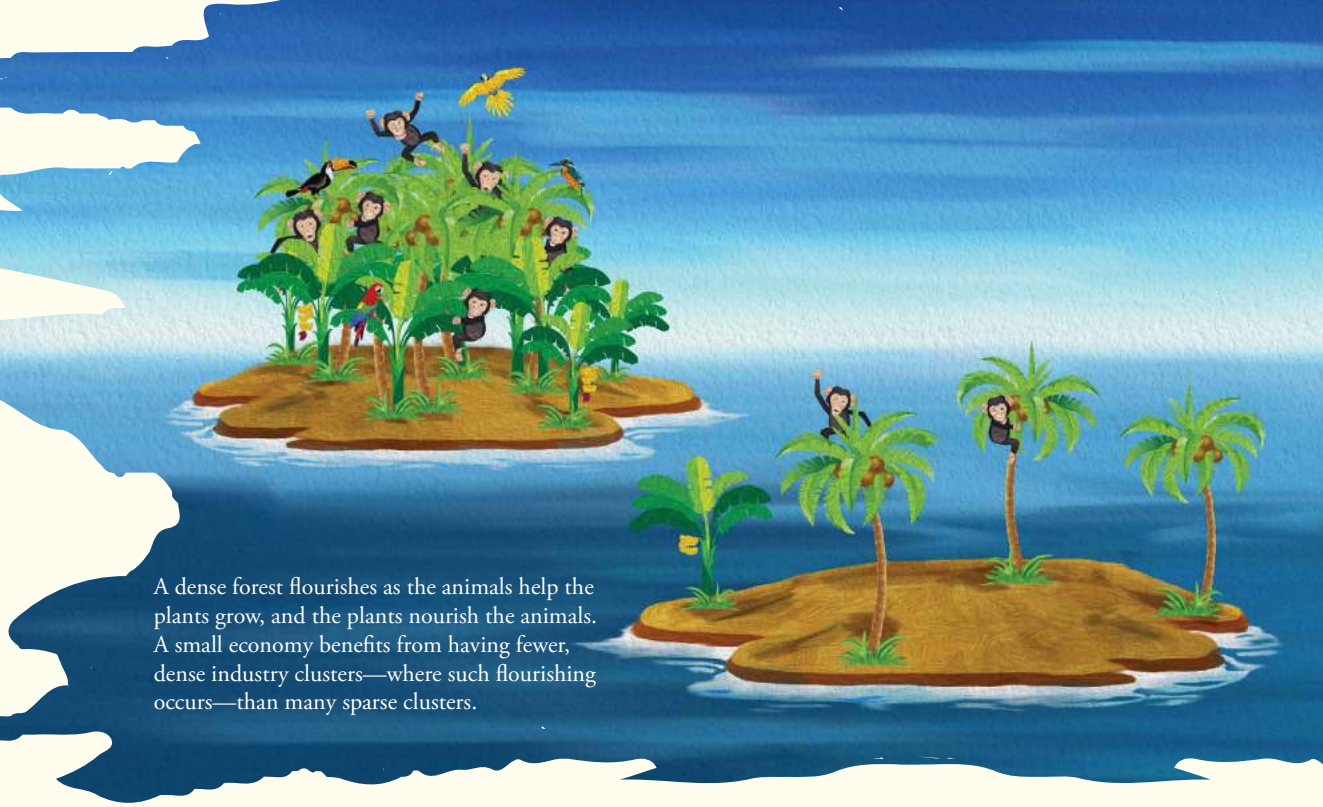
Dr Skilling is the founding director of Landfall Strategy Group, an economic research and advisory firm set up in Singapore in 2011. David advises governments, companies, and financial institutions in several small advanced economies on the impact of global economic and geopolitical issues. Earlier in his career, he worked with the New Zealand Treasury and McKinsey & Company's Public Sector Practice.

Q: GLOBAL ECONOMIC GROWTH MAY BE SLUGGISH FOR SOME TIME. BASED ON YOUR WORK ON SMALL ADVANCED ECONOMIES, CAN WE EXPECT ECONOMIC "HEALTH" IN A SUSTAINED GLOBAL ECONOMIC SLOWDOWN?

Small advanced economies, like Switzerland and the Nordic countries, have achieved strong outcomes even when growing at 1–2% a year—outcomes such as wage growth, high employment levels and a high quality of life. It's more about the quality of growth, driven by productivity and innovation, than the pace of growth. What helps too is that these countries have adopted policies to share the benefits of growth, while encouraging risk-taking and innovation—schools in which students master skills that businesses need, training and placing workers in new jobs, income redistribution and social insurance.

> *"It's more about the quality of growth, driven by productivity and innovation, than the pace of growth."*

In the case of Singapore, it is moving from extremely strong growth to more moderate growth. It faces a weak external environment, where global economic and trade growth have been slowing since the 2008 Financial Crisis. This in turn dampens growth in Singapore. It is also undergoing a transition: it has joined the ranks of rich countries, which usually grow more slowly. It is trying to rely more



A dense forest flourishes as the animals help the plants grow, and the plants nourish the animals. A small economy benefits from having fewer, dense industry clusters—where such flourishing occurs—than many sparse clusters.

on innovation and productivity to grow, rather than by simply adding more workers and building more factories—an ongoing transition.

Because of the external environment and the economic transitions, it is more reasonable to accept 2–3% growth rates than to get anxious. If you get too anxious about hitting growth rates of 4–5%, you may pull all stops to attract foreign investment and immigrants, rather than focus on the quality of growth—growth that is slower, but that works for everybody and improves the quality of life.

Q: HOW DO OTHER SMALL ADVANCED ECONOMIES ACHIEVE GROWTH THAT IS SLOWER BUT THAT WORKS FOR EVERYBODY?

The small advanced economies, such as Switzerland, Sweden and Denmark, invest heavily in education—compulsory education, vocational education, tertiary education and adult education. This provides workers the skills to raise productivity and take up better jobs. The benefits of growth are therefore diffused across a wide swathe of the population, even if the economy isn't growing at 5–6% yearly.

These economies also have many

> *"For the person in the street, well-being increases because unemployment is low and the median wage is high. He or she gets opportunities for a fulfilling and meaningful career."*

> *"Not every percentage point of GDP growth generates the same outcomes in terms of employment, opportunities and quality of life."*

home-grown global companies embedded in clusters of local companies; multi-national companies (MNCs) and foreign talent are, of course, part of the mix too. The global giants buy equipment and services from local companies. They develop products and even train workers jointly. So when these global companies sell more abroad, they create business for local companies, raising wages for workers and tax revenue for the government. This makes growth more inclusive.

For the person in the street, well-being increases because unemployment is low and the median wage is high. He or she gets opportunities for a fulfilling and meaningful career. Hence the quality of life and satisfaction levels among people are very high in the Nordics, the Netherlands and Austria.

The point is that not every percentage point of GDP growth generates the same outcomes in terms of employment, opportunities and quality of life. For economies moving from high growth to low growth that works for everyone, there is a trade-off. In the short term, you can almost guarantee faster growth through attracting MNCs and foreign talent. In the long term, however, this may not grow clusters of local companies that create opportunities and enable benefits to be shared—the domestic engines of growth. Indeed, going for growth in the short term could lead to a high-income trap—MNCs push up wages across the economy, making it hard for small local companies to attract workers and make a profit. Managing this trade-off is more salient in an increasingly difficult external environment where MNCs may be harder to attract.

Q: YOU SPOKE EARLIER ABOUT INNOVATION AND PRODUCTIVITY AS A WAY OF SUSTAINING "HEALTH" IN A LOW-GROWTH WORLD. WHICH ASPECTS OF INNOVATION POLICY OUGHT TO RECEIVE MORE ATTENTION?

Small advanced economies, such as Switzerland, the Nordics and New Zealand, rank in the top 10 for innovation and competitiveness worldwide. They have many well-established companies, with a long history, that have built strong competitive advantages in specific sectors. Whereas companies in Silicon Valley transform society—this is what comes to mind when we think about innovation—these well-established companies in these small advanced economies innovate on the margin. They continually improve processes and designs, using new technologies, and do so as part of clusters of local companies.

Vestas, for example, has grown into a leader in renewable energy. It is extending strengths by adopting data analytics to improve the design and placement of wind turbines, for example. This is how these well-established companies maintain their competitiveness in niches over decades. For them, innovation is not always about big disruptive innovation, such as creating autonomous vehicles and drones, but getting the basics right. It's not a big bang approach to innovation, but about innovating on the basis of domestic strengths and building on them.

Under an innovation strategy that builds on domestic strengths, the benefits that these well-established, global companies reap from innovation are more likely to be shared with the cluster of local companies that supply specialised goods and services, and collaborate on product development. Under a strategy that identifies future growth sectors and attracts growth companies, however, the benefits of innovation are less likely to be shared widely across industries.

For Singapore, it has invested in research and development (R&D), but the challenge has been in converting it into innovative products and services, and sales. The experience of other small advanced economies shows that states need to support bottom-up innovation, specifically clusters of local companies, as well as research institutes through grants. Funding innovation is great. But it's a necessary, not sufficient condition for innovation.

Q: GIVEN THE DIFFICULT EXTERNAL ENVIRONMENT, HOW MIGHT SMALL ADVANCED ECONOMIES STAY RESILIENT WHEN FACED WITH THE RISKS OF RISING TRADE AND INVESTMENT PROTECTIONISM?

There are several dimensions of resilience. If it's about resilience to market risks, you seek exposure to different export markets. If it's about resilience to industry risks, you seek exposure to different types of industries and sectors—Norway, Australia and New Zealand are particularly exposed to certain commodities, while Singapore is debating the size of manufacturing in its economy compared with services. If it's about resilience to the rise and fall of major companies (think about how Nokia's decline hurt the Finnish economy) you seek exposure to various major firms. The idea is to have a portfolio—to have some exposure along these dimensions, but not too much along one particular dimension.

> *"If Singapore, for example, relies more on MNCs, there is a risk that these will choose to relocate and retrench workers if costs rise. This risk is stronger especially if their R&D is done in-house and their suppliers produce outside the country—in other words, if their activities are unconnected with the other parts of the economy."*

> *"A small country, however, is doomed to have concentration. You've got to have a strong competitive position in a sector. If you over-diversify, however, you won't have a deep cluster of firms that can be distinctive and innovative, because you won't have a critical mass and depth."*

There is another, often-overlooked dimension to consider: resilience to location risk. If Singapore, for example, relies more on MNCs, there is a risk that these will choose to relocate and retrench workers if costs rise. This risk is stronger especially if their R&D is done in-house and their suppliers produce outside the country—in other words, if their activities are unconnected with the other parts of the economy.

Thermoplan AG, which supplies Starbucks Corp. with the machines for making espressos and cappuccinos, shows how connectedness with other parts of an economy makes the economy more resilient to location risks. Despite high costs, Thermoplan continues to produce near Lucerne, Switzerland, rather than move to Germany or Malaysia, because it has found a niche market and is building on very deep manufacturing and precision-engineering talent in the country.[1]

It's easy to say that a country should minimise concentration risks to hedge exposures. A small country, however, is doomed to have concentration. You've got to have a strong competitive position in a sector. If you over-diversify, however, you won't have a deep cluster of firms that can be distinctive and innovative, because you won't have a critical mass and depth. So small economies can't have too much concentration, nor can they diversify too far. That's just life. That's why small advanced economies often have a handful of deeply embedded clusters that are well-developed and competitive. Being in these clusters is what gives a firm a special edge. That builds resilience for the economy.

WHY SHOULD WE PAY ATTENTION TO SMALL ADVANCED ECONOMIES?

Small economies themselves face a common set of challenges, notably their deep exposure to the external environment, of needing to develop critical mass and to maintain a competitive position in key industries. They can learn from each other, especially as the external environment is changing so fast: the risk of weaker global growth, challenges to existing rules and institutions, the rise of protectionism in the US and opposition to regional integration in the European Union. All the preconditions of success for the small advanced economies over the past several decades have weakened. So there's value to understanding how other small advanced economies are interpreting and responding to these changes.

The experience of small countries is also relevant to the large economies in the G-20. Globalisation is making large countries smaller and reaching further into their domestic sectors—such as the off-shoring of call centres and import of Chinese-made consumer goods—triggering greater pressures for inclusive growth and pushback against globalisation. These are pressures that the small economies have been grappling with for many years, and so small countries have much insight to share with larger economies.

NOTES:

1 Catherine Bosley and Corinne Gretler, "Starbucks Secret Weapon Is Machine From Sleepy Swiss Village", *Bloomberg*, 6 August 2014. The article is no longer on Bloomberg online, but was carried by the international service of Swiss Broadcasting Corp. at https://www.swissinfo.ch/eng/starbucks-secret-weapon-is-machine-from-sleepy-swiss-village/40540112, accessed 15 June 2017

The sharing economy has the potential to reduce the need to buy new items and to encourage trust and interactions among people—building a greater sense of community.

The Rise of the Sharing Economy

An Interview with April Rinne

By Rahul Daswani

As platforms for home sharing and ride sharing have grown popular, the Centre for Strategic Futures (CSF) has been exploring the sharing economy and its implications for Singapore. To help government agencies understand such developments, we hosted sharing economy expert, April Rinne, in Singapore in January 2016.

Rinne is an advisor to several cities and countries on building economic and social value from the sharing economy, including Seoul, Amsterdam, China, Denmark and the National League of Cities in the US. She also focuses on the themes of policy reform, the future of work and the future of travel. She is a Young Global Leader at the World Economic Forum where she leads the Sharing Economy Working Group and serves on the Global Futures Council for the Future of Mobility and the Urbanization Advisory Group.

In this interview, Rinne expresses hope that the sharing economy will help people feel more connected and spur governments to be nimbler in policy-making.

WHAT'S YOUR DEFINITION OF THE "SHARING ECONOMY"?

I define the sharing economy as an economy driven by "access over ownership"—where you can access a service (for example, transport) without owning the asset (for instance, a car)—and decentralised networks of people connected through new technologies. It is driven by three principal criteria: First, it must result in better resource utilisation, focusing on making better use of under-utilised resources and reducing the need for new purchases. Second, it is decentralised—for example, resources and transactions are exchanged through a peer-to-peer (P2P) network with no single inventory of items. Third, it ought to build relationships, foster human interaction and forge trust among individuals.

HOW WOULD YOU CHARACTERISE THE SHARING ECONOMY TODAY? WHERE DO YOU SEE IT GOING?

As my colleague, Lisa Gansky, has said, the sharing economy is out of infancy, but not yet grown up. That is why we are trying out new languages to describe this phenomenon—the sharing economy, the collaborative economy, the access economy and so on. The terminology is still messy, and we don't yet know what a "mature" sharing economy looks like. By the time the sharing economy has matured, it may have become so accepted as part of our everyday life that it is an indistinguishable part of the economy, no longer seen as different or special.

> *"We need to ask: is this about a transactional sharing and nothing more than meeting a basic need? Or does it enable something deeper and transformative—a new relationship, a feeling of belonging to a broader community, or a new tool for sustainability?"*

Between here and there, we're going to continue to see significant growth in the sharing economy. One aspect would be broader adoption among the elderly, youth and low-income. Another would be uptake by businesses, or business-to-business sharing, which we already see happening as businesses rethink supply chains. For example, in the healthcare space, Cohealo, based in Boston, is a platform that helps medical facilities share their equipment. The company tracks usage of shared equipment and helps move equipment from one facility that isn't using it to another that needs it. Businesses are also adopting more flexible skill-sharing models. Professional services firm PwC has set up Talent Exchange which lets freelancers work on PwC projects and has been extremely successful in identifying and collaborating with independent talent.

> *"One thing I have observed is that the sharing economy platforms today are built on their communities, yet they are still working within the traditional corporate structure... the communities at the heart of these platforms do not have the ability to be owners of the company, and thus are unable to participate in the governance or financial upsides of the company's success."*

I see us doubling down on social value too. We need to ask: is this about a transactional sharing and nothing more than meeting a basic need? Or does it enable something deeper and transformative—a new relationship, a feeling of belonging to a broader community, or a new tool for sustainability? This is the choice—and at times, tension—between transactions and transformations.

We may also want to examine whether platforms promote trusted, sustained interactions. For example, GoodGym, a UK non-profit organisation, matches runners with missions, like visiting isolated elderly and forming running groups to undertake community projects. It was started by a group of fitness enthusiasts who were frustrated by the amount of wasted human energy and talent that they saw in gyms and how disconnected they felt from their community. Recognising the social value of this effort and the benefits to local communities, the National Health Service and innovation foundation NESTA have partnered with GoodGym to help it expand nationally and build a sustainable business model.

Despite the myriad benefits of sharing and access over ownership, we must remain cognisant of how the concept can be abused. For example, there is the risk of "share-washing" in which activities are branded as "sharing" but fall short in terms of building relationships or fostering interaction. It is essential that we all, individuals, companies, policy makers and civil society alike, remain focused on building a responsible, *bona fide* sharing economy—one that helps people live better lives and weaves a social fabric in the process.

WHICH ASPECTS OF THE SHARING ECONOMY MERIT GREATER ATTENTION?

One thing I have observed is that the sharing economy platforms today are built on their communities, yet they are still working within the traditional corporate structure. Founders, employees and outside investors can invest in the companies, but the communities at the heart of these platforms do not have the ability to be owners of the company, and thus are unable to participate in the governance or financial upsides of the company's success.

An emerging solution is to develop new legal vehicles through which service providers can invest and participate in all aspects of the company. It's more akin to a cooperative, and the term commonly used is "platform cooperative". It is still early days and most of the examples are small, but the concept is gaining traction. For example, Stocksy, a stock photography platform, is a cooperative. Every Stocksy photographer owns a share of the company, with voting rights. Investors are increasingly saying, "those are the kinds of companies that I want to invest in", because the ownership structure of the companies reflects participation by the community. Community ownership, in turn, provides additional motivation for the platform to keep improving to meet the changing needs of the community.

"With the sharing economy, however, you could imagine having local partners and affiliates as part of a global network. But no single node controls the whole network. As a traveller, I am still able to work through this network, whichever city I am in, through the local affiliate."

HOW CAN THESE "HYPER-LOCAL" FORMS OF THE SHARING ECONOMY SCALE UP?

What does scale look like in a networked context? Historically—or at least during the industrial era—there was one central node controlling an expanding network: we have a headquarters and we're going to control what happens around us, and the benefits ultimately come back to us.

With the sharing economy, however, you could imagine having local partners and affiliates as part of a global network based on a similar need, community or business model. But no single node controls the whole network. As a traveller, I am still able to work through this network, whichever city I am in, through the local affiliate. It would be a little like taking a ride via Lyft in the US, and its partners such as Didi in Shanghai or Grab in Bangkok. This model involves rethinking

> *In the near future, I hope cities will be running pilots, developing policies based on those pilots and saying, 'We're going to check again in three, six or 12 months and see how it's going, and we're going to iterate again.'*

ownership and sometimes control. Not all the benefits are necessarily going to come back to the headquarters. But the advantages of being a part of that network is you will have a much more valuable flow of users coming through, and there is no question that the economic benefits are flowing back to the local community.

Q: AS COMPETITION STIFFENS, HOW CAN SHARING ECONOMY PLATFORMS CREATE AND CAPTURE VALUE?

The most popular business model by far that is emerging is based on transaction fees. This is generally a smart business approach as it inserts the platform directly at the source of where value is being created. That said, some platforms have struggled, particularly if they serve as the initial facilitator in a transaction but not in a sustained way. People can meet and pay the transaction fee initially through the platform, but they figure out that they can continue to transact outside the platform and side-step the fee.

To capture value, you need to be sticky, for example, by providing insurance or other support services to enable the transaction. In the case of insurance, this could be protection for the house being cleaned or the worker for his health. Participants will want some insurance—the owner won't want to risk having the cleaner burn down the house, the cleaner won't want to risk breaking his back because of hazards in the house, and it is often not clear who or what is covered. The role and importance of insurance in the sharing economy cannot be understated. It is one of the key growth opportunities to facilitate more, and more responsible, sharing.

HOW WOULD YOU ADVISE GOVERNMENTS ON THE KIND OF REGULATIONS AND POLICIES THAT WOULD SUPPORT THE GROWTH OF THE SHARING ECONOMY?

There was a time where the discussion was about either banning these platforms, or allowing them to exist with an implicit assumption that there would be little or no regulation. The discussion was all or nothing. The real discussion, however, is about updating outdated and outmoded regulations, in a way fit for the 21st century.

What does that look like? I tend to be an advocate of a lighter-touch approach early on, to make sure that platforms have enough ability to take root, and for us to see what's happening. This ensures that we don't kill the very innovation we seek to support—something many policy-makers don't seem to realise! This also helps us understand and regulate real public risks, not perceived risks. A real risk is something that concerns safety and security. A perceived risk is along the lines of "we need to regulate X simply because we've never seen X before", but not because there is some inherent risk. In an ideal world, governments would also recognise that there is a whole segment of the sharing economy that they don't need to regulate, because there are no real public risks—for instance, the segment about community sharing, which we want to stimulate.

I am broadly in support of a gradual, iterative policy reform process. In the near future, I hope cities will be running pilots, developing policies based on those pilots and saying, "We're going to check again in three, six or 12 months and see how it's going, and we're going to iterate again."

What I hope to see is a much nimbler process. It's going to take a radical rethinking of the policy reform process: "What if my intention is never to establish a law that is on the books for the next 50 years, but instead for just 12 or 24 months?" That is just one idea. In my experience it continues to be extremely difficult for policy-makers to get their heads around this way of thinking. However, it reflects the way the world is evolving. In future, I hope many more places will think along these lines—co-designing regulations with the platforms, or even crowd-sourcing some of the solutions from the community members themselves.

Who's Afraid of Artificial Intelligence?

By Hannah Chia

After losing three games of Go to Google Deepmind's *AlphaGo*, the world's second-ranked Go player in 2016, Lee Sedol, said, "I will have to express my apologies first. I should have shown a better result, a better outcome."[1] While Lee was apologising for his play, many also understood his statement as an apology for the limits of human intelligence and the advent of a superior form—Artificial Intelligence (AI).

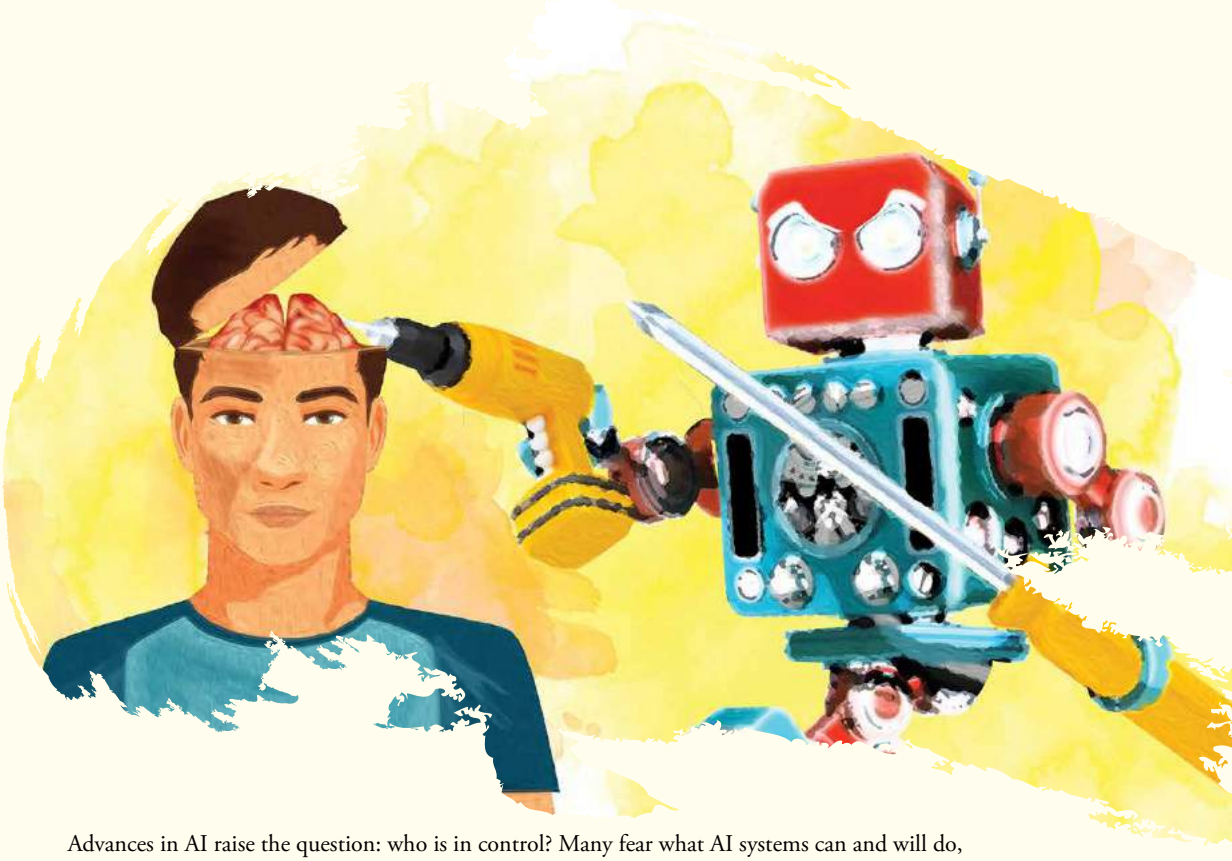
THE AI EFFECT

AI has been making headway for decades. In 1959, Arthur Samuel created a checkers-playing programme which improved itself through self-play. In 1997, IBM's *Deep Blue* triumphed over World Chess Champion Gary Kasparov. And in 2011, IBM's *Watson* beat Brad Rutter and Ken Jennings at *Jeopardy*. Some experts attribute our collective amnesia and hence surprise at each milestone of AI achievement to a paradox—the "AI effect". Each time AI brings a new technology into the common fold, people become accustomed to it and stop considering it "AI".[2] The definition of AI thus evolves constantly, confounding meaningful discussion and making it easier for the popular media and culture to paint AI dystopias.

Other experts, however, have staked their reputations on claims that recent breakthroughs are different and deserve attention. Elon Musk, Steve Wozniak and Stephen Hawking, for example, have signed open letters calling for greater focus on the societal implications of AI, and warning of the potential dangers of AI in warfare.[3] Amidst the debate, this article raises three issues associated with AI: inequality, inscrutability and ethics.

UNIMAGINABLE INEQUALITY

Human societies in the 21st century may be the most unequal in history. Historian Yuval Harari argues that equality is a modern value, born of industrialisation.[4] In feudal societies, inequality was accepted as a natural condition and it was unimaginable for a serf to aspire to equal status with a noble. However, the Industrial Revolution created conditions where economies and armies relied heavily on the contributions of the masses, eroding centuries of aristocratic privilege and legitimacy. Developments in AI, however, may reverse this trend. The best armies may no longer rely on millions of foot soldiers, but on a few elite soldiers with high-tech kits. AI may outperform humans in certain tasks, creating mass under-employment and a new underclass. These changes signal a new industrial and technological revolution, which shifts power into the hands of a new aristocracy—technology corporations and their CEOs. Signs of this extreme inequality are arguably emerging. The five biggest companies in the world by stock market value are all tech companies.[5] We may be moving to a new normal where inequality is a natural state of affairs.



Advances in AI raise the question: who is in control? Many fear what AI systems can and will do, when their abilities far surpass our own.

HEART OF DARKNESS

In Joseph Conrad's novel, *Heart of Darkness*, the central character Marlow travels up the Congo River to bring back a rogue ivory trader—Mr Kurtz. Marlow's discovery of Kurtz's descent into savagery climaxes in Kurtz's haunting words, "The horror! The horror!" Darkness, a motif so prevalent in the book that it appears in the title, symbolised the depraved aspects of human nature and the hidden, the unknowable and hence the feared.

Discussions about AI draw upon similar references to darkness. Some have described AI as a "black box", as being "radically inscrutable" and possessing a "dark secret".[6] This "darkness" or inscrutability refers to our inability to explain how AI programmes reach their conclusions. It conjures similar fears and unease about the nature of AI and what it might do.

Inscrutability has emerged as a concern recently due to the success of Deep Learning (DL) implemented through "artificial" neural networks, which simulate the type of processing done by vast numbers of neurons in the human brain.[7] This has allowed machines to "learn" in new ways—for instance, by recognising patterns from large data sets or by repeatedly making decisions and then receiving feedback on them.[8] While we know (and can describe) what is causing AI to make certain decisions (i.e. it is learning from experience, using real-time data to generate new algorithms), we cannot explain its *reasons* for reaching its conclusions. Picasso alluded to this predicament when he said, "Computers are useless. They can only give you answers." In receiving the solutions without the reasons, we face a trade-

> ***"Picasso alluded to this predicament when he said, 'Computers are useless. They can only give you answers.'"***

> *"The prospect that AI systems can flummox their creators raises fears that they may one day create unanticipated, harmful consequences. Who should be held accountable then?"*

off between explainability and effectiveness. For example, if AI-empowered systems can identify patients at risk of developing cancer (with 90% accuracy), but can only identify half of the risk factors for cancer, should doctors prescribe treatments, without knowing why their patients are at risk in the first place? If AI systems can accurately identify individuals with a high risk of violence and recidivism, without giving reasons, is preventive action against such individuals justifiable?

While some accept inscrutability, citing Arthur C. Clarke's Third Law that any sufficiently advanced technology is indistinguishable from magic, inscrutability is neither inevitable nor desirable. Knowledge advances as the magical is demystified, as what was inexplicable becomes understandable, allowing further advances. In fact, to demystify AI, research is being done to achieve greater explicability via visualising the different layers of neural networks, and designing programmes to play back the decision-making process.[9]

Box 1: Isaac Asimov's Three Laws of Robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or the Second Law.

> *"Human societies in the 21st century may be the most unequal in history."*

SHADES OF GREY

As AI has some of the autonomy we normally attribute to moral agents, this has made it difficult to decide on how we should understand the status of AI in the moral community.

Some argue that AIs are not moral agents, but merely pattern recognition or goal-seeking programmes. Just as it is the laboratory scientists we blame for the creation of new viruses and consequent epidemics, not the viruses themselves, it should be AI developers we treat as moral agents, not the AI they develop.

However, others argue that AI developers should not be culpable for the unpredictable consequences that arise from AI's self-learning nature. AI systems often act in surprising ways beyond their creators' calculations. For example, when *AlphaGo* made "Move 37" during Game Two against Lee, it surprised many seasoned Go players and even the *AlphaGo* creators themselves, because it seemed like a terrible mistake.[10] While this "mistake" was harmless (*AlphaGo* eventually won the game), the prospect that AI systems can flummox their creators raises fears that they may one day create unanticipated, harmful consequences. Who should be held accountable then?

Should we programme ethical rules within AI systems so that they can govern their own behaviour? The challenge is that the proper application of ethical codes, such as Isaac Asimov's "Three Laws of Robotics" *(see Box 1)*, is often context-dependent. These codes, when taken to their logical conclusion without reference to context, could lead to undesirable and morally problematic outcomes. In the movie *I, Robot*, for example, the robots ensure the survival of the human race (in line with the Three Laws) by stripping humans of their free will. This contextual nature of morality is also captured in a thought experiment known as the Trolley Problem. While pulling a switch to divert a train—saving five people but killing one—seems permissible (or even obligatory) to many people, the same utilitarian principle does not seem to hold in a different context, where one has to push someone onto the tracks (instead of just pulling a lever) to save the five people. The same moral calculation that we can sacrifice one person to save five applies in one case, but not the other.

It would be relatively easy to programme AI systems with a set of broad ethical codes. But these codes, no matter how intuitive, fail to map onto our human intuitions about what is acceptable and what is horrific in many cases. An AI subway management system that is programmed to maximise the

> ***"Programming AI to understand how to behave morally across a range of contexts—when we barely understand it ourselves—is a difficult task."***

good, will push someone onto train tracks to save five people, and an AI-empowered triage system programmed the same way might hasten the death of terminally-ill patients to harvest their organs for other patients. An AI-nursing system programmed to protect human life might keep their patient maximally sedated, to discourage them from risking their lives by leaving the room. Programming AI to understand how to behave morally across a range of contexts—when we barely understand it ourselves—is a difficult task.

Some efforts are being made to train AIs to use their machine-learning intelligence to understand the morality of their actions. These include attempts to develop contextual awareness through creating the digital equivalent of "guilt" as a feedback mechanism or through feeding AI millions of stories to allow it to generate conclusions about social norms.[11] When much of our moral understanding is built on a history of applications of moral rules and precedents, might AI eventually aggregate and comprehend all of these, becoming not just morally on par with the average human being, but superior? Might AI be our sages and saints of the future?

CONTROL+Z

Advances in AI raise the question: who is in control? Surely, the idea that AI will outwit and control humans must be a red herring. The three problems of inequality, inscrutability and ethics raise intrinsically human issues, not AI ones. Even as AI drives economic and productivity growth, the fear that it will displace people and widen inequalities forces the question of how far societies will pursue equality. The unknowable that is AI speaks to something instinctual and urges us to talk about our own values and how we rationalise our decisions. Similarly, AI's inability to discern the contextual nature of morality compels us to have difficult conversations—about when it is right to make sacrifices for the greater good, what is the greater good and when we should uphold the sanctity of individual life or accede to individual choice. AI forces these issues upon us.

Some have thus called for greater public engagement about AI development.[12] Through open and honest engagement, governments and AI companies can allay irrational fears about AI and develop consensus over a future where people are empowered, not enslaved, by technology. If such conversations remain within the confines of governments and technology giants, misinformation and distrust will proliferate, and even return to haunt us in the same way that the public backlash against globalisation circled back against the elites.

"Who is in control" is about more than AI. It is also about how societies—not just corporates, but also governments and communities—decide our futures. Only in truthful and open engagement about these age-old issues of good, equality and progress, will we be able to write the next chapter in human history.

NOTES:

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2 *One Hundred Year Study on Artificial Intelligence: Report of the 2015 Study Panel*, Stanford University, September 2016, accessed 28 March 2017, https://ai100.stanford.edu/sites/default/files/ai_100_report_0831fnl.pdf

3 Samuel Gibbs, "Musk, Wozniak and Hawking Urge Ban on Warfare AI and Autonomous Weapons", *The Guardian*, 27 July 2015, accessed 10 April 2017, https://www.theguardian.com/technology/2015/jul/27/musk-wozniak-hawking-ban-ai-autonomous-weapons

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5 Shira Ovide, "Silicon Valley's Ma Bells", *Bloomberg*, 27 April 2017, accessed 9 June 2017, https://www.bloomberg.com/gadfly/articles/2017-03-27/ma-bells-of-silicon-valley-raise-monopoly-concerns

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7 Cade Metz, "2016: The Year That Deep Learning Took Over The Internet", *WIRED*, 25 December 2016, accessed 23 June 2017, https://www.wired.com/2016/12/2016-year-deep-learning-took-internet/

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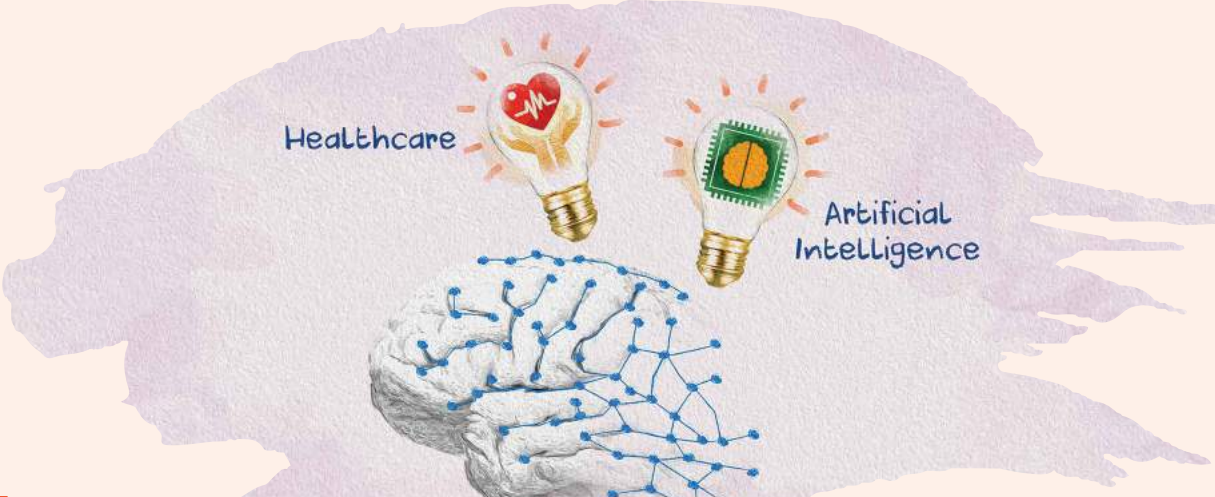
10 When the move was played, the commentators and other seasoned Go players declared that it was a strange move and a mistake. Even Lee Sedol left the match room for 15 minute break to compose himself and settle on a response to a highly unexpected move. Details found in Cade Metz, "How Google's AI Viewed the Move No One Could Understand", *Wired*, 14 March 2016, accessed 5 June 2017, https://www.wired.com/2016/03/goggles-ai-viewed-move-no-human-understand/

11 Ron Arkin, a roboethicist at Georgia Tech is researching a model of ethical AI that has an "ethical adapter" which seeks to simulate human emotions, in order to help robots learn from their mistakes. His system hopes to allow a robot to experience something similar to human guilt. Cited in Simon Parkin, "Teaching Robots Right and Wrong", *The Economist 1843*, June/July, accessed 31 May 2017, http://www.1843magazine.com/features/teaching-robots-right-from-wrong. Mark Riedl, Director of Entertainment Intelligence Lab focuses on the intersection of artificial intelligence, virtual worlds and story-telling. His research is supported by the NSF, DARFPA, the U.S. Army, Google and Disney. The example of using stories to teach AIs the rules of human social situations was also cited in Parkin, "Teaching Robots Right and Wrong".

12 John Browne, Robin Nuttall and Tommy Stadlen, *Connect: How Companies Succeed by Engaging Radically with Society*, New York: PublicAffairs, 2016); also, *The Partnership on AI to Benefit People and Society*, is a not-for-profit organisation dedicated to advancing the public's understanding of AI and serve as an open platform for discussion and engagement about AI on society. Members include the Leverhulme Centre for the Future of Intelligence (CFI). Details found in Partnership on AI, https://www.partnershiponai.org/#s-goals, accessed 23 June 2017.

Emerging Strategic Issues



Igniting the Neuroscience Economy[1]

Imagine exploring one of the last frontiers of science: the more than 90 billion neurons that make up the human brain. What if a Google Maps of the brain existed and anyone could see "street views" of neural connections and explore the topography of neurons?[2]

This is what neural mapping hopes to achieve. Since they started in 2013, the US Human Connectome Project and the European Commission's Human Brain Project have driven research about the brain's circuitry—how the brain and thinking work.[3] Such work has spurred innovative techniques, such as algebraic topology analysis, which uses complex algebra to explore the brain's 3D structure.[4]

The results from neural mapping may unlock economic opportunities in neurotechnology, just as mapping of the human genome did for genomics.[5] SpaceX and Tesla founder Elon Musk is heading a new venture, Neuralink. It aims to use these research findings to develop non-invasive brain implants to treat neurodegenerative diseases such as Alzheimer's, and devices for brain-to-brain and brain-to-machine communication.[6] Greater understanding of how our minds work has spurred advances in artificial intelligence through neural networks, and could spur further advances.

However, neural mapping also brings risks. Just as ethical concerns over the use of genetic screening accompanied mapping of the human genome, what new forms of discrimination might emerge, for example, based on the size of one's "creative" brain region? And if passwords still exist in this future, might they be phished from people's minds through their neural implants?[7]

NOTES:

1 Many thanks to CSF intern Vanessa Goh, who helped research this emerging strategic issue.

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3 See Human Connectome Project, "About", accessed 21 June 2017, http://www.humanconnectomeproject.org/about/ and Human Brain Project, "Overview", accessed 21 June 2017, https://www.humanbrainproject.eu/en/science/overview/

4 "How the Physical Features of Brain Structures Could Help Us Better Understand the Wiring Inside", *MIT Technology Review*, 24 August 2016, accessed 21 June 2017, https://www.technologyreview.com/s/602234/how-the-mathematics-of-algebraic-topology-is-revolutionizing-brain-science/

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On Neuralink, see Liat Clark, "Elon Musk Reveals More About his Plan to Merge Man and Machine with Neuralink", *WIRED UK*, 21 April 2017, accessed 21 June 2017, http://www.wired.co.uk/article/elon-musk-neuralink

7 Adam Piore, "Mind-Reading Computers That Can Translate Thoughts into Words", *Scientific American*, 24 March 2017, accessed 21 June 2017, https://www.scientificamerican.com/article/mind-reading-computers-that-can-translate-thoughts-into-words/

The Death of Ageing

The rich and powerful have long dreamt of the death of ageing, if not of outright immortality. There is now serious money in it. Anti-ageing startup Unity Biotechnology raised US$116 million in 2016 from Amazon CEO Jeff Bezos, Paypal co-founder Peter Thiel and others to further its research in rejuvenation therapy and prevention of senescence (that is, wear and tear with age).[1] Google-backed biotechnology company Calico and biopharmaceutical company AbbVie invested US$250 million each in 2014 to jointly develop drugs targeting diseases associated with old age.[2]

While biology is hard to crack, we are seeing signs of a solution in labs today: the removal of aged or damaged cells, 3-D printing of organs and the identification of bio and genetic markers of ageing, so that they can be targeted through drugs and CRISPR.[3] More modest solutions closer to being commercialised include Metformin, a drug which is used to treat Type 2 diabetes, but has been found to increase the lifespan of mice by nearly 40%.[4] In 2016, the US Food and Drug Administration approved the TAME trial (Targeting Aging with Metformin), which uses Metformin to delay age-related diseases including cancer, cardiovascular disease and Alzheimer's disease.[5]

Rich and powerful countries also have similar dreams. Delaying ageing may allow countries to maintain productivity and prolong economic growth, without excessive reliance on immigration. Studies in Japan have found that extended longevity could encourage people to prolong their working years, potentially raising GDP per capita by 12% by 2025.[6] Rising healthcare costs—the economic cost of Alzheimer's disease in the US is projected to be US$1 trillion in 2050—could be stemmed if citizens are more healthy even in their old age.[7] However, while the cost of existing drugs like Metformin are relatively cheap, new anti-ageing treatments may deepen socio-economic inequalities especially if a combination of interventions is needed.[8] New drugs will be costly, at least initially, while the personalised nature of gene therapy limits access to those with deep pockets. Even as we race to beat the clock, we may already need a plan to share the spoils of longevity.

NOTES:

1 Caroline Chen, "Anti-Aging Startup Raises $116 million with Bezos Backing", *Bloomberg*, 28 October 2016, accessed 20 June 2017, https://www.bloomberg.com/news/articles/2016-10-27/anti-aging-start-up-backed-by-fidelity-bezos-raises-116-million

2 Ransdell Pierson, "Google's Calico, AbbVie Forge Deal Against Diseases of Aging", *Reuters*, 3 September 2014, accessed 20 June 2017, www.reuters.com/article/us-health-abbvie-google-idUSKBN0GY24H20140903

3 On the removal of damaged or aged cells, see "Anti-Aging Therapies Targeting Senescent Cells: Facts and Fiction", *Science Daily*, 29 December 2016, accessed 20 June 2017, www.sciencedaily.com/releases/2016/12/161229141835

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5 Stephen Hall, "A Trial for the Ages", *Science*, 18 September 2015, accessed 15 June 2017, from http://science.sciencemag.org/content/349/6254/1274

6 N Ogawa and R Matsukura, "The Role of Older Persons' Changing Health and Wealth in an Ageing Society: The Case of Japan" at UN Expert Group Meeting on Social and Economic Implications of Changing Population Age Structure, 31 August–2 September 2005, accessed 20 June 2017, www.un.org/esa/population/meetings/EGMPopAge/EGMPopAge_9_NOgawa.pdf

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8 Metformin costs a few US cents per dose, cited on p.1275 of Stephen Hall, "A Trial for the Ages", *Science*, 18 September 2015, accessed 15 June 2017, from http://science.sciencemag.org/content/349/6254/1274; the argument for widening inequality is explained in Linda Marsa, "The Longevity Gap", *Aeon*, 2 July 2014, accessed on 23 June 2017, https://aeon.co/essays/will-new-drugs-mean-the-rich-live-to-120-and-the-poor-die-at-60

Feeding the Future[1]

How will the world feed a population projected to grow from 7.6 billion in 2017 to 9.8 billion in 2050? Climate change will accentuate weather volatility and the amount of arable land is projected to decline from 0.23 hectares per person in 2000 to 0.15 by 2050 due to environmentally unsound practices.[2]

Precision agriculture and biotechnology are promising solutions for achieving sustainable and stable food production. Reflecting this view, investment in agriculture technology grew, on average, 63% yearly from 2010–2015.[3] In smart farms, moisture sensors in the soil are linked to the farm's irrigation and humidity systems, while operations like weeding and harvesting are performed by agri-bots. With farming processes mirroring tightly-controlled factory operations, food production could become more stable, efficient and cost-effective. Advances in genome-editing could also better optimise food production. For example, the C4 Rice Project, a global project led by International Rice Research Institutes, aims to improve crop yields of rice by altering its biochemistry and reorganising its internal structures. Research suggests the potential increase could be around 50% of current yields.[4]

However, many people may not stomach genetically engineered food; they may oppose or slow such developments.[5] Some of the opposition also stems from the second-order implications of these developments. Whether companies or countries, those who can apply these technologies will likely become the key food producers or the owners of key food-production intellectual property. Will everyone have access to food, even as production expands to feed the growing population?

NOTES:

1 Many thanks to CSF intern, Chiu Chai Hao, for researching this emerging strategic issue.

2 World population estimates were obtained from United Nations, "World Population Prospects: The 2017 Revision", 2017, accessed 22 June 2017, http://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf; statistics about arable land per person were taken from Food and Agricultural Organisation of the United Nations, "Achieving Sustainable Gains in Agriculture", 2009, accessed 22 June 2017, www.fao.org/docrep/014/am859e01.pdf

3 Monitor Deloitte, "From Agriculture to AgTech: An Industry Transformed Beyond Molecules and Chemicals", 2016, accessed 9 June 2017, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/Deloitte-Transformation-from-Agriculture-to-AgTech-2016.pdf

4 "Technology Quarterly: The future of agriculture", *The Economist*, 11 June 2016, accessed 5 June 2017, www.economist.com/technology-quarterly/2016-06-09/factory-fresh

5 "Tens of Thousands, March Worldwide Against Monsanto and GM Crops", *Agency France-Presse*, carried in *The Guardian*, 23 May 2015, accessed 23 June 2017, https://amp.theguardian.com/environment/2015/may/24/tens-of-thousands-march-worldwide-against-monsanto-and-gm-crops

Satellites Down[1]

In August 2016, a 1-cm-wide man-made object collided with the European Space Agency's (ESA) Sentinel 1A satellite, creating a 40-cm crater and a change in orbit.

As more and more satellites are launched, the risks of space debris disabling satellites and disrupting navigation and communication systems will rise. Indeed, roughly one in ten functioning satellites in the Earth's orbit had experienced collisions like that of the Sentinel 1A.[2] The frequency of such collisions is rapidly increasing; it is predicted that over the next two decades, the average time interval between collisions could shrink from 10 years to just five.[3]

And it is not just space debris that might disrupt satellites. Solar superstorms will cause similarly extensive disruptions.[4] In 1989, for example, a superstorm led to space agencies losing track of 1,600 spacecraft and to the collapse of the power grid in Quebec, Canada within two minutes. The total cost of the disruptions amounted to $6 billion.[5] Insurer Lloyd's of London estimates that a reasonable range for the recurrence of a Quebec-level storm is 35–70 years.[6]

The impact of satellite disruptions could extend beyond the social and economic. Satellite disruptions could be misinterpreted as acts of aggression and could lead to unintended conflicts, especially as space is already emerging as a strategic arena (see page 30). The UN has yet to comprehensively address the challenges of space debris and space weather.[7] Satellites have enabled many of the things that we take for granted—getting directions via Global Positioning System devices or remote communication, for example—leaving us to ask: are we sufficiently prepared for a world where satellites have gone down?

NOTES:

1 Many thanks to CSF intern, Peter Ooi, for research into this emerging strategic issue.

2 Peter B. de Selding, "Study suggests 10% of satellites suffer debris impacts", Space Intel Report, 27 April 2017, accessed 22 June 2017, https://www.spaceintelreport.com/study-suggests-10-of-satellites-suffer-debris-impacts/

3 Corinne Burns, "Space Junk Apocalypse: Just Like Gravity?", The Guardian, 15 November 2013, accessed 22 June 2017, https://www.theguardian.com/science/blog/2013/nov/15/space-junk-apocalypse-gravity

4 A solar storm occurs when the sun emits a large burst of energy, sending a stream of charged particles and electromagnetic radiation towards the Earth. This disturbs the Earth's magnetic field and disrupts electronic devices such as satellites in its path.

5 CENTRA Technology, Inc., "Geomagnetic Storms", 14 January 2011. This report was written as a contribution to the OECD project "Future Global Shocks", accessed on 26 June 2017, www.oecd.org/gov/risk/46891645.pdf

6 Lloyd's of London, "Solar Storm Risk to the North American Electric Grid", May 2013, accessed 26 June 2017 https://www.lloyds.com/news-and-insight/risk-insight/library/natural-environment/solar-storm

7 The UN Committee on the Peaceful Uses of Outer Space (COPUOS) published a "Compendium of space debris mitigation standards adopted by States and international organizations" in 2016. COPUOS has endorsed an "international framework for space weather services" as one of the seven thematic priorities for its 2018 UNISPACE+50 conference.

Climate Winners and Losers

Climate change is about more than melting icecaps and flooded coastal cities. Climate change action, or inaction, will affect which nations and economies become tomorrow's economic and geopolitical winners and losers.[1] Food production could shift. Canada, Siberia and potentially even parts of Antarctica could become more habitable and productive, while current bread-baskets in the US and China face increasing desertification and extreme weather.[2]

Climate change also puts increasing stress on fraying economic and social systems. It amplifies water conflicts and extreme-weather displacements, and blurs the distinctions between an economic migrant, a political refugee and an environmental migrant. Even climate "winners" such as northern Europe can be affected, thanks to large-scale migration from climate "losers" such as Syria.[3] Global collaboration to protect people displaced by climate change has started: the Nansen Initiative is a state-led platform for engaging stakeholders and recommending action.

However, the sheer millions to be displaced in the coming decades and the limits of receiving countries to absorb climate migrants mean it may be more feasible to climate-proof societies *in situ*. The Netherlands, for instance, sets aside roughly 1 billion euros yearly for the Delta Programme, a key plank of its water management efforts, and is developing new ways to manage water, such as designing lakes, garages and parks to act as reservoirs when waters rise.[4] The Netherlands is also helping places such as Indonesia deal with coastal erosion, a sign that the know-how to deal with climate change may be the next source of competitive advantage as others seek similar solutions.[5] Climate change will bring risks, but whoever can capitalise on those risks and turn them into opportunities may well rule the world. Who will they be?

NOTES:

1 Ed Crooks, "US Falling Behind in Energy Technology, Say Generals," *Financial Times*, 7 June 2017 https://www.ft.com/content/6a3bac0e-4ad0-11e7-919a-1e14ce4af89b

2 Parag Khanna, "Will Climate Change Force Human Migration", 28 July 2016, accessed 20 June 2017, http://www.paragkhanna.com/home/2016/7/29/will-climate-change-force-human-migration

3 Colin Kelley et al, "Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought", *Proceedings of the National Academy of Sciences* 112: 12 (2015), accessed 20 June 2017, http://www.pnas.org/content/112/11/3241.full.pdf

4 Regarding Delta programme funding, see Dutch Government, "Organisation of the Delta Programme", accessed 20 June 2017, https://www.government.nl/topics/delta-programme/contents/organisation-of-the-delta-programme. Regarding new approaches of water management, see Michael Kimmelman, "The Dutch Have Solutions to Rising Seas. The World Is Watching", New York Times, 15 June 2017, accessed 20 June 2017, https://www.nytimes.com/interactive/2017/06/15/world/europe/climate-change-rotterdam.html?smid=fb-nytimes&smtyp=cur

5 Ministry of Infrastructure and the Environment and Confederation of Netherlands Industry and Employers, "The Netherlands to Assist Indonesia in Coastal Reinforcement and Port Development", 23 November 2016, accessed 20 June 2017, https://www.government.nl/topics/water-management/news/2016/11/23/the-netherlands-to-assist-indonesia-in-coastal-reinforcement-and-port-development

The Foresight Process

Communicating Scenarios: The Gentle Art of Inception

By Jeanette Kwek and Liana Tang

As a scenario planner, your worst fears are coming true. The scenarios that you have just presented to your audience are met with silence and you receive what appear to be sceptical looks from around the room. You are unsure where you lost the audience. You wonder if you could have done something differently…

Good scenarios achieve a number of outcomes: they focus attention on unresolved questions and dilemmas, benefitting people who have to make decisions, and they introduce a host of developing trends and their potential impacts to a broad audience, building a shared understanding of the changes an organisation will face. Simply put, good scenarios undermine the assumptions that support our understanding of the world, and sometimes even replace them with new ones. Most people find this deeply unsettling. So, a good scenario discussion requires artful design to give participants a safe space to challenge their own ways of thinking.

> ***"You are trying to manipulate people into being open-minded."***[1]
>
> *- Ted Newland, manager of Long-Term Studies 1965–1971; scenario team leader 1980–1981, Royal Dutch Shell*

Scenarios are not always the easiest to engage with, especially if you are pressed for time, or if the scenario does not immediately relate to your work. For instance, if you were a busy police officer, a scenario about a digitally hyper-connected world and cross-border digital economies would require you to take several mental leaps before you could see how it affects policing. Would the most prevalent crimes in this future be cybercrime and identity theft? How might the Internet of Things and sensor networks

alter investigations? Exhausted from these mental leaps, you might have little energy left for further discussion of the responses that such a future might call for.

We view every scenario planning exercise as an opportunity to try out new approaches and hone our craft. Our latest exercise, from 2015–16, was no different. This article shares a few things that the CSF team did to shake things up a little—to give uncomfortable, new ideas the best chance of getting through to the audience.

1 GET MORE OUT OF THE SCENARIO PLANNING PROCESS

Deep research into driving forces that will shape the future is a mainstay of scenario planning. Scenario planners need to explore the full range of trajectories that each driving force could take, and assess which aspects may be key uncertainties for their audience. While the research typically yields a voluminous report, the wealth of information can be cumbersome and end up being read by only the scenario planning team itself.

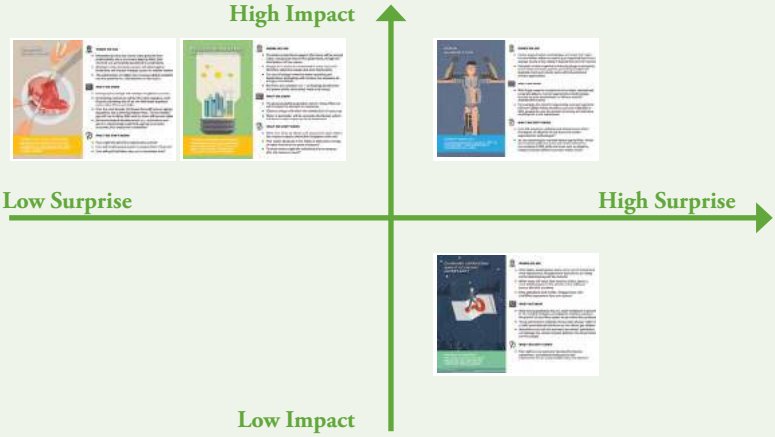
This time, to build a shared understanding of the changes that Singapore faces and garner outside perspectives, we took the additional step of distilling the research into trend cards.[2] Each card focuses on one driving force. It draws out key ideas about the state of play, the pre-determined aspects, critical uncertainties and potential implications for the reader to consider. This makes it much easier for readers to quickly understand the driving forces, without having to comb through a long report.

An example of the Driving Forces cards, which illustrate key points at a glance. Users could understand quickly the current state of play, some predetermined elements, and some critical uncertainties.

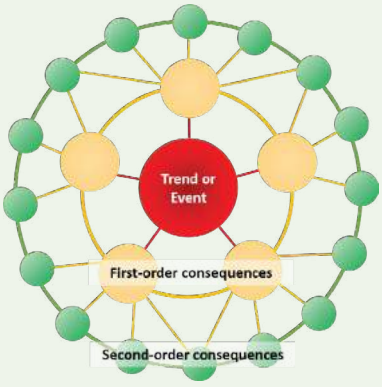
With the deck of cards, our possibilities expanded. Workshop participants could use the cards to piece together how the driving forces might reinforce one another, creating wicked problems and opportunities. Or participants could have conversations not just about direct impacts of each driving force, but also possible second- and third-order effects that might affect them. Groups could also rank the driving forces to prioritise areas for further study, and explore whether lowly ranked cards reflect collective blind spots.

Driving Forces Cards: Many Ways to Play

An Impact vs Surprise ranking exercise can help groups prioritise issues for further research

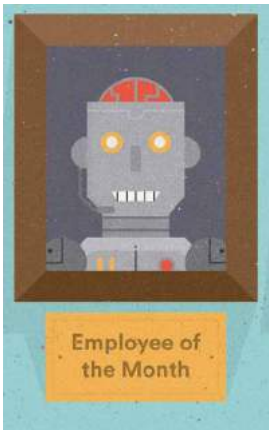


A Futures Wheel activity helps participants identify second- and third-order impacts that their organisations might be unprepared for. Players can place a Driving Force card in the middle of the circle and draw out, in expanding concentric circles, first-, second-, and third- order impacts from that driving force.



To encourage more divergent conversations around the driving forces, we took inspiration from the Hawaii Research Centre for Futures Studies' concept of "alternatives futures". This sets out four archetypes of continuation, collapse, discipline and transformation for scenarios.[3] We found that we could also apply these at the driving forces level to arrive at different trajectories for each driving force.

HUMAN SUBSTITUTION



CONTINUATION

Alpha Goes To Work. Highly autonomous technology acts as a substitute for most mid-level economic functions. Inequality rises as large swathes of the population experience structural unemployment, while wealth accrues to owners of capital and non-substitutable occupations.

TRANSFORMATION

Coexistence. Gradual changes reduce the need for human labour. Clever deployment in less productive sectors increases value. As adoption is gradual and differs between sectors, people can re-skill both horizontally and vertically, minimising job losses.

DISCIPLINE

False Dawn. Ethical and safety considerations result in public and regulatory pushback, particularly where human life is concerned, such as in the deployment of autonomous vehicles and fully automated weapons platforms. Workers keep their jobs but uneven productivity growth leads to stagnating wages.

How might human substitution pan out? The trajectories could be used to construct mini-scenarios in workshops

The modular, flexible nature of the cards helped in two ways. First, the cards raised awareness of the driving forces, and introduced new ideas and vocabulary even before the scenarios were developed. For example, we saw policy-makers begin to reference the idea of "people as businesses", which described new work arrangements enabling individuals to manage and sell their skills and expertise in slices, when discussing the future of work, business and society. Another term that caught on was "digital barons", which drew the analogy between the rise of powerful digital corporations and the influential railroad barons of the past.

Second, it helped us reach out beyond the Government to members of the public and students, because the cards were less imposing and easier to understand than a formal report. As our stakeholders took the cards and adapted them to their own organisations, we learnt quickly that our list of activities was not exhaustive. People quickly invented their own ways of using the cards. For instance, the National Youth Council created their own cards, based on ours, for a workshop with youth leaders to explore ways to mobilise communities to prepare for the future. We hope this engagement of a wider audience, inside and outside the Government, will allow us to develop a more broad-based futures-thinking capability in Singapore.

2 SHOW, RATHER THAN TELL

When the audience *does* have the appetite for scenarios, how do we get them to empathise with the stories? In our experience, our audiences often approached scenarios analytically, with their heads rather than their hearts. They sought to understand the chains of cause-and-effect that produced the end scenario. As a result, our readers frequently did not emerge with a sense of what the scenarios meant to the average citizen, and thus without empathy for their struggles and opportunities.

We therefore developed a video to present the scenarios, to allow our audience to "see and hear" a slice of life in the scenarios and feel the forces influencing and constraining the choices they might have to make in those situations.

Adam takes the audience on three different taxi journeys, each showing a slice of life in the scenarios.

In it, we ride along with the same main character, Adam, on three taxi journeys in "parallel worlds" of the future. We listen in to his conversations with his driver and fellow passengers. Through Adam's eyes, we experience the joys of and frustrations about life in each scenario. Our audience also gets to compare and contrast the lived experience across the different scenarios. This helps policy-makers, in particular, walk around in the shoes of the everyman, consider the plight of diverse groups in society, and take these perspectives into the discussions about the implications of the scenarios.

3 LIVE IT, DON'T THINK IT

Much has been said about the merit of serious games and how "policy games" can be used to improve the quality of planning and decision-making. We have experimented previously with games that situate public officers in conditions of incomplete information and ambiguity, to simulate decision-making under these constraints.[4] These have helped us understand hidden complexities, reflect on our reflexes and teach us the tacit considerations needed to do our jobs well.

Inspired by the immersive games that the Ministry of Manpower created during their scenarios exercise in 2015, we too developed a game, in-house, in our recent exercise. The game was not meant to help public officers rehearse decisions that they might face, but to immerse them in the scenarios, to fire up their imaginations and spark richer discussions. The game has helped participants internalise the tensions in each scenario and experience the factors beyond their control that favour one group and disadvantage another. Ultimately, the players empathise: what happened to me in the game can happen to anyone in the scenario. And that realisation tells them why they should care about responding to the scenarios.

At the end of the day, a scenarios exercise should not be judged based on whether the scenarios themselves materialise, but on the extent to which they compel us to

Example of a Scenarios Game

In a workshop setting, scenario participants played a game that situated them in the scenario worlds, with each round corresponding to one of the scenarios. Players started with individual profiles, accompanied by a set of resources, namely money and social connections. Using these resources, players competed to achieve various objectives, some of which required cooperation and some of which did not. The incentives in each round were designed to create psychological and social dynamics (such as frustration of the poverty cycle and anxiety in a gig economy) that mirrored life in the respective scenario. The game required players to get up and move around the room, and to bargain or cooperate with fellow "citizens".

Players collaborate to unlock an economic opportunity that will yield a generous pay-out. But can they organise themselves before the clock stops ticking?

"This world is tough for someone like me without money and connections. I can't get ahead; no opportunities are open to me. I feel hopeless."
- Participant reflecting on his experience living in a winner-takes-all world of technology-driven growth

"It was difficult to do well in this world, but once the community got together, we realised we actually could win."
- Participant reflecting on living in a world of economic uncertainty, where communities had to rally together to survive

The result was that people got out of their comfort zones of dispassionate analysis, having fully experienced the brutal rules and dynamics of each world. This activity even served as an ice-breaker of sorts. Participants emerged energized, open to sharing personal reflections of what it was like living in each world.

re-examine conventional wisdoms and reframe strategies to meet potential challenges and opportunities. How well they succeed in doing so hinges on how the underlying research can be made accessible to the audience, and in turn used to generate good discussions. Spending effort in designing the right vehicles for the content is as important as (if not more important than) developing the scenarios themselves. When participants are in the right frame of mind to discuss the range of possibilities, they are that much closer to understanding what might happen in the future, and what they ought to do today to be ready for it.

NOTES:

1 Quoted in Angela Wilkinson and Roland Kupers, "Living in the Futures", *Harvard Business Review*, May 2013, accessed 20 June 2017, https://hbr.org/2013/05/living-in-the-futures

2 These cards are available on the CSF website: http://www.csf.gov.sg/docs/default-source/default-document-library/future-deck-cards.pdf

3 Jim Dator, "Alternative Futures at the Manoa School", *Journal of Futures Studies*, November 2009, accessed 15 May 2017, http://www.futures.hawaii.edu/publications/futures-studies/AltFuturesManoa2009.pdf

4 In CSF's *Foresight* 2015 article "Trust and the Public Service", we discussed the effort to use gaming to help public officers grapple with the abstract concept of public trust and how the choices they make in their daily work can impact and shape public trust. *Foresight* 2015 is available at http://www.csf.gov.sg/docs/default-source/default-document-library/csf-report-2015.pdf

Meeting The Team

Meet the CSF Team

Derrick CHAM
Strategist

Derrick has worked in the field of foresight for two years with a focus on horizon scanning, especially in the area of emerging technologies. In his spare time, he plays video games and avoids physical exercise.

Hannah CHIA
Senior Strategist

Although Hannah began civil service life in a classroom teaching Literature and History, she has always been interested in futures. Since joining CSF, she particularly enjoys the wide array of issues, diverse personalities she encounters and the space to ask unthinkable questions. At the office, she sometimes responds to "nah-nah".

CHAN Chi Ling
Strategist

Chi Ling stepped into the foresight world in 2015, and has since enjoyed running down various rabbit holes with CSF. Her previous projects include exploring the changing R&D landscape in China, opportunities from the sharing economy, and the future of ageing in Singapore. Invigorated by her experience hunting black swans, black elephants and sacred cows at CSF, she is now looking forward to her next project on the future of care-giving in Singapore.

Gunathilakan DARMALINGAM
Executive

Gunathilakan, or Guna as he's affectionately known, is the office's resident swami. After spending each workday bailing his colleagues out of trouble, Guna goes home to his lovely grandchild, three kids, two nephews, an amazing cook-of-a-wife and their veritable assortment of adorable pets. He loves airplane models and has a collection to rival the best of them.

Cassandra CHEW
Senior Strategist

Cassandra has co-authored two books about Singapore's first prime minister Lee Kuan Yew as well as covered both local and foreign politics over a six-year stint at *The Straits Times*—where she has travelled far and wide: from the housing estates in Moulmein-Kallang GRC to the slums of Jakarta, and Melbourne's city centre, among other places, for news assignments. But close friends and family know she is happiest baking in the kitchen or painting in her makeshift art studio at home.

Rahul DASWANI
Senior Strategist

Rahul's life is filled with adventure. Having lived and worked in Indonesia, Papua New Guinea and Ethiopia, he has moved his exploration to the world of ideas. He is keeping his goal of an annual dive trip alive, with previous destinations of Zanzibar, the Great Barrier Reef and Fiji (just off the island where *Cast Away* was filmed). A practitioner of mindfulness and meditation, Rahul's zen state provides a tranquil energy for the office to launch into discoveries of a wide array of possible futures.

Yulia HARTONO
Manager, Information Research

Yulia's exposure to the confounding world of foresight began in the mid-2000s, with the advent of the Futures Group in the Ministry of Trade & Industry, where she worked as a librarian. She is still coming to terms with futurists who craft plausible futures for 2037, but forget to carry an umbrella for lunch in perennially rainy Singapore.

Jeanette KWEK
Deputy Head, CSF / Assistant Director

Jeanette has been called the team's resident cynic, probably because she has decided that pessimists are never disappointed, so expecting the worst means you can only be pleasantly surprised. (Wait, does that make me a closet optimist?!) She has spent the last decade toggling between two loves: geopolitics and strategic foresight. They've had to jostle for room with a husband and two precocious children, as well as a rapidly-expanding library and mugs of hot coffee.

Melissa KHOO
Director, Strategic Planning & Futures

Melissa enjoys the good fortune of shepherding the CSF team, and helping with strategic planning for the Singapore government. She isn't new to talking about futures either, having coordinated Our Singapore Conversations (2012–13), a yearlong process of getting thousands of Singaporeans to talk about their concerns and aspirations for their futures. Having worked in the private sector, she values getting external voices and perspectives into government conversations about futures and strategies.

LEE Chor Pharn
Principal Strategist

In his day job, he hunts for cognitive surplus to tickle future demand, and sets aside time to identify asset-light modes of operating. His night job involves taxidermy-ing butterflies and sketching Asian deities lost in a secular environment. CP is increasingly sentimental about re-used futures. He now has a robotic cat.

Leon KONG
Senior Strategist

Leon is drawn to eclecticism. He joined CSF after a stint at a headhunting firm in New York, and close to three years with the Ministry of Finance working on social policy. His hobbies, too, are catholic, including such activities as riding his KTM motorcycle and scouring the Esplanade library for obscure movies from remote times and places. These developments were, admittedly, not immediately anticipated. Yet, they had always been there, concealed in time present, past and future. We see through a glass, darkly; Leon looks forward to doing so full-time and on a national scale.

Wei Jian LEONG
Assistant Director

Reactants → Products. A chemist by training, Wei Jian has always been fascinated by reactions. Since joining CSF, he spends a good part of his time thinking about how to balance the equation of governance, as reactions on the ground are more volatile than before. Wei Jian is also the office's human-jukebox.

Inthira MAILVAGANAM
Senior Executive

Indra is our resident superhero, who keeps this ship of foresight from grounding itself. We would be lost without her.

Terence POON
Assistant Director

Terence loves *trying* to think beyond the confines of his messy desk, a symbol of the complicated and sometimes complex world in which we live. Before joining CSF, he spent seven years in Beijing where he reported on the Chinese economy, and arranged training for Chinese government officials to learn about trade and economic regulation from the European Union during the worst of the Euro crisis.

Joan MOH
Head, CSF / Deputy Director

Joan's foray into the wonderful world of futures has been an exhilarating ride, and she is constantly amazed by the new ideas and connections that she encounters. An engineer by training, she has embraced the diverse, multi-disciplinary good folk of CSF and is quite humbled by the generous licence the team has to think about the future.

Liana TANG
Senior Assistant Director

Liana has dabbled in many disciplines. A biologist by training, her career has ranged from tinkering in service prototypes and proof-of-concept projects in social and mobile media, to designing policies relating to digital literacy, libraries and national archives. She's been into futures ever since she, egged on by Jared, started reading Liu Cixin's *The Three-Body Problem* series of science-fiction novels. In the office, she is the resident critter expert, regaling her terrified colleagues with lurid facts about spitting spiders, horsehair worms and intestinal parasites. In her spare time, she cycles, does a lot of yoga, and harasses her pet cat, Dirty.

Jared POON
Lead Strategist

Jared likes ideas, and likes helping ideas interact and reproduce. He loves both the a *priori* analysis of concepts as well as the empirical studies on how we think and feel, and is trying to build a better life and a better world through reason and research. To this day, he denies being a superhero, and all reports of him fighting crime in spandex are probably just anecdotal, and to be disregarded.

Joanne WONG
Strategist

Joanne loves a challenge. She is an idealist who believes that the world's most complex technical and people problems can be solved, that the individual can make a significant impact on the world. Her childlike, persistent curiosity has inadvertently accumulated eclectic experiences for her, from conducting social experiments in online games and delivering a baby, to chatting with the mafia in a Sao Paulo *favela* and hanging out at mystical Christian trance parties. She keeps herself entertained by trying new and unusual foods, watching sci-fi anime and reading conspiracy theories, especially those concerning the supernatural.

Meet Our Researchers

Many thanks to the legions of researchers who have helped us in the past two years. Their perspectives and industry enriched our work; their good cheer and youthful energy enlivened our office.

Yi Heen BOEY,
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National University of Singapore

Winston CHEE,
London School of Economics/ University of Cambridge

Qing Ying CHIAN,
National University of Singapore

Chai Hao CHIU,
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Shu Min CHONG,
Peking University

Eddie CHOO,
National University of Singapore

Benjamin CHOY,
Singapore Management University

Gabriel CHUA,
London School of Economics

R Daminisree,
Nanyang Technological University

Benjamin GOH,
Harvard University

Derek GOH,
Tufts University

Hannah GOH,
Nanyang Technological University

Vanessa GOH,
University College London

Yuhuai HUANG,
National University of Singapore

Kamala Malar d/o KAMALACUMAR,
National University of Singapore

Benz KOH,
NUS High School of Mathematics and Science

Lionel KUEK,
Yale-NUS College

Jodi LAU,
National University of Singapore

Chi Chian LEE,
Peking University

Deborah LEE,
National University of Singapore

Joseph LEE,
University of Cambridge

LI Jie Sheng,
University of Birmingham

Cain LIM,
Nanyang Technological University

Derek LIM,
National University of Singapore

Ming Kit LIM,
University of Oxford

Benjamin LIU,
Singapore Management University

Zul Hazmi Bin NORDIN,
Nanyang Technological University

Bing Lin NYANG,
Yale-NUS College

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John TAN,
Peking University

Shona TAN,
Singapore Management University

Tanuj GEORGE ,
Singapore Management University

Yi Heng TEO,
Singapore Management University

Zhi Ping TEO,
Stanford University

Ziqiao WANG,
National University of Singapore

Elvin XING (CSF Fellow),
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Yixuan YANG,
Yale University

Nicole YEE,
Singapore Management University

Vinna YIP,
National University of Singapore

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