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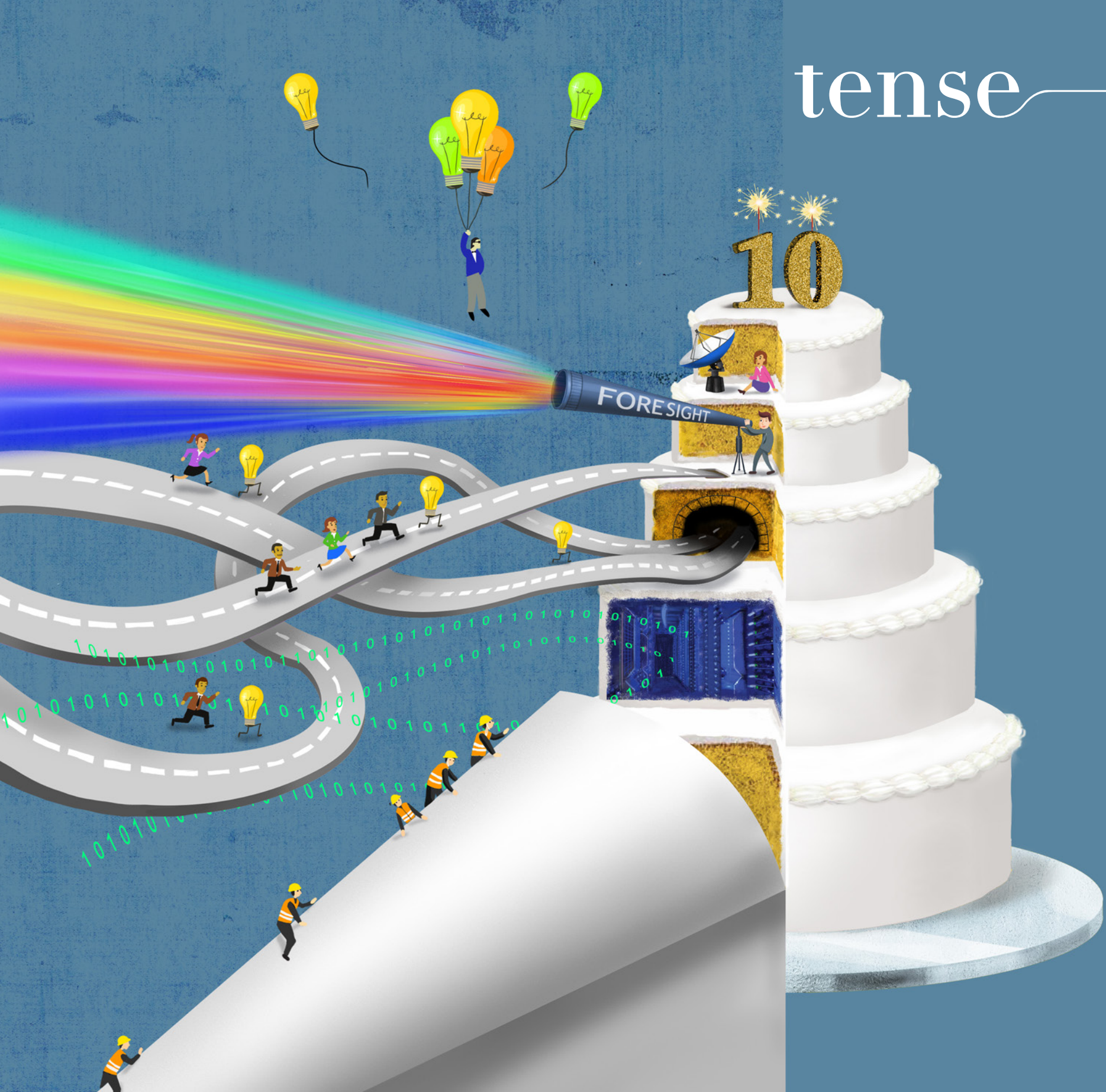

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FOREWORD

2016 marks ten years since the Futures Group was set up. This is an important milestone for the unit and I would like to congratulate the team and thank the alumni who have contributed to its success over the years.

The considerations guiding foresight work today are vastly different from a decade ago. It is arguably a more challenging environment for foresight practitioners, with greater expectations driven by compressed cycles of unexpected change. At the same time, the ecosystem of foresight units across the Singapore government has matured to keep pace with the increasingly cross-cutting nature of policy work. Amidst these changes, the Futures Group has had to reinvent itself continuously while retaining a focus on delivering insights to influence strategy and policy formulation.

Foresight will continue to remain relevant as we refine existing strategies and develop new initiatives to keep Singapore's economy vibrant and create good jobs. The external environment is uncertain and has seen significant structural shifts. There is also a constant tug-of-war between addressing concerns in the present and future-proofing our economy to meet the challenges ahead. This will undoubtedly test the mettle of the Futures Group as it translates analysis of long-term trends into insights for strategy in the short to medium-term.

I hope you enjoy reading this edition of Future Tense.

Loh Khum Yean
Permanent Secretary
Ministry of Trade and Industry, Singapore

EMERGING STRATEGIC ISSUES

In 2014, the Futures Group piloted a process to scan and track developments relevant to the operating environment of Singapore's economy. The intent of developing this was to identify system-level shifts and create a pipeline of issues for further exploration and discussion. We were inspired by the Centre for Strategic Futures' projects on emerging strategic issues (ESIs) in 2009 and 2012, and learned from their experience. Three years on and several ESIs later, we continue to refine our process and remain committed to dig for clues on how our turbulent, uncertain and ambiguous world will change. In this section, we share what we have learned and highlight connections between and across some of the ESIs we have identified.

The Futures Group would like to acknowledge the following individuals who have contributed to our ESI scans over the years: Bill Cai, Chiu Chai Hao, Glen Chua, Shuyuan Ho, Lee Chor Pharn, Rebecca Lim, Siantar Christopher She Dongfa, Damien Soh, Tan Chor Hiang, Minlu Zheng

UNDER THE HOOD

Manoj Harjani

The iterative way in which we scan and track developments is both a strength and a weakness. Each of the four steps highlighted here has its own internal loops to follow. While this allows us to fine-tune ESIs and reshape them as new developments come to light, it can also slow things down past the ideal moment to communicate an idea. Another important learning point is that the benefits of having a structure can be eroded by the loss of flexibility it inadvertently creates. Sometimes the best ideas for ESIs emerge from outside the process itself, and space needs to be catered for this so that the scans retain their ability to surprise and challenge mental models.

FARMING SOURCES

The sources we consult form the backbone of the ESI process, and there are some factors guiding how we identify and choose to retain them:

1)"Hit rate" – how often does the source generate relevant developments? We put all our new sources on probation and look for an acceptable ratio between the number of relevant developments and the overall quantity of content a source generates.

2)Diversity – where is the source based and what spectrum of opinion (i.e. mainstream versus fringe) does it represent? The boundary between mainstream and fringe can be quite grey sometimes – blogs and magazines that started out small can narrow their views as they change hands and develop a larger readership. Our fringe sources tend to be individuals with unusual, unconventional and unexpected views.

3)"Multipliers" – periodicals are a staple, but newsletters and social media feeds where thought leaders and experts curate selections that appealed to them are invaluable. Social media metrics – followers, likes and shares – are useful here, as well as observing what sources these "multipliers" themselves consult.

FILTERING DEVELOPMENTS

This step has two layers. The first layer is relevance with respect to the operating environment of Singapore's economy. This requires the individual strategist to have deep knowledge of the driving forces affecting the operating environment as well as existing policy initiatives and strategies. The second layer has two aspects – evidence of impact within a five to ten-year horizon and impact across at least two domains (society, technology, economy, environment and politics). The second layer is trickier to gauge, particularly for impact across time. To minimise bias and false positives, we aim to validate evidence of impact across a range of sources, and keep ourselves open to revising our assessments when new evidence surfaces.

CLUSTERING DEVELOPMENTS INTO ESIS

Our goal here is to distinguish between incremental and step changes to the operating environment in order to prioritise the latter. Incremental changes can trace causation, whereas step changes are akin to water becoming ice – made of the same stuff, but behaves quite differently. We prioritise step changes because they tend to have disproportionate implications for the systems they affect, and unlike incremental changes, do not exhibit features that can be extrapolated to facilitate forecasting.

The clustering step of the process is also where much of the iteration takes place – as we draw connections between filtered developments to develop them into ESIs, new implications and issues often surface.

ANALYSING ESIS OVER TIME

The main goal of this step is to keep the pool of ESIs being tracked relevant. We do this by assessing the momentum of each ESI – what direction is it heading in, and how quickly is it creating changes to the operating environment. Similar to the filtering step, we aim to validate across sources, but consensus can be difficult to reach because trajectories for ESIs vary in their degree of uncertainty. We stop tracking ESIs once they enter the mainstream, i.e. they find a place on the policy agenda and/or are the subject of a policy response.

SYSTEM-LEVEL SHIFTS: 2014-2016

As our crop of ESIs grew in the past three years, we were able to explore connections between them and identify system-level shifts in the operating environment that they were feeding into. With the benefit of hindsight, we outline four such shifts, and look at the ESIs that have fed into and sprung out from them. Taken together, these shifts comprise the beginnings of a map to understand how the operating environment for Singapore's economy has fundamentally changed in the past few years, and to spur discussion around where the next shifts may emerge.

DECARBONISING ELECTRICITY

In an ideal world, renewable energy would be able to stand on its own as a reliable, competitively-priced alternative to fossil fuels, with the externalities arising from using fossil fuels appropriately accounted for (**PRICING THE ENVIRONMENT**). However, we do not live in an ideal world yet. Fossil fuels are still a major source for electricity production, receiving a boost from the discovery of unconventional sources (**METHANE HYDRATES, US SHALE**) and changing political dynamics (**SHEIKH VS SHALE**). Furthermore, renewable energy business models still depend on government subsidies in order to derive profit. In Germany, for example, deliberate policy measures (**ENERGIEWENDE**) to move towards a climate-friendly energy supply have driven a renewables boom but at the same time harmed industrial competitiveness and surprisingly not reduced CO_2 emissions.

Even if renewables are cost-competitive without subsidies, they suffer from irregular supply. Affordable grid-scale energy storage solutions using batteries can smooth the peaks and valleys of irregular supply, allowing renewables to compete on cost (**BATTERIES NOW INCLUDED**). However, the excitement over "renewables plus storage" competing on cost has fed into a narrative of grid defections. But utilities are not going anywhere anytime soon. In fact, they are responding to distributed generation by adopting the very same decentralised business models used by startups aiming to disrupt them (**UTILITIES' REINVENTION**).

PRICING THE ENVIRONMENT

In 2014, we highlighted how more companies were shadow-pricing carbon to gauge opportunities and manage risk in anticipation of a global carbon price[1]. While carbon markets have yet to mature to that stage, there is still a need to monitor how business models and value chains may be affected by the pricing in of environmental goods.[2]

METHANE HYDRATES

The Futures Group noted in 2014 how the commercial exploitation of methane hydrates – ice deposits that contains natural gas – could drive an energy boom similar to the "Shale Revolution."[3] We also examined efforts made by Japan to exploit this untapped resource given the supply insecurity it faced as a result of the change in its energy mix post-Fukushima.[4] While low oil prices may have reduced the incentive for other countries to pursue exploitation of methane hydrates, Japan appears to be pressing ahead, with commercial production planned for 2023.[5]

US SHALE

Our interest in the so-called "Shale Revolution"originally stemmed from its potential impact on the manufacturing sector in the US.[6] Developments we monitored between 2013 and 2015, however, show that the re-shoring of manufacturing production to the US has been more hype than reality.[7] Nevertheless, the geopolitical impact of the US becoming an energy exporter is arguably more significant, which we explored in the 2015 ESI "Sheikh vs. Shale."

SHEIKH VS. SHALE

In 2015, the Futures Group examined how lower oil prices as a result of the US "Shale Revolution" prompted a response from major oil producers that exerted further downward pressure on oil prices.[8] While prices have since recovered, these developments raised larger questions for the sustainability of economic growth in oil-dependent economies and more broadly for their political stability, particularly in the case of countries in the Middle East.

UTILITIES' REINVENTION

Decentralised renewable energy generation and storage has yet to create a "death spiral" for utilities. In 2015, the Futures Group highlighted how utilities are developing new business models to stay ahead of the competition, e.g. deploying power routers that allow utilities to harness energy from any source and distribute it.[14]

ENERGIEWENDE

Germany launched its Energiewende ("energy transformation") policy in 2011 to shift the energy base from nuclear and fossil fuels to renewables (solar, wind) – with a target of 80% electricity from renewable sources by 2050. Ironically, this has made Germany more energy insecure, hurt its industrial competitiveness and increased carbon emissions.[9] Looking ahead, Energiewende may be a source of inspiration to countries attempting to make the transition to clean energy, but is less likely to be considered a blueprint.[10]

BATTERIES NOW INCLUDED

The Futures Group has long been interested in battery technology. We first wrote about how better batteries were driving the growth of mobile technology in 2008.[11] Since then, lithium-ion battery technology has matured and affordable grid-scale energy storage solutions have become more commercially viable.[12] At the same time, the growth of lithium-ion battery technology has stifled development of alternatives that may be more viable at scale, and energy storage research remains highly fragmented.[13]

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PUSHING OUT TO THE FRONTIER

Throughout history, economic growth has been fuelled by an expanding pool of workers and/or rising labour productivity.[1] As developed and emerging economies face a sharp decline in the number of available workers, catching up to the labour productivity frontier will make all the difference for future growth. But raising productivity is not for the faint of heart in an environment of low growth where new constraints and costs have emerged, such as pressures to account for carbon emissions and greater scrutiny of tax incentives. However, technology breakthroughs (e.g. **PEER-TO-PEER LEDGER**) and business model innovation (e.g. **SHARECONOMY, INNOVATING INNOVATION**) are opening up new ways to raise productivity, and the companies championing them (**DIGITAL CONGLOMERATES**) have ended up playing outsized, quasi-national roles. At the same time, there have been unintended consequences. For example, the rise of technology companies has changed the landscape of value creation globally, rendering the traditional hub-and-spoke model less relevant (**ONE HUB TO RULE THEM ALL**). Furthermore, increasing digitisation of the physical world has opened the door to new risks from cyber-attacks (**SMART BUT INSECURE**).

PEER-TO-PEER LEDGER

Amidst the hype over Bitcoin's failures in 2014, the Futures Group highlighted opportunities for the blockchain technology upon which it is based.[2] Since then, we have observed the emergence of a wide range of blockchain-based applications, e.g. in financial services and distributed autonomous organisations.[3] As this ecosystem has matured with more sectors adopting blockchain technology to facilitate transactions, we have observed a splintering between applications based on public blockchains versus those based on private ones. Read on in "Trust thy Intermediary".

SHARECONOMY

The Futures Group first wrote about the development of a globalised auction of jobs in 2011[4] and later on observed the rise of freelancing and flexible work arrangements facilitated by digital platforms.[5] By 2014, these platforms had matured into the sharing and gig economies, and Airbnb and Uber were changing supply and demand dynamics in their respective sectors.[6] Since then, we have noted how the sharing and gig economies have faced regulatory hurdles and public backlash, casting doubt on the long-term viability of their business models.[7] As sharing and gig economy companies become a greater source of employment, the risks associated with both their growth and failure have increased.

INNOVATING INNOVATION

In 2016, the Futures Group highlighted three ways in which companies were exploring beyond traditional models of R&D, arguably signalling a shift in the nature of the innovation ecosystem itself.[8] Read on in "Innovating Innovation".

DIGITAL CONGLOMERATES

The Futures Group first highlighted how Chinese digital conglomerates like Alibaba, Tencent and Baidu were moving into non-adjacent sectors in 2013.[9] We subsequently tracked the emergence of the next crop of digital conglomerates, examining "decacorns" – startups with funding of US$10bn or more – like Xiaomi and Uber.[10] As more companies embrace digitisation and "digitally native" companies become the norm, we explored the implications arising from this in the 2015 ESI "One hub to rule them all".

ONE HUB TO RULE THEM ALL

In 2015, we noted how digitally native companies tended to be asset-light yet productive.[11] This has implications for the value proposition of a hub to site finance, R&D or logistics activities. Network effects are likely to create a winner-takes-all outcome with one or two global winners based in one "superhub" to access global markets. Furthermore, asset-light digitally native companies are less sticky and by comparison more willing to unwind their activities and pull out. In contrast, asset-heavy companies (e.g. those in the energy and chemicals sector) are more stable and sticky investments, but their land and carbon-intensive footprints disadvantage small economies.

SMART BUT INSECURE

With the growth of the Internet of Things, the Futures Group noted how cyber-attacks increasingly had a physical impact.[12] Furthermore, companies are spending more on cybersecurity, but this is not leading to a reduction in business costs arising from cyber threats. Nevertheless, new approaches are being developed that could change the cybersecurity landscape. Read on in "Smart but Insecure".

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12. *Emerging strategic issues scan 2016*

LABOUR RUPTURE

Economies are diligently pursuing optimisation with technology's help, but have yet to fully address the side-effects on workers. This task is made more challenging by the fact that the current wave of automation is creating polarisation on two fronts. The first and most overt front is between workers empowered by the growing pervasiveness of technology and those displaced by it. The second and less obvious front is between governments and companies over responsibility for training and sustaining the workforce.

As governments, companies and workers search for a new equilibrium amidst these changes (**NEW SOCIAL COMPACT**), what is clear is that fears of an AI-led labour "apocalypse" are unwarranted (**LABOUR APOCALYPSE: NOT QUITE YET**). However, there has been an uneven recognition that labour's role in terms of creating value has changed as humans find themselves caught between robots and software (**HUMANS GETTING SQUEEZED**). We also see a silver lining in signals which highlight that, where software aids humans in making better decisions, there may be a labour "augmentation" leading to an increase in productivity instead of an apocalypse. Read on in the "Labour rupture" deep-dive.

NEW SOCIAL COMPACT

In 2015, the Futures Group observed how values such as hard work and meritocracy, which had traditionally underpinned the social compact, were being undermined[1] as workers saw their jobs broken down to become tasks which were either automated or outsourced to freelancers in a gig-based model. This has exerted increasing pressure on governments to meet displaced and underemployed workers' expectations and improve their welfare, e.g. through a "living" rather than minimum wage or a guaranteed basic income. In contrast to previous reconfigurations of the social compact, however, technology companies will have a larger role to play this time around in order to mitigate public backlash against the negative side-effects of the disintermediation and disruption they have created.

HUMANS GETTING SQUEEZED BETWEEN ROBOTS AND APIS

The Futures Group noted in 2015 how middle rungs of the job ladder were also beginning to fall victim to software capable of performing basic managerial tasks such as coordination and delegation.[3] When commoditised, however, such machine-generated expertise can actually open doors for more companies, particularly SMEs, to benefit. This could create jobs to offset those lost as a result of more sophisticated automation by software.

1. *Emerging strategic issues scan 2015* (Singapore: Ministry of Trade and Industry Futures Group, 2015)
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3. *Emerging strategic issues scan 2015*

LABOUR APOCALYPSE: NOT QUITE YET

We took aim at the growing hype (and hyperbole) over the loss of jobs to robots and software in 2016 by highlighting two opportunity areas arising from automation.[2] Firstly, automation has achieved a degree of productivity beyond human capability in some business processes, e.g. high-frequency trading, which has unlocked new sources of value. Secondly, automation of routine tasks has created opportunities for knowledge workers to spend considerably more time and energy on tasks that utilise creativity and emotion. More importantly, with the advent of AI as a perfect substitute for human labour, our idea of labour as a factor of production has changed. Read on in "Labour rupture" deep-dive.

POLES TO POLARISATION

Let's get over the idea of a "new normal". Even a brief look at our global system in recent years shows that things have been anything but normal. The post-Cold War global order has kept us all guessing, swinging wildly between fragility and resilience. Amidst this chaotic transition, two major transformations have taken shape.

Firstly, as the digital economy has grown and increasingly transforms the physical economy, lines have been drawn across and between countries and companies over control of the Internet and the digital flows it facilitates. Sovereignty over data and governance of the Internet's underlying infrastructure have been sore points between governments following the Snowden revelations (**SPLINTERNET**). Managing the social and political influence of platforms created by digital giants like Google and Facebook is only part of the story. Governments are keenly aware of the ability to create a conducive environment to nurture their own digital champions through the very same barriers (**DIGITAL PROTECTIONISM**).

The second major transformation is seen in the ongoing consolidation of China's rise to the economic apex of the global system. China is recognising the power of its newfound position as a major global investor (**THE NEXT CHINESE CAPITAL WAVE**) and using it to lay out a vision for its economy to dominate everything from advanced manufacturing to outer space (**STILL MADE IN CHINA**). This has important implications for the rest of Asia as China's economy matures into one driven by consumption, reconfiguring global value chains in the process. Furthermore, a leadership vacuum has emerged on the global stage. America's traditional role for issues such as free trade and climate change is now uncertain following President Trump's declaration of his administration's "America First" orientation.[1] With China signalling its intent to assume greater responsibility on the global stage,[2] questions remain over how it seeks to shape the global order and how the institutions it has supported as alternatives will now function alongside the status quo.[3]

SPLINTERNET

In 2014, the Futures Group monitored fallout from the Snowden revelations in the form of data sovereignty initiatives in Europe and Brazil that pointed towards the emergence of a "balkanised" Internet.[4] At the same time we noted a push by China for an alternative governance model for cyberspace to the current one dominated by the US.[5] Since then, the Internet has not splintered into a multitude of regional "Internets", but there has been increased adoption of regulations governing storage of personal data which impose restrictions on cross-border data flows. Read on in "Industry of me".

DIGITAL PROTECTIONISM

As China embraced the success of nurturing digital giants behind its "Great Firewall", we observed Europe attempting a similar strategy through its Digital Single Market initiative in 2015.[6] Such manifestations of "technationalism" prompted us to examine the potential for ASEAN countries to adopt similar strategies. Read on in "Digital divides".

THE NEXT CHINESE CAPITAL WAVE

Alongside the rapid growth in China's outward investments, the Futures Group also identified a diversification of destinations from primary resources in developing economies to include intellectual property and technology in developed economies. We also observed initiatives by China to develop an alternate set of financial institutions as well as trade and production networks around its growing outward investments.[7]

STILL MADE IN CHINA

The Futures Group noted the pressures faced by China's manufacturing sector from reduced price competitiveness and over-reliance on foreign technology in 2015.[8] At the same time, we highlighted the development of "Made in China 2025", an ambitious vision to create a manufacturing renaissance that would raise China's productivity, develop technological core competencies and nurture new export industries.[9]

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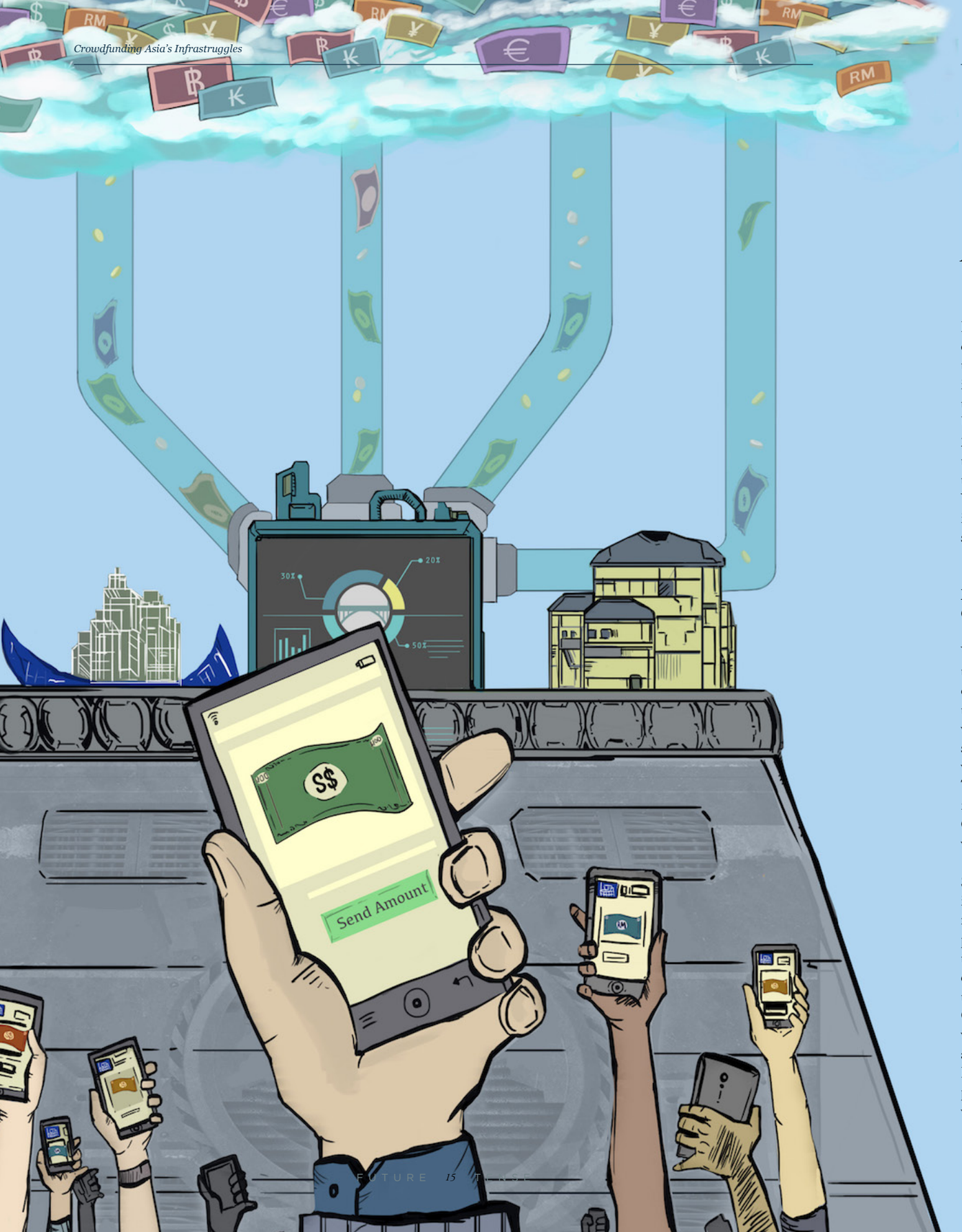
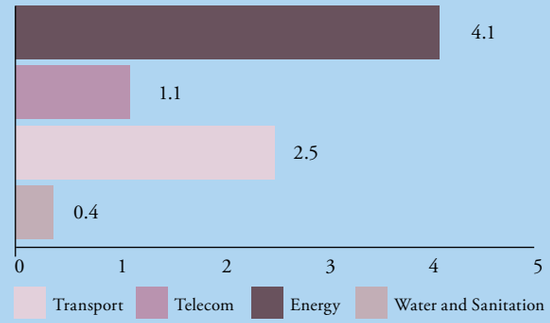


CROWDFUNDING ASIA'S INFRASTRUGGLES

Ajinkya Suhas Chougule

Infrastructure funding has traditionally been the domain of governments and international organisations. However this model appears increasingly inadequate for Asia, where infrastructure needs have long been unmet. According to the Asian Development Bank (ADB), Asia will need US$8tn (S$11.1tn) in cumulative investment between 2010 and 2020 to meet infrastructure needs.[1] However, the ADB also estimates that less than half of the US$8tn target will actually be spent, leaving a significant shortfall.[2] Without adequate (and timely) funding for critical infrastructure, Asia's growth story may lose more than its shine.

Figure 1: Investment needs for Asia's identified and pipeline infrastructure projects, 2010-20, $ trillion



Source: Asian Development Bank; Clean Edge; World Bank Private Participation in Infrastructure (PPI) Database; McKinsey analysis

MUCH MORE THAN A KICKSTARTER CAMPAIGN

With existing infrastructure funding, players who are unable to scale up commitments and spend fast enough, crowdfunding has emerged as a possible way to bridge the current funding gap. Until recently, crowdfunding was largely focused on donation-based models. This has since expanded into rewards and equity-based models, with users ranging from start-ups to large conglomerates.[3] Today, thanks to crowdfunding, an individual is able to raise capital in the US, contract manufacturing out to China and ship final products to "backers" all over the world.

Some mature European economies have seen infrastructure crowdfunding platforms in operation for some time. In the UK, small-scale community-level projects costing a few thousand pounds have been funded through platforms such as Spacehive.[4] Such platforms enable "civic" crowdfunding, where citizens come together to crowdfund projects in their own communities. Observers have argued that civic crowdfunding is one way to rejuvenate urban areas by targeting community amenities such as the local community centre or park.[5] Platforms like Abundance, which funds renewable energy projects, have also shown that a crowdfunding model is viable to investors despite the larger funding requirements of these projects.[6] Across the pond in the US, the city of Denver offered US$12mn (S$16.7mn) worth of municipal bonds – priced in US$500 (S$695) denominations – in the last phase of a US$550mn (S$764.8mn) municipal bond program to fund a project approved by Colorado voters to repair roads and civic buildings.[7] These "mini-bonds" were available only to Colorado residents and sold out within an hour of being launched online.[8]

CAN INFRASTRUCTURE CROWDFUNDING TAKE-OFF IN ASIA?

From these examples, we can delineate crowdfunded infrastructure financing into three tiers according to their funding scale. The first tier consists of community-level crowdfunding for civic infrastructure. The second tier follows the impact investment model and is often domain-specific, e.g. Abundance's facilitation of renewable energy infrastructure projects.[9] The third and final tier consists of government-led initiatives involving complex infrastructure projects that have national objectives in mind.

We are seeing some signals of government-led infrastructure crowdfunding efforts in Asia. These efforts appear to be intended more as experiments to gauge feasibility than signs of a shift away from the existing model. For example, in 2013, BTS Group launched Thailand's first ever fund aimed at financing a specific infrastructure project.[9] The fund, called the BTS Rail Mass Transit Growth Infrastructure Fund, set the record for the largest IPO in Thailand in 2013, with US$2.1bn (S$2.9bn) from both institutional and individual investors. To improve the attractiveness of the offering, the government also granted 10-year income tax holidays to individuals investing in such funds.[10] Similarly in 2014, DanaInfra Nasional Bhd, set up by the Malaysian Ministry of Finance to raise funds for the Klang Valley MRT project, issued RM100mn (S$33mn) worth of Islamic bonds ("sukuk") to expand the MRT line.[11] Applications from the Malaysian public represented 3.95% of the overall bond issuance value, and the company expects that retail investors will increasingly represent a larger source of funds for future bond offerings.[12]

However, infrastructure projects rarely lie at the sweet spot where profitability and an acceptable timescale for returns will intersect, and tend to overrun both in budget and duration.[13] Governments may also not be willing to cede control over infrastructure planning and prioritisation to crowdfunding platforms. Furthermore, the regulatory obstacles that lie before infrastructure crowdfunding can be scaled up are significant. These range from responsibility for maintenance of crowdfunded infrastructure to protections for investors. Regulatory frameworks will take time to adapt to the needs of infrastructure crowdfunding, but this may be time that some Asian economies do not have as they grapple with slowing global growth and ageing populations.

While not on the same scale as the government-led infrastructure crowdfunding efforts, projects in the first two tiers are also emerging in Asia. For example, the Singapore-based SolarPVExchange platform launched in June 2014 is focused on linking installers, investors and project initiators.[14] In May 2016, a residential property in Singapore successfully crowdfunded an installation of solar cells valued at S$22,500 on SolarPVExchange within 11 days.[15] As more platforms like SolarPVExchange emerge and scale, crowdfunded infrastructure projects are likely to become more commonplace and also move beyond typical domains like renewable energy as investors gain familiarity with the model. A hybrid approach could therefore be more appropriate to bridge the infrastructure funding gap in Asia. This would allow governments to continue planning, prioritising and initiating infrastructure projects, and then leverage crowdfunding for concluding phases. ⊣

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SMART BUT INSECURE

Goh Yeow Chong

In 2016, the Futures Group noted how increasing digitisation had opened the door for cyber threats to have a physical impact, e.g. through attacks on critical infrastructure such as energy grids.[1] Whilst the damage incurred from cyberattacks is still primarily felt in terms of impact on stored information, weak cybersecurity in the internet of things poses a growing risk in terms of physical impact.[2] For now, Singapore does fairly well on international scales of cyber vulnerability, ranking 49/50 on Rapid7's National Exposure Index[3] and 12/19 on Microsoft's Malware Infection Index in Asia[4] for 2016.[5] However, Singapore's current position in terms of cyber threats is not guaranteed as opportunities for cyberattacks will grow with more pervasive digitisation.

SPENDING IS NOT TRANSLATING INTO SECURITY

Companies are spending more on cybersecurity, however this is not leading to a reduction in business costs arising from cyber threats. PwC's 2016 Global State of Information Security Survey showed an increase in cybersecurity spending of 24% in 2015,[6] yet reported cyberattacks increased by 38% in 2015.[7] It is worth noting that better detection and reporting would likely skew the relationship between cybersecurity spending and reported cyberattacks. Nevertheless, MicroMarketMonitor predicts a 14.1% CAGR for cybersecurity spending up to 2019 in the Asia-Pacific region.[8] Even for the largest companies, such spending trajectories are not sustainable.[9]

A SHORTAGE OF TALENT…

One of the drivers for increased cybersecurity costs is the global shortage of talent,[10] with Frost & Sullivan forecasting a 1.5mn shortage by 2020.[11] While this issue is acknowledged in the National Cybersecurity Strategy,[12] the shortage of cybersecurity talent in Singapore persists despite the number of specialist training centres and courses in local universities and polytechnics.[13] The shortage of talent is costly in two ways. Firstly, companies with a cybersecurity talent shortage spend up to three times more to recover from a cyberattack according to a 2016 report by Kaspersky Labs.[14] Secondly, the global talent shortage has pushed up annual wages of cybersecurity professionals to between S$72,000 and S$240,000,[15] making in-house IT security teams expensive even for large companies.

…AND OF AWARENESS

Compounding the lack of cybersecurity talent is a general lack of cybersecurity awareness among employees. Both Symantec's 2016 Internet Security Trends Report and Verizon's 2016 Data Breach Investigations Report noted that most attacks begin by targeting human behaviour.[16] However, this vulnerability is the most affordable to address.[17] The imperative for companies to invest in cybersecurity awareness training is underscored by the follow-up costs of a cyberattack. Lower-end estimates from NetDiligence's 2015 Cyber Claims Study found the median follow-up costs of a cyberattack to be US$60,563 (S$81,800) for crisis services, US$73,600 ($$99,400) for legal defence and US$50,000 (S$67,500) for legal settlement.[18] For larger companies, the average claim in 2015 was US$4.8mn (S$6.48mn). Given that the effects of a cyberattack can reverberate for years after the initial intrusion,[19] the financial cost can be large enough to shut down smaller companies.[20] Cybersecurity awareness training will therefore become an increasingly cost-efficient cyber threat mitigation strategy in the coming years.

Another driver for increased cybersecurity spending is the perceived lack of strategy when investing in cybersecurity infrastructure. A 2015 survey by Morgan Stanley noted a trend of greater expenditure on security layering,[21] with the majority of the surveyed companies intending to use at least 15 different security products.[22] Security layering is extremely costly even for the largest companies, burdening IT departments with multiple platforms that are difficult to integrate[23] and do not necessarily guarantee greater security of IT infrastructure.

NEW TOOLS TO COMBAT CYBER THREATS?

A potentially more cost-effective alternative[24] to security layering is Unified Threat Management (UTM).[25] UTM offerings adopt heuristic analysis and machine learning to detect unknown malware and malicious network activity.[26] With research showing the severity of security exploits affecting traditional (signature-based) anti-virus programs,[27] companies and consumers have a greater incentive to move towards UTM solutions. Consolidation in the cybersecurity industry such as Symantec's 2016 acquisition of Blue Coat Systems, will also accelerate this trend as major cybersecurity players acquire and integrate missing capabilities in their products.[28]

The high cost and global shortage of cybersecurity specialists and the fast-paced evolution of cyber threats has also prompted research into automating cybersecurity. Two major research projects are IBM's Watson for Cybersecurity and DARPA's Grand Cyber Challenge, which share a common goal to automate the discovery of vulnerabilities. Successful conversion of their research into a cybersecurity product would not only reduce the demand for cybersecurity professionals and also free up existing cybersecurity teams to tackle issues which are more difficult to automate like training.

The potential for an automated cyber threat detection system to scale would only be limited by the computational power of the server hosting the cybersecurity AI, which means that such a service could eventually become accessible at a price point that even smaller companies could afford. While there are no current estimates available for the market value of a successful cybersecurity AI service, Cybersecurity Ventures estimates global cybersecurity spending exceeding US$1tn between 2017 and 2021,[29] which provides a sense of the potential opportunity involved.

NO TARGET TOO SMALL

Symantec noted that 43% of all attacks targeted small companies in 2015,[30] highlighting the fact that no company is too small to be of insignificance to attackers. Even companies with no valuable information of their own can be used as a gateway to attack bigger targets, as seen in the 2013 attack on Target.[31] With surveys by KPMG and FireEye both showing that consumer trust is dented in the aftermath of a data breach regardless of industry sector,[32] there is a strong incentive for companies to take cybersecurity seriously.

At the same time, new approaches are being developed that could change the cybersecurity landscape. Formal verification, which involves writing code in a manner similar to a mathematical proof, could safeguard software from hackers.[33] However, the adoption of formal verification is by no means simple, as it would mean finding ways to express the wide range of program

functions in mathematical terms. Nevertheless, some use cases are emerging. For example, the blockchain platform Ethereum is aiming to leverage formal verification to improve security of smart contracts developed on its platform.[34]

Another approach is being pioneered by UK-based startup Darktrace. Its Enterprise Immune System flips the starting point of cybersecurity threat management away from defining a threat to examining network behaviours and addressing anomalies to those behaviours instead.[35] Darktrace's use of machine learning in its cybersecurity products differs in that it uses unsupervised machine learning instead of supervised machine learning.[36] This allows it to detect and manage novel threats, and prepare for the possibility of AI-driven cyberattacks.[37] ⊣

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TRUST THY INTERMEDIARY

Jared Nair

Conceived as a backbone for the Bitcoin cryptocurrency,[1] blockchains facilitate financial transactions without the need for intermediaries to validate these transactions.[2] However, with the rise of applications beyond Bitcoin, the blockchain universe is splintering between public and private models. Unlike the original blockchain design, "private" blockchains strengthen an intermediary's role in validating transactions while retaining the efficiencies generated by blockchain technology. The emergence of private blockchains has been driven by intermediaries that are keenly aware of risks to their relevance as well as high-profile cybersecurity failures of public blockchains. These incidents showed that intermediaries are still a necessity to sustain an ecosystem around blockchain technology. Given the success of intermediaries that have appropriated a technology designed to disrupt them, it remains to be seen which model of blockchain-based transactions will dominate.

A GAME OF NODES

The underlying technology for both private and public blockchains is known as distributed ledger technology (DLT). Each time a transaction takes place, the entire system of nodes (i.e. computers participating in the peer-to-peer network) verifies a transaction against their respective ledgers. Public blockchains such as Bitcoin and Ethereum allow anyone to join their networks, gain access to transaction data and participate in the verification of transactions. On the other hand, private blockchains use permissioned ledgers that limit access as well as the overall number of nodes which can verify transactions.

DLT was originally designed to ensure immutability of transactions on blockchains. Since transactions are stored on every node's ledger, any revision in transaction history would necessitate revising all of these ledgers. The large number of nodes present in public blockchain-based systems like Bitcoin would thus prevent such revisions from taking place. However, revisions are not impossible.[3] A cyberattack leading to the theft of US$50mn (S$72.2mn) from a distributed autonomous organisation on the Ethereum platform in June 2016 prompted a "hard fork" that reversed the losses incurred by victims.[4] While this incident challenged the notion of transaction immutability on public blockchains, the decision to perform the hard fork was agreed upon by a majority of the Ethereum community.[5]

The smaller number of nodes in a private blockchain has some advantages. Unlike public blockchains, private blockchains typically have fewer users and thus a smaller volume of transactions to verify. This results in less data being utilised per transaction, which allows private blockchains to attain transaction speeds comparable to current database-type transactions.[6] The smaller quantity of data required by private blockchains to verify transactions also reduces transaction costs compared to the US$0.01 per transaction for public blockchains.[7]

BOX 1:
CROSS-BORDER FINANCIAL TRANSACTIONS – ALL THAT GLITTERS IS NOT BITCOIN

INTERMEDIARY AT STAKE:
Banks and other financial institutions

DISRUPTOR:
Decentralised currencies such as Bitcoin

Cross-border financial transactions such as remittances and foreign exchange investments have typically required intermediaries to conduct and verify the authenticity of transactions. The verification process is time-consuming and intermediaries typically charge transaction fees. Decentralised currencies powered by a public blockchain such as Bitcoin allow for immediate transactions without transaction fees.[8] With an estimated worth of US$500bn, the remittance market is already witnessing entrants challenging incumbents for a share of transactions.[9]

HOW INTERMEDIARIES ARE PUSHING BACK

Financial intermediaries have turned to private blockchains to compete with digital currencies on cost and speed of transaction. For example, the R3 consortium represents over 75 of the world's largest financial institutions and aims to create a distributed ledger platform that facilitates continuous global transfer of funds.[10] This consortium which has banks participating from major global economies and financial centres represents a global pushback by intermediaries as they seek to adopt blockchain to strengthen their existing position.

LIKELY VICTOR?

Private blockchains are likely to crowd out public blockchains as current financial intermediaries have the necessary resources at hand to successfully implement blockchain technology and lower transaction costs for their existing customers. Furthermore, unlike traditional currencies, Bitcoin's volatile fluctuations cannot be managed through monetary policy. This leaves Bitcoin an unreliable currency for those seeking safe remittance of their earnings back home.

BOX 2:
REAL ESTATE TRANSACTIONS – PLOTTING AN UPHEAVAL

INTERMEDIARY AT STAKE:
Real estate brokers

DISRUPTOR:
Blockchain-based land registries and private companies digitising real estate transactions

Real estate transactions are traditionally brokered through brokers who are paid a commission on successful sales. Recently, however, startups are leveraging public blockchains to break into the real estate market with a focus on transparency of transaction information. US-based Ubiquity has successfully completed its first blockchain-based transaction in a public ledger, and has a long term goal to provide a transparent, immutable record of all real estate transactions.[11] Closer to home, Singaporean startup Averspace is using smart contracts to enable lessors and lessees to create tenancy arrangements directly.[12]

HOW INTERMEDIARIES ARE PUSHING BACK

Private blockchains can also use an immutable ledger of real estate transactions to their advantage. Singapore-based POPETY is using private blockchains to capture details of a property (such as its insurance coverage and when it underwent renovation) onto a ledger that is available only to its members. Instead of competing with real estate brokers, POPETY is preserving (and profiting from) the intermediary model by selling listing data to real estate brokers.[13]

LIKELY VICTOR?

At this stage no clear victor is apparent as blockchain applications in real estate are far more nascent than those in financial transactions. However, private blockchains appear to have the shorter end of the stick, as governments are more likely to regulate private blockchains if their operations result in a lack of transparency in the real estate sector.

THE INTERMEDIARIES AWAKEN

The differences between public and private blockchains do not always pose a tension. In some types of transactions one model is clearly preferred. For example, transactions involving sensitive personal data in the healthcare sector would clearly require a private blockchain. However, for transactions that are currently verified by an intermediary where data is less sensitive, a tension is emerging between public and private blockchains. New entrants are using public blockchains to disrupt the intermediary model of transactions while incumbents are using private blockchains to preserve their relevance and increase the efficacy of their transactions. We examine the tensions in cross-border financial transactions (see Box 1) and real estate transactions (see Box 2) given the prominence of intermediaries in these sectors. ⊣

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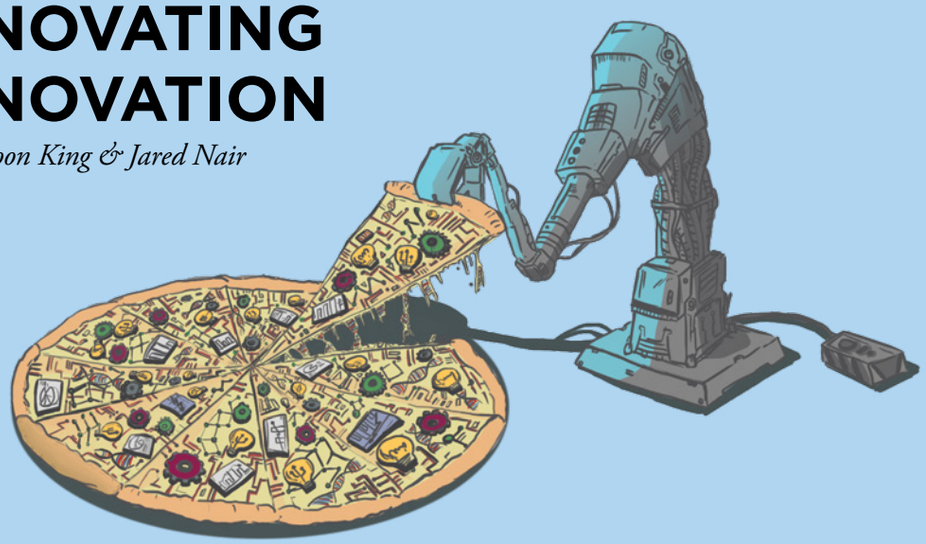
INNOVATING INNOVATION

Quek Boon King & Jared Nair



To anyone who has read The Innovator's Dilemma by Clayton Christensen, the underlying message for companies is stark: innovate or perish.[1] Companies are keenly aware of this, as seen in PwC's Global Innovation 1000 survey for 2016, which reported that R&D spending grew at a compound annual rate of 4.94% between 2005 and 2016.[2] However, spending more on R&D does not necessarily equate to better performance[3]. Companies are ironically disrupted by focusing on delivering incremental innovations to established customers while ignoring breakthrough solutions that may not yet have an established customer base.[4] In the pharmaceutical industry, for instance, a study by Deloitte showed a consistent decline in projected returns on R&D investment for the top 12 companies since 2010.[5] We see light at the end of the tunnel, however. Companies are exploring beyond traditional models of R&D, arguably signalling a shift in the nature of the innovation ecosystem itself. Below, we highlight three ways in which companies are innovating innovation.

INDUSTRIALISING R&D

In contrast to other players in the pharmaceutical industry, drug discovery at Shanghai-based WuXi AppTec resembles a production line, with different types of workers assigned to narrowly-defined steps. While initial discovery is undertaken by researchers with deep medical expertise, the fulfilment of other steps is executed by university graduates.[6] For example, processes like compound creation are subdivided into numerous small tasks, eliminating production bottlenecks and the need to deploy expertise throughout the R&D process.[7] Chinese telecommunications giant Huawei similarly partitions its R&D process into a range of narrow tasks, eliminating the need for its engineers to get tied up in multi-faceted design considerations.[8]

However, the ability of Chinese companies like WuXi AppTec and Huawei to industrialise R&D successfully relies on access to a large pool of cheap yet skilled talent.[9] Most advanced economies that are unable to compete similarly are instead forming partnerships with Chinese companies. For example, in the pharmaceutical industry, AstraZeneca and Eli Lilly are partnered with China-MediTech, while Merck has linked up with BeiGene.[10] Similar examples are seen in other areas. Germany's Manz AG formed a R&D joint venture with Shanghai Electric Group Co. and Shenhua Group Co. for thin film technology used in solar cells,[11] while Dutch semiconductor manufacturer NXP has a R&D partnership with Hangzhou-based automotive manufacturer Geely for in-vehicle infotainment and telematics.[12]

READY-MADE R&D

Beyond partnerships, "PhD" APIs could potentially become an alternative means of overcoming the talent deficit in the industrialisation of R&D. Ready-to-deploy software that calls upon existing natural language processing (NLP) and deep learning techniques has the potential to not only help companies improve their operational processes and reduce overhead costs, but also to make research less costly and catalyse product development. For example, IBM acquired AlchemyAPI, a startup specialising in NLP and visual recognition APIs to augment the capabilities of Watson.[13] As the API market grows and becomes increasingly accessible, e.g. through open-sourcing, there is potential for adoption rates to increase. For example, the open-source extension CognizeR allows data scientists to use the R programming language to tap into IBM Watson's language translation and visual recognition capabilities.[14]

At the same time, while the offerings for PhD APIs are still mainly applicable to data science, R&D processes themselves are seeing increased usage of big data analytics. IBM's Watson, for example, has been deployed in pharmaceutical R&D processes to support researchers seeking new drug targets and indications.[15] The expansion of big data analytics into other sectors to aid in product discovery, when paired with APIs that can then be deployed and used by smaller companies, has the potential to unlock significant new sources of value.

CROWDSOURCED R&D

Technologies like additive manufacturing which have made prototyping and manufacturing itself more accessible have entered the mainstream since the Futures Group wrote about them in 2011.[16] In addition to companies of all sizes, individual "makers" increasingly have access to micro-manufacturing facilities, with the number of "makerspaces" globally has increased 14 times between 2006 and 2016.[17] More than just hobbyists, makers are emerging as proponents of a new model of collaborative production that does not require scale to be viable.[18] What sets collaborative production apart is the use of a crowd- and open-source approach where ideas are freely shared and developed together in makerspaces.

While the claim that collaborative production will ultimately displace traditional models of production remains to be seen, larger companies seeking a competitive advantage in their product development processes are co-opting this crowdsourcing of product design to their advantage. FirstBuild, a General Electric Appliances spin-off, employs the same lean modes of organisation and a "fail fast, learn fast" approach as a hardware startup to experiment with flexible product design in a thriving maker community.[19] Aspiring engineers and designers get a space to develop innovative products and receive a commission from any sales generated by their invention. FirstBuild designs, from Opal (a nugget icemaker) to a barcode-scanning oven, have proven successful at low production volume on crowdfunding platforms like Indiegogo.[20] As more large manufacturers adopt similar crowdsourced R&D platforms to augment their traditional R&D processes, this will broaden participation in innovation ecosystem. ⊣

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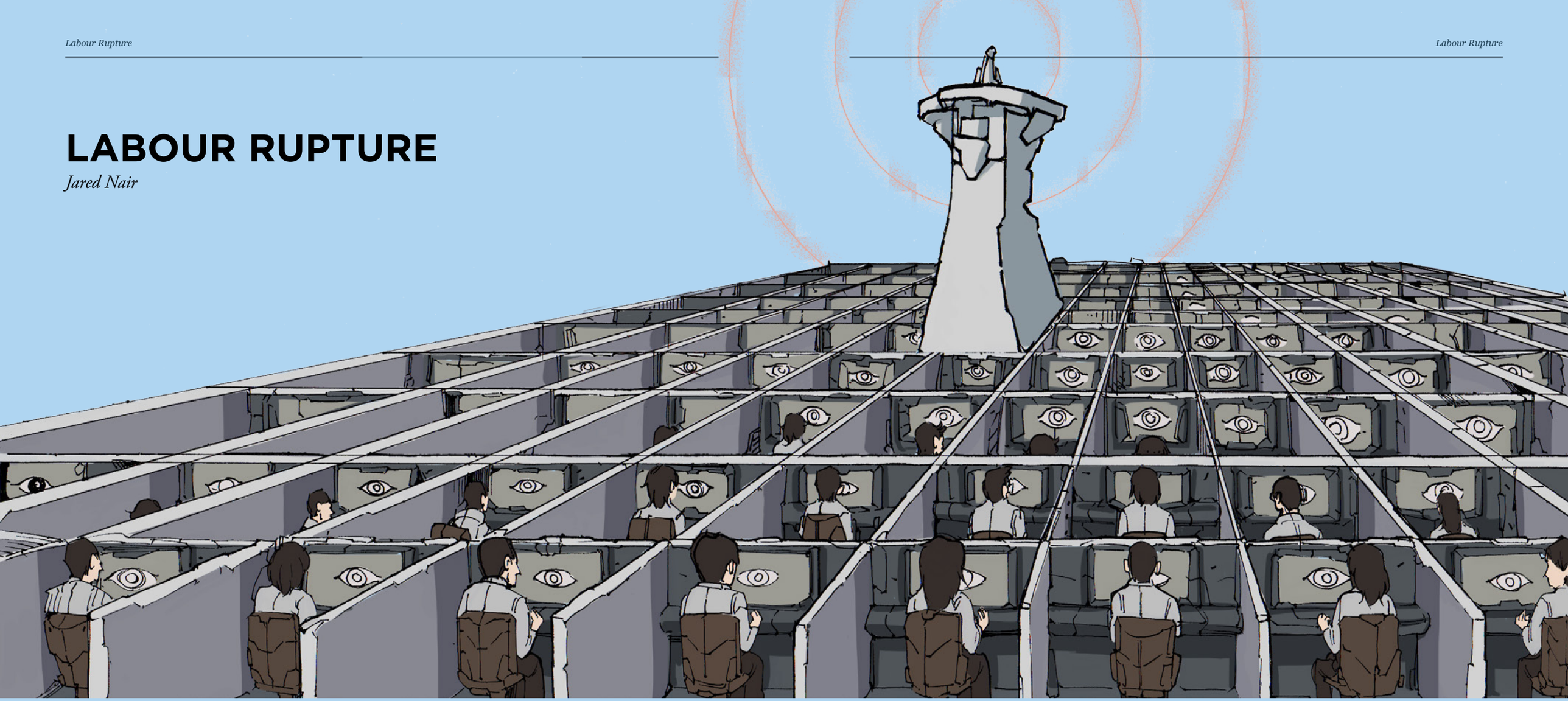
Labour Rupture

LABOUR RUPTURE

Jared Nair



"Labour was the first price, the original purchase-money that was paid for all things"
Adam Smith, *The Wealth of Nations* (1776)

Economics classifies labour as a distinct factor of production for an economy. At the same time, history shows that technology has frequently disrupted the role of labour in an economy, forcing it to reorganise and reskill. The current wave of advances in automation technology that is seeing software replace humans in the office has sparked fear of a "labour apocalypse."[1] Driven by advances in computing power and big data analytics, artificial intelligence (AI) software such as IBM's Watson are being considered a perfect substitute for certain types of tasks typically performed by humans.[2] The ensuing uneasiness for workers stems not only from the potential loss of a job but the uncertainties over how to reskill and retrain as well.

Nevertheless, there are reasons to believe that the labour apocalypse is not yet upon us – in fact, it may never occur. While there will be an inevitable loss of some jobs to software, there are limitations for the applicability of AI in automating most jobs.[3] Furthermore, while AI can process, predict and synthesise better than humans,[4] there are signals indicating that, when AI aids humans in making better decisions, the results are more productive. Instead of a labour apocalypse, where AI is a perfect substitute for human labour, we might instead witness a labour "augmentation" where AI increases the productivity of labour.

Would such an augmented workforce still be considered labour? Some argue that AI is a new type of resource – a labour-capital hybrid factor of production.[5] The procurement of an AI system can be characterised as an investment into a capital good but the productivity gains would be classified under labour. One might argue that this is no different from a factory's production line being automated and that productivity gains should be measured on a capital basis. These arguments are at the heart of what we term the labour "rupture" – with the advent of AI as a perfect substitute for human labour, our idea of labour as a factor of production has changed.

APOCALYPSE NOW? WHEN?

In their seminal 2013 study, Frey and Osborne showed that approximately 47% of total occupations in the US were at high risk of automation over the subsequent two decades.[6] One of the key factors they highlighted as a driver was the computerisation of non-routine cognitive tasks seeing viable commercial applications, e.g. the use of IBM's Watson in healthcare diagnostics.[7] Since then, IBM's Watson has found use in more than just healthcare diagnostics – it has been employed as a lawyer,[8] university tutor,[9] and more recently to handle claims for a Japanese life insurance company. Fukoku Mutual Life Insurance

directly replaced 34 staff because the cost of investing in and maintaining a Watson-based system was cheaper than paying salaries.[10] Looking at these types of examples, AI's proposition as a perfect substitute for human labour appears to be cemented.

However, AI software like IBM's Watson has yet to cause widespread technological unemployment despite being deployed for some years. Instead of taking jobs, AI often ends up working alongside humans, helping them make better decisions. In the healthcare sector, Watson accurately diagnosed a rare case of leukaemia that had previously stumped doctors, enabling a curated course of treatment to be provided for the patient.[11] In the cybersecurity sector, an AI-human hybrid system developed for MIT can detect about 85% of cyber threats.[12] These examples highlight how AI is helping humans to become more productive – a labour augmentation as opposed to an apocalypse.

A 2017 study conducted by McKinsey Global Institute reinforces this notion of a labour augmentation. Using work activities as the unit of analysis instead of an entire occupation, the study found that only 5% of jobs globally can be fully automated away.[13] Instead, about 60% of occupations worldwide have at least 30% of their work activities that can be automated away using currently available technology.[14] This implies that AI may be a perfect substitute for some types of human labour, but for the majority of occupations an apocalyptic narrative may not be warranted.

The notion of a labour augmentation may, however, be tested by future technological advances in AI. Progress towards achieving "strong AI"[15] could further blur the current distinction between human and software. For example, DeepMind, a company acquired by Google, has developed an AI software that learns how to optimise its goals in a given environment.[16] In a well-known and significant achievement, the software beat the world's

leading human Go champion, something thought to be computationally impossible given the intricacies of the game.[17]

In addition, progress is also being made towards the three types of tasks Frey and Osborne emphasised in their study where human labour has retained its unique value proposition – perception and manipulation tasks, creative intelligence tasks and, social intelligence tasks.[18] These types of tasks were assessed by Frey and Osborne as bottlenecks for automation because they are either poorly understood or the sheer complexity of the task prevents meaningful programing. Human creativity for instance, is not fully understood, and this limits the ability to program it for AI.[19]

I, HUMAN

Aside from inherent technical difficulties for a transition into "strong AI," there also significant social obstacles that need to be overcome. A report published by the UK House of Commons recommended the formation of a commission[20] to focus on governing the development and application of AI techniques, in addition to advising on any regulations required.[21] Furthermore, we are starting to see weak signals of companies setting up their own ethics boards and forming industry associations such as the Partnership for AI.[22] Key figures in the technology industry have also raised concern over the governance of AI. For example, Elon Musk has been vocal in his support of efforts to manage the risks of strong AI, as seen in the founding of OpenAI in 2016.[23] Similarly, Bill Gates has proposed a tax on the deployment of AI in order to fund retraining of workers displaced by automation.[24] This uncertainty surrounding strong AI is at the heart of debates surrounding the labour rupture. As our view of labour as a factor of production changes, so too must the standards and norms governing both labour and AI. ⊣

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DIGITAL DIVIDES

Marissa Foo & Manoj Harjani

Digital flows have grown significantly in the last decade compared to traditional flows of goods, services and finance. A 2016 study by the McKinsey Global Institute highlighted that cross-border digital flows made a larger contribution to global GDP than flows of goods in 2014,[1] and have grown 45 times larger in absolute terms since 2005.[2] However, the growth of digital flows has also been accompanied by cases of countries/ regional blocs erecting digital barriers and regulating the digital economy in order to privilege domestic technology companies' growth over large multinationals. China's use of the "Great Firewall" is the most obvious example,[3] with the EU's Digital Single Market initiative striking a similar tone through its stringent rules on competition, privacy and intellectual property.[4] If more countries and regional blocs adopt similar "technationalist" strategies, this could limit the growth of digital flows and create a fragmented global digital economy. Of particular concern is the growth of technationalism within ASEAN, which would create challenges for Singapore as it seeks to encourage the internationalisation of local companies and leverage the digital economy as a growth sector.

TECHNATIONALISM ON THE RISE

Technationalism has thus far manifested primarily through data localisation, internet access control and antitrust investigations. Data localisation typically involves laws and regulations that mandate user data being stored in the country of its origin. Prominent examples include Russia's Yarovaya Law, China's Cybersecurity Law and Brazil's Civil Rights Framework for the Internet. Within ASEAN, data localisation measures that go beyond protection of personal data have emerged in some countries (see Box 1).

Countries have also turned to directly controlling internet access. China is once again the most well-known example, however other Asian countries such as Vietnam, Thailand and Myanmar also have adverse ratings in Freedom House's *Freedom on the Net* report, which examines obstacles to Internet access and limits on content.[5] It is important to note, however, that internet access control restrictions are often not driven primarily by trade or economic concerns, with social and security concerns typically have a bigger part to play. Finally, antitrust investigations conducted against large technology multinationals have also acted as a barrier to their operations. The EU, for instance, has filed four formal antitrust charges against Google as of July 2016.[6] These charges cover Google's comparison-shopping service in its search results, the Android mobile operating system and the AdSense ad-placement service.[7] Similar antitrust investigations have yet to be seen in ASEAN, but cannot be ruled out as technology multinationals' user bases grow in the region.

If left unchecked, technationalist measures could limit the growth of digital flows and create a fragmented global digital economy. Data localisation laws in particular have the potential to increase cross-border transaction costs and limit the scope of companies' cross-border operations. For example, distinguishing between data that needs to be stored locally and data that can be moved across borders (i.e. personal vs. non-personal data) is not a straightforward task.[8] In addition, when companies are legally bound by data protection laws to relocate their servers, this can increase the risk of data breaches if the storage locations do not have adequate cybersecurity measures in place.[9] A study by the Swedish National Board of Trade also highlighted that data localisation affects the production of physical goods because it limits manufacturing companies' ability to exercise control and coordination, conduct R&D and manage supply chains.[10]

BOX 1: SELECTED DATA LOCALISATION MEASURES IN ASEAN

Regulation No. 82 mandates companies that provide internet-enabled services to Indonesians to locate data centres within Indonesia. Indonesia is also drafting a regulation to regulate both application and content-based "over-the-top" (OTT) service providers.

Vietnam's Decree on Information Technology Services mandates that companies providing internet-enabled services locate at least one server within Vietnam. Like Indonesia, Vietnam is drafting a regulation to regulate OTT service providers.

Source
Data localisation snapshot (Washington: Information Technology Industry Council, 2017)

As data localisation measures become more prevalent in ASEAN, they could pose an obstacle to Singapore's strategy to promote the internationalisation of local companies within the region. Companies looking to operate across multiple countries would have to account for the costs imposed by data localisation laws in those countries. The impact would be felt more severely by companies that have business models which are based on "over-the-top" digital services.

COPING WITH A FRAGMENTED DIGITAL ECONOMY

Digital blocs that transcend geographical location are emerging as one way to cope with technationalism creating a fragmented global digital economy. For example, the "Digital 5" (D5) alliance comprising Estonia, Israel, New Zealand, South Korea and the UK emphasises open standards and open-source software. The D5 underscores an important fact of the digital economy and a digitally-globalised world – countries (or even cities) need not be bound by geography to benefit from functional integration.[11] Besides government-driven initiatives such as the D5, company-led industry associations could provide another way to overcome technationalism. The Information Technology Industry Council (ITI) and Software Alliance are examples of influential industry associations that are committed to shaping the agenda on the digital economy and digital trade in particular.

It remains to be seen, however, whether ASEAN will follow the EU and build a "walled garden" for its digital economy. Such a scenario would potentially benefit ASEAN countries in terms of technationalism's low-hanging fruit such as the adoption of common standards and elimination of internal barriers for digital flows. At the same time, this would make relations between digital blocs more important in the future, potentially making the global digital economy a federation of blocs both geographical and geodesic in nature. ⊣

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THE NEXT SPACE RACE: FRONTIERS EMERGE

Chiu Chai Hao

Two years ago, the Futures Group explored changing dynamics in the space industry as it shifted from a cost-plus, government-dominated model to a cost-competitive model that was increasingly accessible to the private sector.[1] This update highlights three key developments that have implications for the space industry going forward. First, interest in satellite applications has increased, especially within Southeast Asia. This is not surprising given that it currently offers the greatest certainty of returns within the space industry. However, more surprising is that space mining and space solar power have emerged stronger than expected two years ago. This enthusiasm is set to grow as important resources become scarcer on earth. Finally, the absence of an international agreement over ownership of space resources in spite of growing interests complicates the relationships between space-faring countries.

PRIVATE LAUNCH COMPANIES POWER ON

Since 2014, private space launch companies SpaceX and Blue Origin have conducted successful landings, a key step towards reusable rockets that will decrease launch costs significantly.[2] Space launch costs are already less than 10% of the costs in 2011, and are expected to fall at least 10 times more with greater utilisation of reusable launch systems.[3] Today's launch costs into low earth orbit (LEO) are already below US$1,000/pound, and SpaceX's target is to reduce the cost 100-fold.[4]

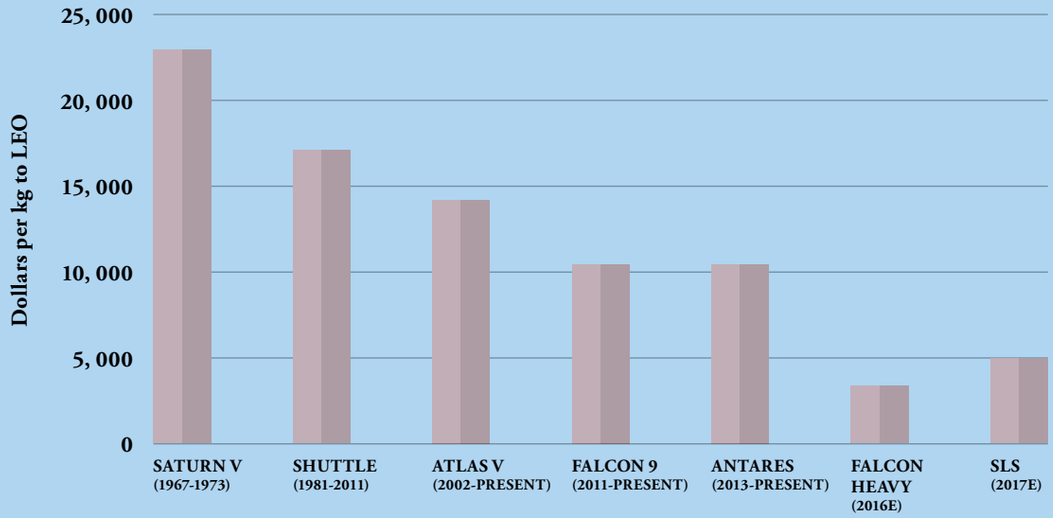
Meanwhile, smaller form-factors continue to make satellites and related services cheaper and more accessible. Lower launch costs and smaller satellites have fuelled the growth of the global satellite industry, setting up a positive feedback loop as lower launch costs allow for shorter satellite life expectancies.[6] Almost half of the 300 satellites launched in 2014[7] weighed less than 10kg and 49% of the satellites in 2015 were "cubesats" that weigh less than 1.33 kg.[8]

Southeast Asian countries have also charted plans to develop industrial clusters for satellites, from manufacturing to developing indigenous capabilities in satellite services. For example, Vietnam has unveiled ambitious plans for an ecosystem to manufacture and launch earth observation satellites by 2040.[10] Given the rising competition within the regional and global space industry, it will be important for Singapore to develop deep-rooted capabilities that complement a wide range of adjacent sectors (see Figure 3). At present, Singapore is developing capabilities in niche areas such as satellite technology and services for downstream applications. Various global players (e.g. Inmarsat, Orbital ATK) have established operations in Singapore,[11] and local startups are entering this space too. For example, AstroScale is developing technologies to remove space junk[12] – a potential problem as the scramble into LEO intensifies. It has recently secured US$35mn from Japanese investors to develop and test innovative space propulsion systems.[13]

A SPACE COMMODITY AND ENERGY BOOM ON THE HORIZON?

Natural resource extraction (e.g. of rare earth metals) from outer space that can alleviate scarcity and environmental degradation on earth is becoming increasingly economically viable. Space mining is not a new idea, but commercial interest has rekindled in recent times due to falling launch costs and advances in robotics.[14] For example, the US and Luxembourg are developing regulations and enacting policies to encourage ventures in this area. The likelihood of more countries following suit is strong as global demand for rare earth metals (REMs) will continue to grow on the back of their use in the production of electronic devices. At the same time, mining REMs has become increasingly costly and pushback has intensified over the environmental degradation it causes. Two prominent US firms – Deep Space Industries and Planetary Resources have signalled clear intentions to develop capabilities in space mining. The space mining industry will be costly initially, but

Figure 1: Launch costs per payload kg have fallen over time.[5]



*Antares launch costs estimated

Figure 2: Growing interest in cubesats[9]

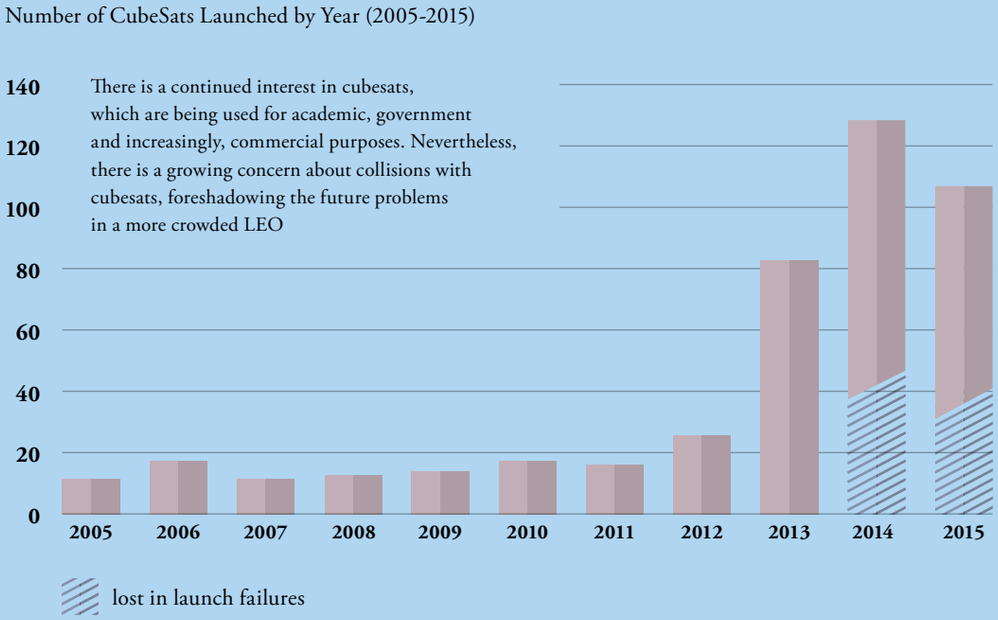
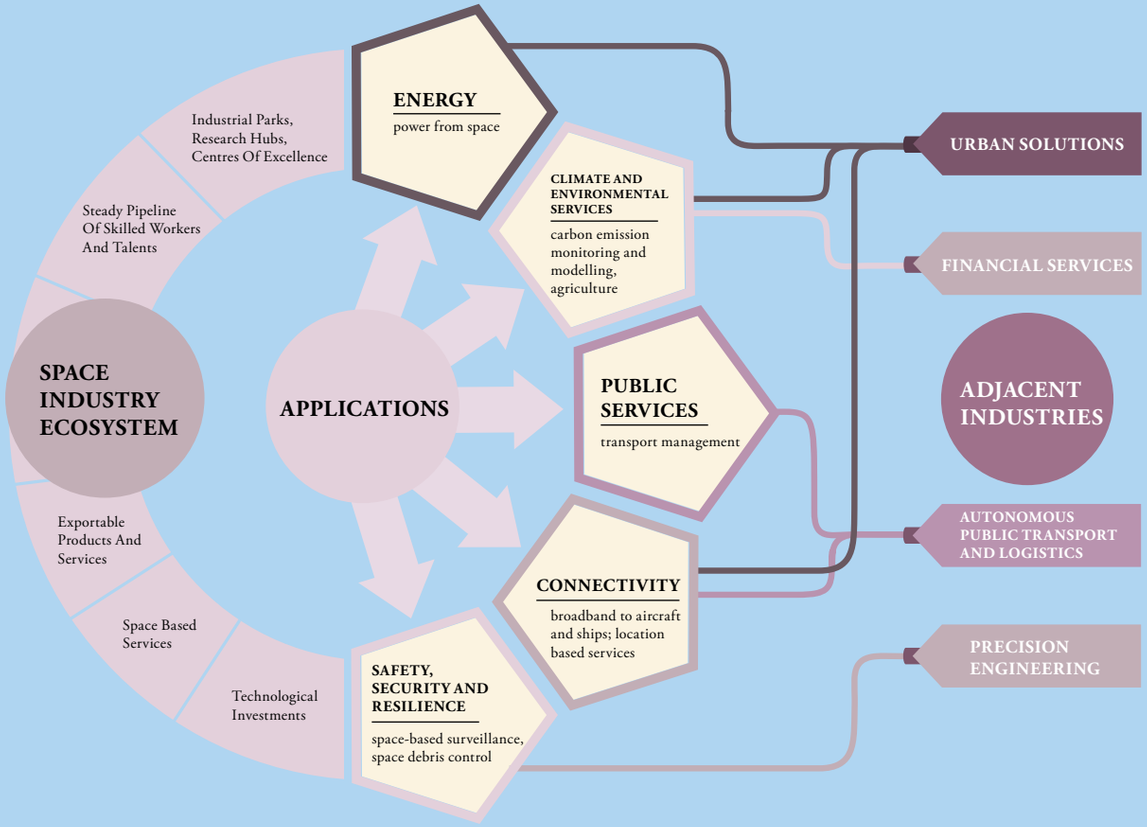


Figure 3: Potential areas for Singapore's space industry to explore



highly lucrative in the long-term given the abundant quantities of REMs and other elements available on near-earth asteroids.[15]

Similarly, sustainability concerns and technological advances are also driving endeavours to obtain clean energy from space. Space solar energy (SSE) is non-polluting and generates a small carbon footprint compared to terrestrial energy sources. Japan is the strongest advocate of SSE technology, with the US, China and Russia on board as well.[16] In space, solar panels can harvest solar radiation continuously and transmit energy as microwaves to receiver stations on land, which can then supply electricity. SSE is a potential game-changer, not only due to its cleanliness, but also because it resolves the energy policy trilemma[17] immediately. Most land-based electricity generation from renewables is intermittent and require batteries for storage, but SSE is available round-the-clock, eliminating the need for large-scale battery storage. Development and adoption of SSE technology could intensify as pressure mounts to reduce greenhouse gas emissions in order to curb the rise in global average temperatures.

Nevertheless, significant engineering challenges remain for both space mining and SSE. It is still challenging to ascertain the exact composition of asteroids and too costly to construct massive solar panels and send them to space.[18] Converting electricity into microwaves and beaming them back to Earth is currently 80% effective, almost near the target of 90%, but more important and notably unexplored are the potential unintended effects (e.g. on humans), which may become a stumbling block for implementation.[19] At the same time, while it is tempting to dismiss space mining and SSE as lofty and technically impossible, they continue to advance

on the back of developments in other industries. Better robotics and autonomous systems for terrestrial use could help make unmanned mining economically feasible, as would cheaper solar panels and the push to decarbonise electricity make harvesting of SSE attractive.

The prospect of mining rare earth elements in space and facilitating their trade on earth represents an opportunity for Singapore that would not necessarily be limited by current resource constraints. A similar argument applies to SSE. However, for Singapore to become a space mining and SSE player requires long-term talent and infrastructure planning. It would also mean that Singapore vies for stake in setting global rules and norms related to space exploration and resource exploitation. There is currently no internationally recognised framework governing the ownership of resources from space. The 1967 UN Outer Space Treaty has a predominantly military focus. In the present, there is at least a clear need for legislation on ownership rights to help encourage investments and mediate future disputes as the economic feasibility of space resource exploitation increases. To this end, Singapore could consider acting as an interlocutor to reach an agreement, which secures space-faring nations' and companies' interests and collective good, and allowing Singapore to start her space programmes too.[20] ⊣

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TAKING OFF: WHERE IS THE AEROSPACE SECTOR HEADED?

Cheong Kai Jian & Manoj Harjani

Singapore's aerospace sector has enjoyed significant growth with a CAGR of 8.6% from 1995-2014, and its maintenance, repair and overhaul (MRO) cluster contributes to over 10% of the global market.[1] The prospects for growth continuing are bright – a forecast by Oliver Wyman expects a near doubling of the in-service aircraft fleet in China, India and the Asia-Pacific region from 6,854 in 2016 to 12,954 by 2026.[2] This will in turn increase demand for MRO services, with ICF International forecasting the most growth in the modifications, engines and components segments.[3] Singapore will benefit from the expected growth in demand for MRO services, but rapid changes in aerospace technology and business models pose risks for the global MRO market. Such developments are worrying for Singapore's aerospace sector as it is dependent on revenue from the MRO cluster, and emphasise the need to diversify the sector.[4]

STRONGER NEIGHBOURS, RISING COMPETITION

With most of the growth in MRO services expected to take place in Asia, regional competitors have plans to develop their aerospace sectors (see Figure 1). If successfully realised, these plans will erode Singapore's competitive advantage as a MRO hub.

Beyond national plans, engine and airframe OEMs are also eyeing a larger slice of the growing MRO pie, which could crowd out traditional MRO service providers. In particular, the increasing technological complexity of engines and airframes restricts the ability of third-party MRO service providers to compete.[13] With greater adoption of digital Aircraft Health Monitoring systems, OEMs and airlines will have a further edge over traditional MRO service providers.[14]

COMPOUNDED CHALLENGES: TECHNOLOGICAL ADVANCEMENTS AND CLIMATE CHANGE

Technological advancements are also altering the nature of MRO services and their place in the overall aerospace sector value chain. According to a 2016 survey by Oliver Wyman, big data applications related to aircraft health monitoring (AHM) and predictive maintenance (PM) are moving past the early adopter phase.[15] Engine and component OEMs are acting aggressively to protect their intellectual property and stake claims on data generated by their on-board systems to cut out independent MRO providers.[16] As AHM and PM applications become more widespread, they will reduce maintenance costs and downtime through early detection and even remote resolution of faults. Furthermore, the adoption of new materials such as carbon fibre composites and ceramic matrix composites will reduce the need for maintenance and repairs.[17]

Concern over aviation's contribution to climate change is another area that will affect growth in the aerospace sector and thus demand for MRO services. The impact of a new carbon offset scheme agreed upon by International Civil Aviation Organisation member states in October 2016 is still unclear. Beyond initiatives aimed at improving fuel efficiency, pressure to meet climate change targets

Figure 1: Regional competitors' aerospace sector development plans

Indonesia announced plans to establish a special economic zone for MRO services in Bintan, which could pull MRO players away from Singapore due to lower costs for land and labour while retaining proximity to talent in Singapore.[5]

Thailand is implementing its Aerospace Industrial Estate Development Plan (2016-2045) to create a hub for original equipment manufacturers (OEMs) and MRO in the Rayong Province. The hub will target Tier 3 component and Tier 4 composite manufacturing as well as MRO for airframes, engines and components.[6] In addition to providing tax incentives, Thailand aims to draw in companies by leveraging its experience and capabilities in automotive and electronics manufacturing.[7]

Under its National Aerospace Industry Blueprint 2015-2030, Malaysia aims to capture 5% of the global MRO market and be a regional leader for aerospace component manufacturing as well as aerospace education and training.[8] Malaysia's Asia Aerospace city project will pose a direct challenge to Singapore's Aerospace Park when completed in 2018.[9] Taken together with the KLIA Aeropolis project launched in 2016,[10] Malaysia will significantly ramp up its MRO capacity and capabilities in the coming decade.

China's initiative to develop commercial aircraft and dismantle the duopoly of Airbus and Boeing is part of its broader "Made in China 2025" strategy.[11] It is likely that China will go on to construct a comprehensive ecosystem that will include MRO capabilities. Given that it already has the highest usage of industrial robots by numbers,[12] China's integration of robotic solutions into the MRO cluster could further increase its competitiveness. Although China currently does not have the ecosystem to challenge Singapore's position, this may not be the case in five to ten years' time.

may also hasten fleet renewal programmes.[18] At the same time, efforts are also underway to transition away from fossil fuels to bio-jet fuel. While there is support across the aviation industry for use of bio-jet fuel, the current cost of production remains a significant barrier.[19] Nevertheless, with leadership from OEMs (Airbus and Boeing both have bio-jet fuel programmes[20]) and support from governments, bio-jet fuel production can ramp up significantly in the medium-term. In Asia, only Indonesia has so far indicated support for bio-jet fuel, with its mandate to be implemented in 2018.[21]

WHAT LIES BEYOND MRO FOR SINGAPORE'S AEROSPACE SECTOR?

Given the pressures from regional competitors, changes in aerospace technology and climate change commitments, it is worth considering what lies beyond MRO for Singapore's aerospace sector. In the medium-term, there are niches that Singapore can diversify into, such as leasing (see Box 1). Looking further ahead, however, Singapore may need to explore new areas such as electric flight (see Box 2) and urban air mobility solutions (see Box 3) in order to retain its competitive edge.

BOX 1: BREAKING INTO LEASING

Ireland is the current global leader in aircraft leasing, but Brexit could affect this position[22]. Local player ST Aerospace has already taken steps to enter the aircraft leasing market, announcing a partnership with Japan-based Sojitz Corporation in Feb 2016.[23] However, Singapore will be competing with other aviation and finance hubs like Hong Kong in this space, which could mean a small window of opportunity.

BOX 2: GOING ELECTRIC

As commitments to cut carbon emissions ramp up, going electric may become a necessity for the aviation industry. However, current battery technology will prove a significant hurdle to overcome. For electric cars, battery cost and capacity remain major issues, and weight will factor in as well for electric planes.[24] Electric hybrid engines could be a more viable solution. For example, NASA is exploring development of a Boeing 737-size hybrid turbo-electric powered aircraft.[25] Electric flight represents an opportunity for Singapore to leverage its existing research initiatives in battery technology and its aerospace sector capabilities simultaneously.

BOX 3: URBAN AIR MOBILITY

Vertical take-off and landing (VTOL) craft are emerging as a potential mobility solution for megacities coming to terms with traffic congestion. Airbus' Project Vahana, for example, aims to conduct flight tests for its VTOL prototype by end-2017.[26] VTOLs, particularly if they use electric engines and are autonomous, could transform the current business model for short-haul regional flights. With intra-regional flights set to grow in ASEAN following ratification of its Open Skies policy in 2015,[27] Singapore has an opportunity to become a technology provider in this space.

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THE INDUSTRY OF ME

Sarah Tan & Manoj Harjani

Growing pains over companies' mismanagement of personal data – with breaches and misuse becoming commonplace (see Box 1) – are driving ways to enable individuals to regain control over the data they generate. We highlight two areas in which this is manifesting – personal data marketplaces and regulations on collection and usage of personal data – delving briefly into the implications of an emerging "industry of me".

MY DATA, MY MONEY

Personal data marketplaces tap into the current trust deficit[1] that companies face in relation to managing their customers' privacy and data security concerns as well as the growing desire among individuals for a "data dividend."[2] For example, Datawallet[3] aggregates its users' data anonymously to generate analysis reports that are then sold to companies, with payouts of up to US$50.[4] Beyond monetary payouts, personal data marketplaces are exploring other ways to compensate users for sharing their personal data as well. For example, People.io[5] and Noggin Asia[6] offer users credits or vouchers for other products and services. As more individuals seek to control the data they generate, personal data marketplaces could scale up to challenge the data broking[7] industry, which is expected to witness significant consolidation in the medium-term.[8] However, the ability of personal data marketplaces to scale ultimately depends on whether enough individuals participate, and whether appropriate standards can be developed to ensure interoperability.[9]

PUBLIC RULES FOR PRIVATE DATA

Regulators are taking a hard approach towards mismanagement of personal data. In Europe, the forthcoming General Data Protection Regulation (GDPR) mandates that individuals have the right to transport their personal data from one organisation to another (data portability) and stipulates timelines for organisations to report security breaches.[10] The GDPR also increases penalties, with contraventions subject to

BOX 1: MISHAPS PILE ON…

AN ABOUT-TURN
WhatsApp's announcement of a data sharing agreement with parent company Facebook in August 2016 generated criticism from users and punitive action from European regulators. The incident will likely invite future scrutiny from regulators around how M&A will affect users' rights with respect to use and management of their personal data.

NO APP IS SAFE
Telegram, a messaging app known for emphasising security of its users' data, saw hackers exploit the use of SMS messages for new device activation to gain access to user accounts. The breach cast further doubt on the security of SMS-based two-factor authentication, which is typically relied on by Internet-based services for an additional layer of protection.

DISCLOSURE WOES
The failure of companies to disclose when cyberattacks happen poses a significant risk to users. For example, Yahoo only disclosed the major data breaches it experienced in 2013 and 2014 in late 2016. Part of the problem lies in the uncertainties surrounding discovery and attribution of cyberattacks, but the incident also highlighted that users would be unlikely to successfully seek legal recourse for Yahoo's failure to protect their data.

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BOX 2: REGULATION RELATED TO PERSONAL DATA IN ASIA

China passed its first Cybersecurity Law in November 2016, which will take effect in June 2017. The law requires citizens' personal and transaction data collected within China to be stored in China, with cross-border transfers subject to a security assessment. It also provides for individuals to request for deletion of their personal data.

Japan amended its Act on the Protection of Personal Information in 2015, creating a Personal Information Protection Commission and expanding the definition of personal information to include biometric data. Unlike other countries, Japan has fewer restrictions on cross-border transfers of personal data.

Compared to the rest of Asia, South Korea's personal data regulations are among the most mature and its enforcement measures the most stringent. South Korea's regulatory approach is slightly different, however, with an overarching Personal Information Protection Act complemented by a range of sector-specific regulations, e.g. pertaining to e-commerce and credit information.

Indonesia is the first country in Asia to introduce the right to be forgotten as part of amendments to its law on electronic information and transactions in December 2016. Indonesia also concurrently introduced a personal data protection regulation, but enforcement is limited to administrative sanctions only.

Malaysia introduced a Personal Data Protection Commissioner tasked with implementing and enforcing regulations in 2016. In addition, codes of practice have been created for specific sectors, e.g. utilities, banking and insurance. Data users in these identified sectors are also required to register, with penalties for data users that do not register but continue to process personal data as well as for registered data users that violate regulations.

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fines of up to €10-20mn or 2-4% of global turnover in the case of undertakings.[11]

Asia is no exception. Regulators in several countries have put in place measures emphasising limitations on cross-border transfer of personal data (see Box 2). However, enforcement approaches vary widely, with few countries yet to use penalties on a scale similar to Europe.

WHAT'S NEXT FOR THE PERSONAL DATA INDUSTRY?

In the short to medium-term, companies with business models reliant on unfettered access to personal data will be coping with an increase in compliance costs in light of stricter regulations and penalties. For companies that operate in multiple countries, harmonisation of regulations will be crucial in minimising compliance costs, although this will likely be limited to the level of regional groupings such as the EU and ASEAN.

At the same time, there is a significant risk of future data breaches and misuse widening the trust deficit between companies and individuals, and personal data marketplaces are not immune to this either. This could accelerate adoption of personal data marketplaces and intensify regulatory interventions. Taken together with increasing adoption of wearables generating novel forms of personal data, we may see an "industry of me" emerge where the role of individuals as data producers is both legally protected and remunerated. While some uncertainties remain for the potential of the personal data economy to mature in this manner, decentralised personal data marketplaces could help assuage concerns over misuse of data.[12] For example, the blockchain-based Blockstack[13] platform enables server-less apps to be built where users control their data and apps run on their devices. In a similar vein, social media backup service Digi.me[14] is transforming its business model towards one centred on being a decentralised data value exchange.[15]

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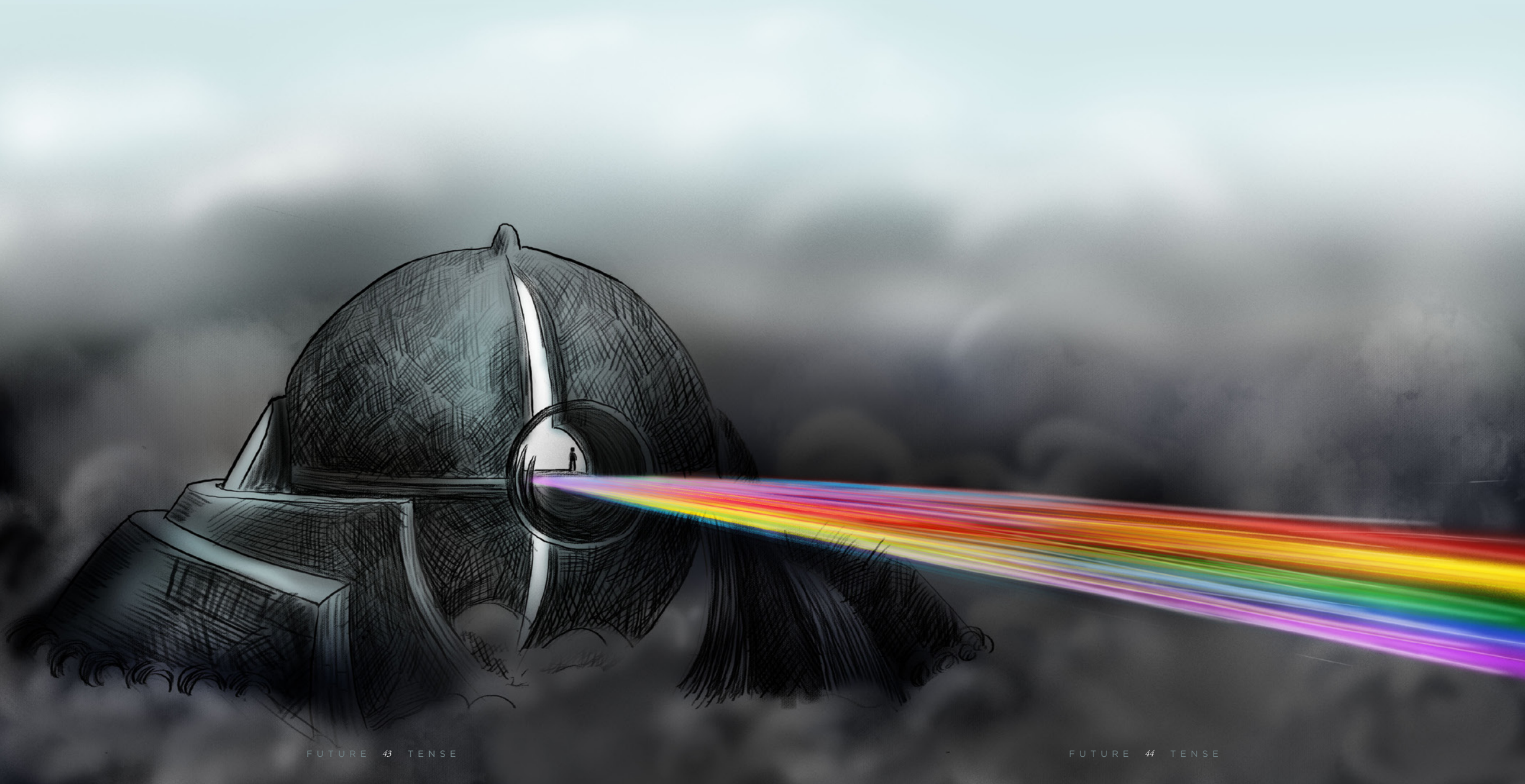
Asian Frontiers

ASIAN FRONTIERS



The Futures Group initiated Asian Frontiers in 2015 to explore the possibility of new models for economic growth emerging in Asia. For this second iteration, we have expanded the coverage to include key Southeast Asian economies. Furthermore, we examine countries' initiatives and strategies to address three challenges namely demographic change, industry transformation and energy insecurity, as opposed to a country-by-country comparison. These changes reflect the reality that, while Asian countries face similar challenges, there is a need to acknowledge the diversity of their circumstances and their capability to cope with the challenges faced.

Special thanks to Chrystal Ang, Chan Pei Lin, Goh Yeow Chong and Quek Boon King for helping us in our research on the various countries covered in this update to Asian Frontiers.

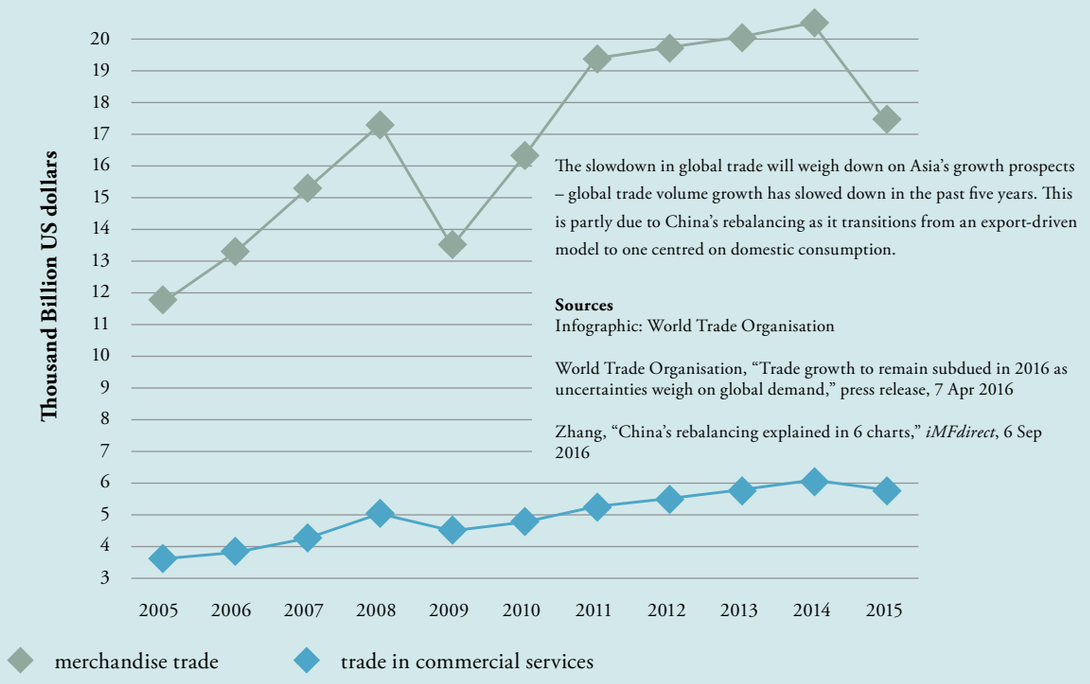
FROM ASIAN FRONTIERS 1.0 TO 2.0

Sarah Tan & Jared Nair

Our starting point for *Asian Frontiers* 1.0 was that the "old" export-driven model appeared to be running out of steam. At the same time, the region's economies faced new challenges for which they had little or no historical reference to borrow from, such as low productivity growth, shrinking workforces and climate change obligations. However, our research from the first iteration of Asian Frontiers, which focused on East Asia, highlighted that governments and conglomerates were developing innovative strategies and solutions to cope with the challenges faced.

Asia as a whole is still a bright spot for economic growth,[1] but faces some risks as growth in global trade has slowed and uncertainties surrounding the role of the US in the region have emerged following the election of President Trump (see Figures 1 and 2). Furthermore, upcoming political transitions in China (2017), Japan (2018), Malaysia (2018) and Indonesia (2019) may also challenge expectations on the pace and consistency of economic reforms in the region. These risks are intertwined with how Asian countries experience the challenges of demographic change, industry transformation and energy insecurity in differing ways. In the case of demographic change, for example, while Japan and South Korea grapple with a shrinking workforce, Southeast Asian economies still retain significant potential to reap a demographic dividend while addressing the shortage of skilled workers. These differences in countries' circumstances are at the heart of Asian Frontiers 2.0 as we highlight examples of how Asian economies are developing and implementing novel solutions and strategies.

Figure 1: Slowdown in global trade volume growth



The slowdown in global trade will weigh down on Asia's growth prospects – global trade volume growth has slowed down in the past five years. This is partly due to China's rebalancing as it transitions from an export-driven model to one centred on domestic consumption.

Sources
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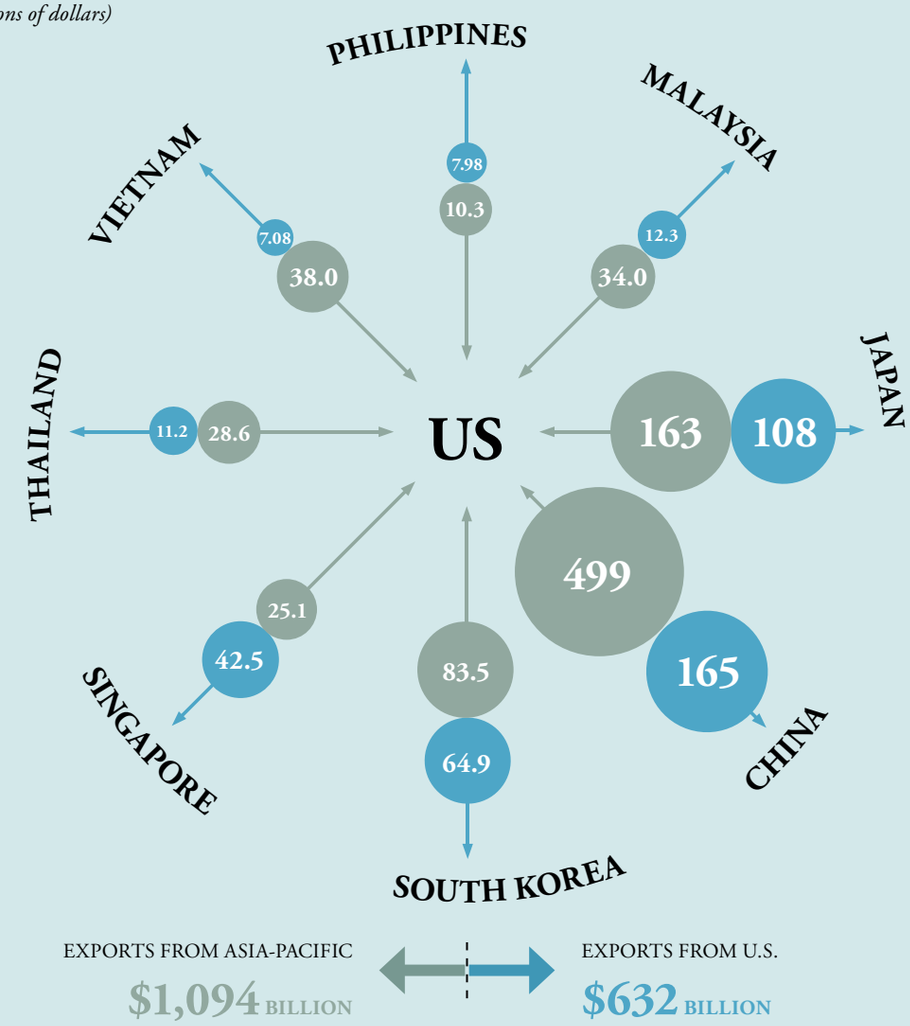
Figure 2: US trade with Asia – what comes next?

US goods/services trade with Asia-Pacific in 2015
(in billions of dollars)



The withdrawal of the US from the Trans-Pacific Partnership in January 2017 has generated uncertainties over how the US will define its role in Asia under the Trump administration.

In the meantime, the increasing prevalence of non-tariff measures within Asia – doubling from 1,200 in 2002 to 2,500 in 2013 – also acts as an obstacle to trade by increasing restrictions on companies looking to gain access to overseas markets.

Sources
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DEMOGRAPHIC CHANGE

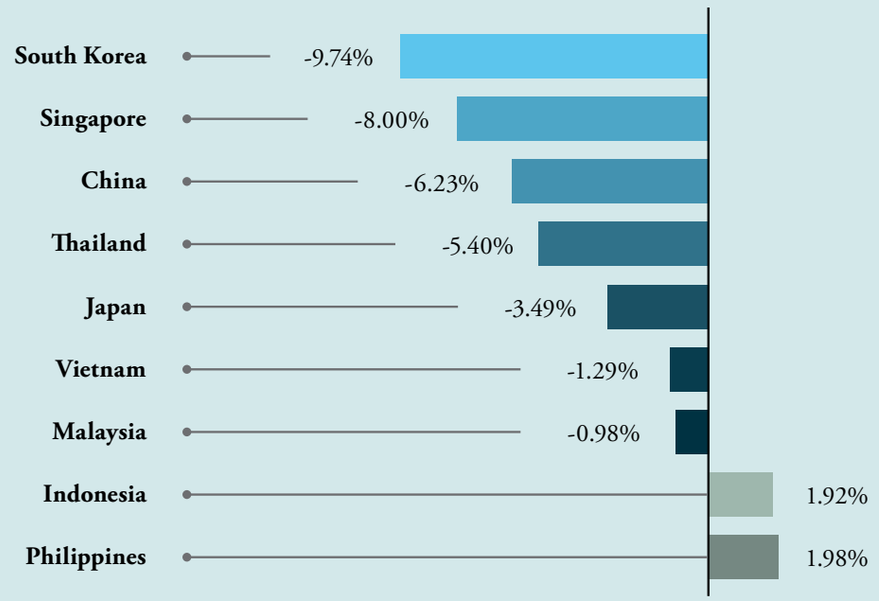
Sarah Tan & Manoj Harjani

Asia is set to experience a demographic transition as the growth of its working age population slows and eventually shrinks (see Figure 3). In Asian Frontiers 1.0, we highlighted how significant productivity improvements were needed for East Asia to cope with its rapidly ageing population. The situation is more varied in Southeast Asia, with some countries feeling the pressure of ageing (e.g. Thailand, Malaysia) while others are still able to reap a demographic dividend (e.g. Indonesia, Philippines and Vietnam).[2]

Looking at Asia as a whole, efforts to stave off demographic headwinds broadly fall into two categories: automation to make up for shortages of workers and bridging the skills gap to raise the ceiling for productivity of existing workers. Some Asian countries are also exploring other solutions in the regulatory space, e.g. immigration and retirement age reforms, in order to draw on foreigners and older workers to fill the gaps. The challenge for these countries will be to strike a balance between the societal impacts of these reforms and the need to stem declining workforce growth.

Figure 3: Asia's shrinking workforce (2015-2030)

Change in working population (15-64) between 2015 and 2030 in Asia-Pacific %



Infographic source: Marsh & McLennan Companies

CHINA

China's rapid growth over the past three decades has been propelled by cheap labour. However, the country's working-age population is predicted to peak by 2024[3] and shrink 24 percent by 2030.[4] Together with rising wages, this has signalled the end for an era of "easy" growth. As China's demographic fortunes reverse, policymakers are turning to automation as an economically viable alternative to human workers and to increase productivity. Local government subsidies are driving the transition towards a robot workforce, with companies like Foxconn Electronics[5] and Ying Ao[6] deploying robots where fewer workers are available. China has also introduced initiatives to attract foreign and diaspora talent to grow its workforce. In addition to its Thousand Talents program[7] to recruit overseas Chinese to return to China, the government is also easing current rules to make it easier for skilled foreigners and foreigners of Chinese descent to obtain a Green Card to live and work in China.[8]

JAPAN

Raising labour participation rates remains critical for super-ageing Japan as companies leverage exoskeletons to help older workers perform physically-demanding tasks, e.g. Panasonic's AWN-03 exoskeleton.[9] Similarly, Kubota Corp. and Iseki & Co. are developing autonomous tractors to address the shortage of workers in agriculture.[10] At the same time, slow progress on immigration reforms with foreigners making up only 1.4 percent of Japan's workforce[11] have also motivated companies to find other ways to address the shortage of workers. More Japanese companies are re-employing older workers with the requisite skills into their 80s and 90s. Cosmetics maker Pola, for example, has a 50,000-strong workforce of elderly "Beauty Directors" to sell their products.[12]

SOUTH KOREA

South Korea's productivity growth remains lacklustre[13] even as its working-age population is expected to peak in 2016.[14] Companies like Hyundai[15] and Hankook Mirae Technology[16] are following their Japanese counterparts and exploring deployment of exoskeletons and other technologies with the aim of increasing participation rates in the workforce. At the same time, the government has increased the mandatory retirement age to 60 from 55.[17] However in a society that values hierarchy, early retirement was a way for companies to overcome limitations faced in terms of hiring and promoting younger staff.[18] To balance this, the increase in mandatory retirement age has been accompanied by a wake peak system that is aimed at reducing the financial burden companies will face.[19] Despite criticism from labour unions,[20] a majority of firms have come on board to implement the wage peak system.[21]

INDONESIA

Unlike the advanced Asian economies, Indonesia faces a different kind of "demographic tax". Despite possessing a young workforce, the country experiences a severe shortage of skilled workers. By 2020, BCG expects a 56 percent shortfall of workers at the middle-management level. The shortage of talent has, however, fuelled new partnerships with companies to create educational programmes that will train a pipeline of future talent. For example, the government has teamed up with Google to train 100,000 Indonesian mobile developers by 2020. In addition, Google announced it would translate its Udacity course material into Bahasa Indonesia, run study groups to mentor developers, and partner with Indonesian universities to provide a semester-long curriculum to develop high-quality Android applications.

MALAYSIA

By 2030, 14% of Malaysia's population will be 60 and older.[25] To mitigate pressures from ageing, the government is growing its current pool of skilled workers. TalentCorp, a national initiative targeting 12 priority sectors, aims to grow the skilled workforce by attracting overseas Malaysians via the Returning Expert Programme and expatriates through the Residence Pass-Talent permit.[26] However, the number of approvals remains low – only 3,100 have been recorded since the programme started in 2011.[27] Nevertheless, TalentCorp's attempts to reduce the gap in female labour participation rates through flexible work arrangements have helped to increase Malaysia's female labour participation rate from 46.8 percent in 2010 to 54.1 percent in 2015.[28]

THAILAND

With its workforce projected to peak in 2017,[29] policymakers are introducing a variety of responses to mitigate Thailand's demographic constraints. The government has urged businesses to hire more elderly workers to increase participation in the workforce. To facilitate this, the government has set up a national employment service centre for elderly workers to ensure that older persons remain part of the productive workforce. Since its pilot run which began in 2015, the centre has helped 400 out of over 500 elderly jobseekers who registered to find employment.[30]

VIETNAM

Enlarging the current base of skilled workers is paramount for Vietnam to prepare itself for demographic change. While Vietnam's labour productivity growth has improved by 24 percent since 2010, the country continues to lag behind other ASEAN economies.[31] Companies with significant manufacturing investments in Vietnam like Samsung are striking agreements with universities for their employees to take free night classes.[32] Others like US-based Jabil are creating in-house training programmes while local conglomerate FPT Group started its own private university in Hanoi.[33]

PHILIPPINES

The Philippines is currently experiencing a demographic boost, with its working-age population projected to increase from 45 to 65 percent by 2030.[34] At the same time, the country also expects its elderly population to reach 10 percent by 2025.[35] However, the government's low spending on education is a significant barrier for successful implementation of initiatives such as the National Technical Education and Skills Development Plan 2011-2016.[36] Domestic conglomerates like Ayala, through initiatives like Ayala Education, are aiming to address the inadequacy of current education and training to make graduates ready to take on jobs.[37] Foreign aid is another important contributor to the Philippines' efforts to grow its skilled workforce. For example, the Japan International Cooperation Agency has collaborated with the government to support vocational education in industries such as agriculture.[38]

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INDUSTRY TRANSFORMATION

Sarah Tan & Jared Nair

In *Asian Frontiers* 1.0, we highlighted how East Asian economies were leveraging on new technologies to spur industry transformation. While Southeast Asian economies are also taking steps to upgrade traditional sectors, ideas for what industry transformation entails vary considerably across countries. For example, many Asian economies have identified the need to capture a greater share of higher value-add activities but their definition for what constitutes such activities differs. Nevertheless, we see two broad similarities across the region. Firstly, Asian economies are increasing productivity through digitisation and developing new growth sectors and markets. Secondly, for economies that have less flexibility in changing the mix of economic activities, transforming traditional sectors to retain their competitiveness is an important strategy.

CHINA

With a shrinking working-age population, China needs to raise productivity to counter its demographic headwinds. While its labour productivity still lags behind advanced economies,[39] China still has a window of opportunity to move away from a workforce growth-led growth model and steer its economy towards productivity and innovation-led growth. If successful, this could generate US$5.6tn of additional GDP by 2030.[40]

SHANZHAI TAKING THE STAGE?

Long criticised for its appropriation of foreign technology, China's shanzhai culture is increasingly recognised for its ability to enable disruptive innovation and potentially grow the next crop of globally-competitive Chinese companies. Smartphone maker Xiaomi is an example of a globally-competitive company that arose out of *shanzhai* culture.[41] Meanwhile, China continues to leverage digitisation to accelerate the transformation of its manufacturing and service sectors, with new footholds emerging:

- Big data and quantum technologies: The launch of Micius, the world's first quantum-enabled satellite is putting China ahead in developing ultra-secure communications.[42]
- Transport: China's push towards clean and renewable energy continues with its development of the world's first hydrogen-powered tram.[43]

GOING NUCLEAR: WATTS UP

Part of China's high-tech push is to become a world supplier of nuclear technology, having developed its own third-generation reactors (e.g. Hualong-1, CAP1400). The government is supporting local players keen to break into international markets, with projects using domestically-developed technology in places like the UK[44] and Pakistan.[45]

JAPAN

Japan's deepening shortage of workers presents an opportunity for the country to reinvigorate sluggish growth as a tighter labour market drives both the government and conglomerates to come up with new technologies to boost labour productivity.

NEW FRONTIERS FOR JAPAN, INC.

Japan's conglomerates continue to pioneer high-tech breakthroughs to increase productivity and give traditional sectors a leg up:

- Materials: Faced with stiff competition from cheaper wood imports in the region, Japan is expanding into R&D for cellulose nanofibers,[46] a sector projected to be worth US$8.2bn by 2030.[47] The material, which is estimated to be one-fifth the weight of steel and five times stronger, could be used in products such as automobiles, large electronic displays, and solar cells.[48]
- Agriculture: Spread Co. is developing a fully-automated farm to improve the efficiency of growing crops and cut labour costs by half in a bid to relieve worker shortages in the agricultural sector.[49]

SOCIETY 5.0

Japan's ambitious *Society 5.0* vision[50] puts it at the cutting edge of citizen-centric digital society development. Solutions being pioneered include:

- Virtual assistants: Japanese startup Vinclu Inc. has designed Hikari Azuma, a fully holographic virtual assistant that users can interact with and also get help to control IoT devices around the house.[51]
- Localisation: To help Japanese companies scale their business in foreign countries, Minimal Technologies has developed WOVN.io, a localisation service that allows optimisation of websites to the language of their markets.[52]

SOUTH KOREA

South Korea faces daunting challenges ahead as it shifts towards innovation-led growth. Potential protectionist measures by the US[53] and a slowing Chinese economy could affect the competitiveness of South Korea's export-oriented sectors.[54] At the same time, South Korea continues its push to reduce reliance on chaebols (conglomerates) and step up support for small and medium-sized companies.

SILVER LININGS

South Korea's government aims to grow 100 promising startups by 2020, and has unveiled plans to build overseas support committees for startup hubs like Korea Innovation and Korea Venture Investment Corp.[55] South Korean startups are also capitalising on growth opportunities in IoT:

- IoT infrastructure: Idolink's low power wide area network to promote IoT service expansion could act as a springboard for applications such as remote gas-metering services and wearable devices for the disadvantaged.[56]
- Smart urban infrastructure: More companies are going upstream to build the infrastructure required to support smart cities. For example, SK Telecom has launched a national network in partnership with Samsung to enable smart devices to communicate with each other. The combined network reaches 90% of Korean territory and 99% of the local population.

South Korea is also investing in new growth areas where the country could emerge as a potential leader:

- Advanced transport technology: The government, in conjunction with the Korea Railroad Research Institute, is supporting development of an ultra-fast train using hyperloop technology.[57]
- Electromagnetic induction wireless charging: With demand for wireless charging technologies set to reach US$22bn by 2022,[58] South Korea is aiming to capture a sizeable share of the market. The country has established Asia's first interoperability lab for companies to test and certify wireless charging products.[59]
- Space: South Korea has unveiled a US$587mn plan to promote indigenous space technology in a bid to become a global space power by 2040.[60] The first part of its space strategy will focus on helping local companies export more space products to overseas markets.

INDONESIA

Indonesia's economy faces uncertainties ranging from the impact of the Trump administration's trade policies to low commodity prices.[61] This has made the need to move up the value chain and to diversify away from commodity sectors more pressing. In particular, improving the country's infrastructure and logistics is critical to facilitate industry transformation. To this end, Indonesia intends to allocate US$480bn[62] in its National Medium-Term Development (2015-2019) strategy to bridge infrastructure gaps:

- Ports: Indonesia has issued guidelines on setting up international ports (e.g. Kuala Tanjung and Bitung Port) under the National Port Master Plan 2016 to raise connectivity and lower costs for transporting commodities.[63]
- High-speed rail: Indonesian authorities have signed a permit to commence the construction for a high-speed rail link between Jakarta and Bandung.[64]

MALAYSIA

As Malaysia's competitive advantage in the electronics sector erodes with the emergence of low-cost manufacturing economies like Myanmar and Vietnam, the country has identified alternative sectors for the development of higher value-added activities in its Economic Transformation Programme:[65]

- Oil and gas: Low oil prices have spurred Malaysian oil and gas companies to explore upstream activities such as deep-water oil production and specialty chemicals to secure future growth.[66]
- Healthcare: Building on its leadership in manufacturing surgical gloves and other rubber-based medical products,[67] Malaysia is venturing upstream into pharmaceuticals, biotechnology, medical technology and health services. This initiative is projected to generate 181,000 new jobs by 2020.[68]

THAILAND

After three decades of breakneck growth, there are signs of fading tailwinds for Thailand in the form of weak global demand, spill-over effects from exposure to China[69] and a rapidly ageing and shrinking workforce. Political uncertainty also continues to cast a long shadow over the country's ability to introduce long-term structural reforms that would realise its future growth potential.[70] In spite of this, there are initiatives being spearheaded by the Thai government that could lay the groundwork for the country's economic transformation.

THAILAND 4.0

Little is known about "Thailand 4.0,"[71] a US$100mn initiative to transform Thailand's economy from low to higher value-added activities. Available information outlines broad strokes of the country's strategy to leverage its existing strengths to develop competitive advantages across a range of traditional and new sectors. These include automotive, electronics, medical and wellness tourism, agriculture and biotechnology, robotics, aviation and logistics, biofuels and biochemical and the digital sector.[72]

SUPER CLUSTERS AND STARTUPS

Thailand's Board of Investment announced a "super cluster" initiative in 2016 to support growth in key manufacturing sectors. This initiative aims to support industry development through exemptions in corporate income tax, import duties on raw materials/parts for export products, personal income tax for individuals and fast-track work permits/visas for foreign workers.[73] Thailand is also looking to develop its nascent startup scene. The government has recently announced its intent to launch a US$570 million venture fund to support 2,500 startups, with a goal to raise the number of startups in the country to 10,000 within 2 years.[74] While these are still early days, several notable VCs, including 500 Startups, have already moved to capitalise on support from the government to grow the startup ecosystem. 500 TukTuks, an arm of 500 Startups, has already raised a US$10mn micro-fund to invest in early-stage startups.[75]

VIETNAM

Vietnam's productivity growth has declined from 5.3 percent between 1990 and 2000 to 4.4 percent between 2002 and 2012.[76] Falling productivity growth as a result of inefficient investments and state-owned companies poses a risk for the sustainability of Vietnam's long-term growth. Traditional engines of growth such as agriculture are also losing steam and will be less able to compete on the basis of low labour costs.[77] In response to this, the government is pioneering solutions to grow the country's technological and innovative capacity:

- Agriculture: Vietnam stands to gain significantly from upgrading its agricultural sector which has been a key driver of the country's growth since the 2000s. A US$2.2bn credit package initiated by the government aims to fund high-tech agriculture and move Vietnam up the global value chain for agricultural products.[78]
- E-commerce: Home to successful startups like e-wallet MoMo and logistics player Giaohangnhanh,[79] Vietnam is gearing up to become a regional centre for technology and innovation. To spur development of early-stage startups, startup accelerator Innovatube has launched a US$5mn pre-seed fund for Southeast Asian startups focused on artificial intelligence, AR/VR, fintech and blockchain.[80]

PHILIPPINES

Tighter global financial conditions and slower growth in China continue to weigh down on the Philippines' growth potential.[81] At the same time, the Philippines has lost its competitive edge in the electronics sector, a traditional driver of growth.[82] In light of this, the government and conglomerates are actively diversifying their investments. For example, the Philippines is building on its success in the business process outsourcing sector to move upstream in the form of business process management services. The government has outlined its strategy in a roadmap up to 2022 which pledges further development in adjacent sectors like animation and game development, health information management and software development.[83] In addition, the government is also promoting "next wave cities" (i.e. current 2nd-tier cities, e.g. Baguio City) as competitive outsourcing destinations as typical hubs such as Manila and Cebu are beset by rising costs.[84]

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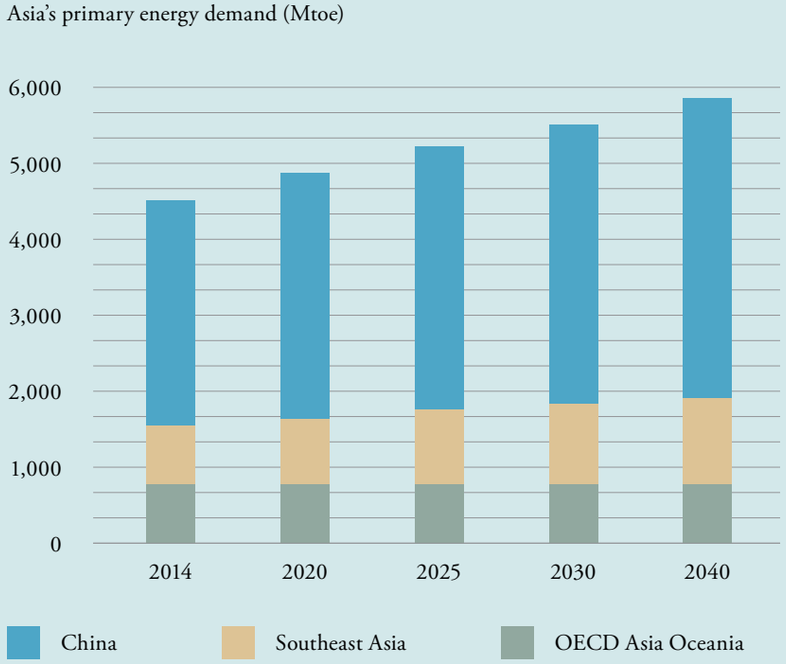
ENERGY INSECURITY

Jared Nair & Sarah Tan

In *Asian Frontiers* 1.0, we highlighted how growing demand for energy (see Figure 4) and the need to meet climate change commitments strengthened momentum for clean energy transitions in East Asia. Southeast Asian countries face similar challenges and are also attempting to diversify their current energy mix towards renewable energy sources. However, apart from China, Japan and India, Thailand was the only other Asian country with at least US$1bn in renewables investments in 2015, highlighting the long road ahead for renewables in Southeast Asia.[85]

The fall in oil prices between 2014 and 2016 is another key factor affecting Asia's energy security given its dependence on fossil fuels. East and Southeast Asia together account for around 40 percent of global oil imports, with most of the countries being net importers.[86] While these countries have benefited from lower oil prices, they remain vulnerable to supply disruptions due to heavy reliance on the Middle East.[87] Furthermore, they will also face rising energy import costs in future as production within Asia has slowed and will fall by about 30 percent between 2016 and 2025.[88] This vulnerability has driven Asian economies to diversify their energy mix, including exploring renewable and nuclear sources. Until Asia reduces its reliance on imports, energy insecurity will remain a challenge for the region.

Figure 4: Asia's energy demand outlook



Source:
World Energy Outlook 2016

Asia consists of **OECD Asia Oceania** (Australia, Japan, Korea and New Zealand); **Southeast Asia** (Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam) and **China**

CHINA

With a pledge to invest US$360bn in renewables by 2020,[89] China has made bold moves to scale-up electricity generated from wind, solar and geothermal sources. However, its path to a clean energy future continues to run up against the ability of its grid to absorb the electricity generated. For example, in the case of wind energy, approximately 21 percent of energy generated is wasted.[90]

China is also moving forward with plans to develop nuclear power. With 36 reactors operational and another 20 under construction, China hopes to increase nuclear energy's contribution to its overall mix from 2 percent in 2012 to 9 percent by 2030.[91] This strategy is not without criticism, with concerns raised over safety and quality of the nuclear plants.[92]

JAPAN

Six years after the Fukushima disaster, Japan is still decades away from decommissioning the damaged nuclear power plant.[93] With fossil fuels coming in to replace the nuclear reactors shut down, Japan has had to cope with an increased reliance on imported energy that has harmed its competitiveness by driving up electricity prices.[94] At the same time, its push to encourage renewables has lost steam due to cuts in subsidies and difficulties in land allocation.[95] Hopes of restarting nuclear power plants may also be unrealistic given public opposition which has led to lawsuits to halt restarts.[96] Significant challenges also remain for Japan's ambitions to tap its geothermal energy reserves as key sources are located within national parks, raising concerns over conservation and pollution.[97]

The silver lining of Japan's troubles with securing its energy supply is its emergence as a world leader in energy efficiency technology. Furthermore, opportunities remain for Japan in developing offshore wind and marine energy. Japan could potentially generate 500GW from floating wind power sources,[98] and is seeking to grow its capabilities in wind turbine technology by partnering with Denmark.[99]

SOUTH KOREA

In a bid to wean itself off fossil fuel imports, South Korea's government announced plans in 2016 to invest US$36.6bn in renewables by 2020.[100] The government complemented this with energy market liberalisation initiatives, as the existing state-owned quasi-monopoly market structure was an impediment for growing renewable energy generation capacity.[101] With a competitive market auction system for renewable energy producers, Korea aims to have renewables contribute 11 percent of the country's electricity supply by 2025.[102] Furthermore, unlike its neighbour Japan, Korea also remains committed to nuclear power generation, although it has scaled back its plans in its 2nd Energy Master Plan.[103]

INDONESIA

Boosted by a fall in prices in 2014,[104] coal continues to dominate Indonesia's energy supply even as it seeks to increase its share of renewables in the overall energy mix to 23 percent by 2025.[105] Nevertheless, the government has also introduced a framework to regulate prices at which utilities procure energy from renewable sources in order to encourage their development.[106] Tidal power is one area in particular where Indonesia could grow its renewable energy supply. It is estimated that the country could potentially generate 60GW from tidal power sources, exceeding the current national electricity generation capacity of around 50GW in 2015.[107] Initiatives like the one between local player PT Air and France-based OpenHydro will help encourage development of the country's tidal energy sources.[108]

MALAYSIA

The Eleventh Malaysia Plan sets out clear targets to increase the installed capacity of renewables to 2080MW by 2020 from 243MW in 2014.[109] At the same time, Malaysia remains dependent on fossil fuels, with 83% of total energy generated from coal and gas in 2015.[110] Fossil fuels are expected to continue to play an important part of the energy mix up, however Malaysia has plans to explore biomass, biogas, wind, geothermal and ocean energy sources.[111] While Malaysia is currently the third largest solar panel manufacturer globally,[112] domestic deployment and generation remains modest.[113] However, this is set to change with implementation of net metering and utility-scale deployment of solar. Four major utilities players – Tenaga Nasional, Malakoff Corp., Mudajaya Group and Integrated Logistics – have been granted approval by Malaysia's Energy Commission to construct large-scale solar power plants.[114]

THAILAND

Like other Asian economies, Thailand's energy insecurity is rooted in dependence on energy imports and rapidly expanding energy demand, which is projected to increase 75 percent over the next two decades.[115] The need for alternative energy sources is also driven by the fact that Thailand's natural gas production will peak in 2017, with reserves projected to run out in the coming decade.[116] Nevertheless, Thailand has invested heavily in renewable energy sources, including solar, wind and hydro, and the government aims to raise solar energy's share of total renewables production from 17 percent in 2014 to 30 percent by 2036.[117] Energy efficiency is also an important part of Thailand's strategy as it seeks to reduce energy intensity by 30 percent in 2036 relative to 2010.[118] While much of its comprehensive Integrated Energy Blueprint has yet to be realised, Thailand appears well-placed to meet the challenge of energy insecurity given the significant budgetary allocation of 300bn baht for increasing power grid capacity from 2016 to 2021 and various initiatives through its Board of Investments to promote investments in renewables.[119]

VIETNAM

Despite a significant increase in energy demand due to rapid economic growth,[120] the initial enthusiasm in Vietnam's renewables push appears to have worn off. This is particularly evident in the case of wind power, where significant potential sources[121] remain untapped due to a lack of subsidies to defray high installation costs.[122] Efforts to build up nuclear power have also stalled as the country abandoned its plans due to high costs.[123] Instead, the Vietnamese government has capitalised on cheap access to strengthen its pipeline for coal projects, which will make it a mainstay of its energy supply in the long term.[124]

PHILIPPINES

With a review of its energy mix ongoing, uncertainties remain for the direction that the Philippines' energy policies will take.[125] However, the Philippine Development Plan 2017-2022 provides some indication of the Duterte administration's intentions, which include expediting implementation of policy mechanisms under the Renewable Energy Act of 2008 to encourage adoption and concurrently facilitating the development of domestic natural gas production.[126]

The key challenge ahead for the Philippines will be to bring down the cost of electricity while securing the reliability of its energy supply. Renewables have a key part to play, as highlighted in a joint study by the International Renewable Energy Agency and the Philippine Department of Energy, which identified significant untapped potential for renewable sources such as geothermal, hydro, solar and wind.[127] At the same time, the government is also exploring other options such as reviving the mothballed 620MW nuclear plant built during the Marcos administration.[128]

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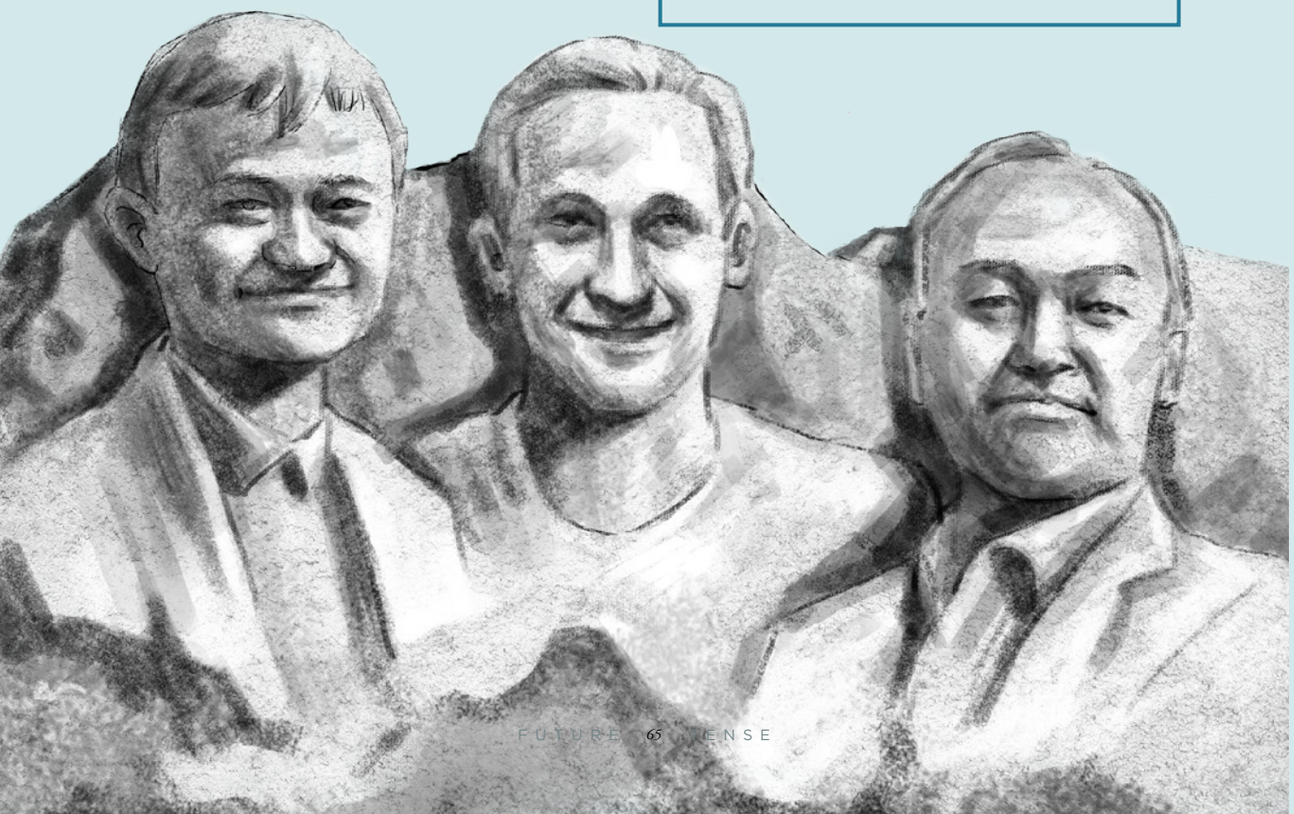
WHO ARE ASIA'S ELON MUSKS?

Sarah Tan & Manoj Harjani

In the US, successful startup founders are more than just drivers of growth and innovation through the companies they lead. They also act as change agents engineering transformations that will underpin the future of their country and often, the world. Elon Musk is the most obvious example of this, with his paradoxical vision of a clean energy future on Earth through Tesla and SolarCity while creating the means to leave Earth and sustain human life on Mars through SpaceX.[129] In recent years, Asia's rapid growth has seen a similar rise of influential entrepreneurs with transformative long-term visions. We highlight three such change agents here.

Jack Ma
Founder and Executive Chairman, Alibaba, China

Jack Ma's disruption of traditional B2B retail models by focusing on supporting small companies with a B2C framework has made Alibaba the face of China's e-commerce industry. Evolving from a "crocodile in the Yangtze river" to a "shark in the ocean,"[130] Alibaba has leveraged its greatest resource – customer data on spending habits and creditworthiness – to gain a foothold in adjacent industries. For example, the company has challenged China's state-owned banks to reform their rules on private lending and liberalise access to finance for small companies through the online-only MyBank.[131] Ma's ultimate goal is for Alibaba to build infrastructure for global commerce that includes cloud computing, artificial intelligence and big data.[132] In addition, Alibaba continues to support China's forays into "frontier" sectors such as deep space exploration and smart city projects.[133]



Jia Yueting
Founder and Chief Executive Officer, LeEco, China

Jia Yueting's vision is to transform LeEco into the "ultimate combination of Tesla, Uber, Apple, Amazon and Netflix."[134] With this in mind, LeEco has been striving to break down barriers between devices and operating systems to create an integrated ecosystem of content and devices for its users.[135] The company has branched out from online video content streaming into an array of internet-enabled verticals, including smartphones and televisions,[136] cloud computing (LeCloud),[137] ride sharing (Yidao Yongche),[138] and real estate.[139] More recently, Jia has taken on the automotive industry with his investment in US electric vehicle startup Faraday Future, challenging traditional automakers to create vehicles that are not only environmentally-friendly and internet-enabled, but can be assembled in a modular fashion.[140]

Masayoshi Son
Chairman and CEO, SoftBank, Japan

Innovation is at the heart of Masayoshi Son's 300-year vision for SoftBank.[141] The company first started as a software distributor in the early 1980s and eventually transformed itself into a telecommunications giant.[142] Son has no plans to stop at telecoms. The next phase of his long-term vision is to transform SoftBank into a company that is ready for the "Singularity," a point in time when machine capabilities will exceed human intelligence.[143] To this end, Son has directed SoftBank's investments to a wide variety of sectors ranging from biotech[144] (Zymergen) to semiconductors[145] (ARM Holdings) and private equity[146] (Fortress Investment Group). Furthermore, Son has also set up the SoftBank Vision Fund – a US$100bn initiative to invest in strategically important technologies for the future.[147] To date, the fund is backed by US$45bn from Saudi Arabia, US$25bn from SoftBank itself, and US$1bn each from Apple, Qualcomm and Oracle.[148]

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FG CONVERSATIONS

HOW SHOULD SINGAPORE DESIGN ITS FUTURE SUCCESS?

In 2016, the Futures Group posed this question to 18 thought leaders across the public, private and academic sectors.

Through curating a diverse cross section of responses, we hope to provide starting points for meaningful discussion on some of the assumptions held on the idea of success and how it can be achieved.

FG Conversations

THEMES FROM FG CONVERSATIONS 2016

SINGAPORE SHOULD NOT GET LOST IN ITS OWN SUCCESS

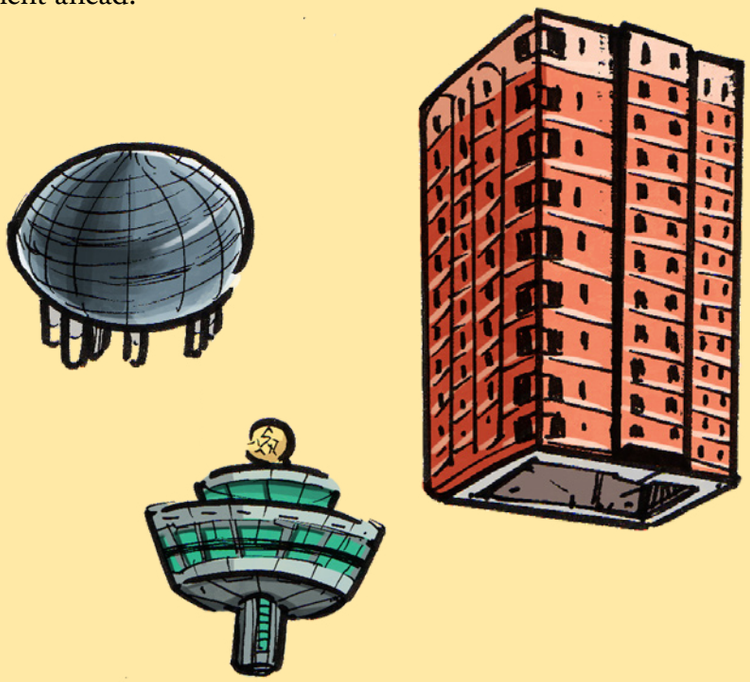
Having reached a stage where Singapore performs well in terms of conventional metrics, we should now think about the other aspects of what it means to be successful. Singapore now faces an ageing population and slower economic growth rates like other advanced economies, and these circumstances are different from those that drove our Pioneers. Many of the thought leaders felt Singaporeans today needed to find greater determination and commitment to achieve future success.

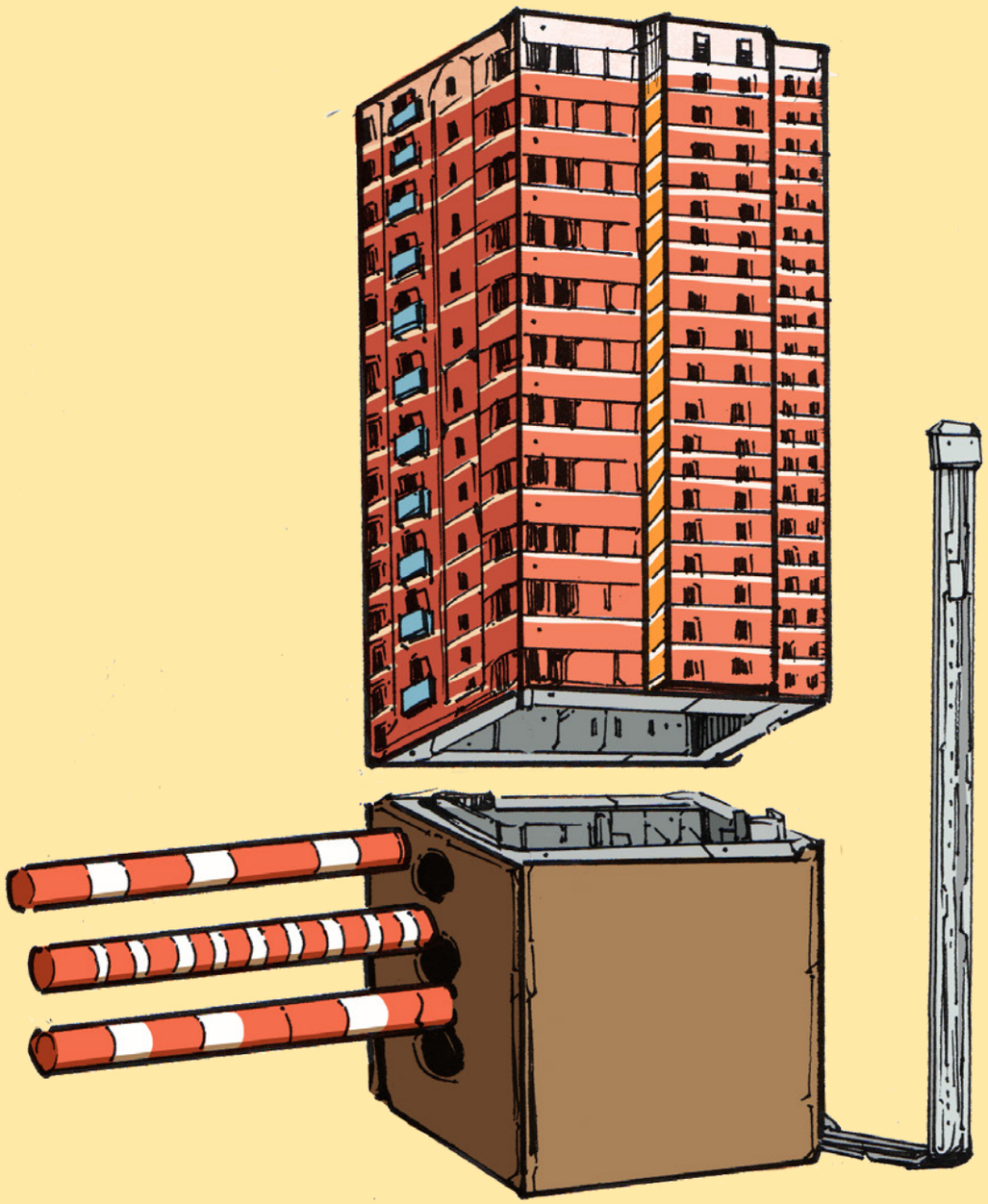
GOVERNMENTS AND COMPANIES WILL NEED TO COLLABORATE TO SAFEGUARD SINGAPORE'S GLOBAL POSITION

New relationships and platforms are needed in a world of fragmented globalisation where Singapore's relevance as an intermediary and interlocutor will be tested. Singapore's reputation as a trusted location for business and its connectivity will remain important, but this will need to be complemented by more Singaporean companies competing on a global level as the government cannot be the only change agent. There were a range of views, however, on the type of ecosystem best suited to develop global champions. One suggestion was a "Joseph Schooling" model, in which we nurture companies locally before embedding them in a foreign ecosystem to see if they thrive. Other ideas emphasised soft factors such as building a supportive culture for innovation and risk-taking.

PEOPLE WILL CONTINUE TO MATTER, BUT IN DIFFERENT WAYS

Our thought leaders offered many ideas for what incoming and future generations need to be equipped with in order to ensure their resilience as they face up to technological change. For example, they will need to have a sense of belonging not just to Singapore, but more broadly to the region as well. Furthermore, they must be able to connect with and influence people and be unafraid of failure and taking risks. Singapore will also need to groom a balanced crop of specialist and generalist leaders as both types are needed to navigate the challenging environment ahead.





DR LIM JUI
Chief Executive Officer
NTU Innovation

Singapore's vulnerability post-independence drove its Pioneer leaders, entrepreneurs and workers to create the systems and institutions that have brought Singapore to where it is today. The exceptional circumstances that led to this no longer exist today, and there is a growing aversion to taking risks which has reduced our agility and efficiency. Looking ahead, designing Singapore's future success necessitates us to prepare for less-desirable situations and not just envision preferred futures. With an increasingly fragmented global environment ahead of us, I see two tension points that we must address. First, Singapore's relevance will be tested in a world where East and West may no longer need us to play the role of intermediary and interlocutor. Nevertheless, especially in the context of a Trump presidency, there are still opportunities in the coming decade that we should take advantage of while they are still there. Second, Singapore also needs to think about how to groom a balanced crop of specialist and generalist leaders as both types are needed to navigate the challenging environment ahead. Specialists are especially relevant to a knowledge-intensive economy.

DR DAVID SKILLING
Director
Landfall Strategy Group

Many of the difficulties that Singapore faces today are the result of its gradual "normalisation" – i.e. it now faces an ageing population and slower economic growth rates like other advanced economies. With a challenging external environment ahead where globalisation is fragmented, Singapore will need to rebalance its economy to escape the "high income trap" in terms of its cost structure and ability to sustain innovation. But this rebalancing is not easy to pull off – more Singaporean companies will need to compete on a global level as the government cannot be the only change agent. At the same time, to ensure Singapore's future success in a changed environment, the government will have to think hard about the exact nature of the transmission mechanisms between its policy decisions and resource allocations and the outcomes it is trying to achieve.

MS JACQUELINE POH
Chief Executive Officer
Government Technology Agency of Singapore

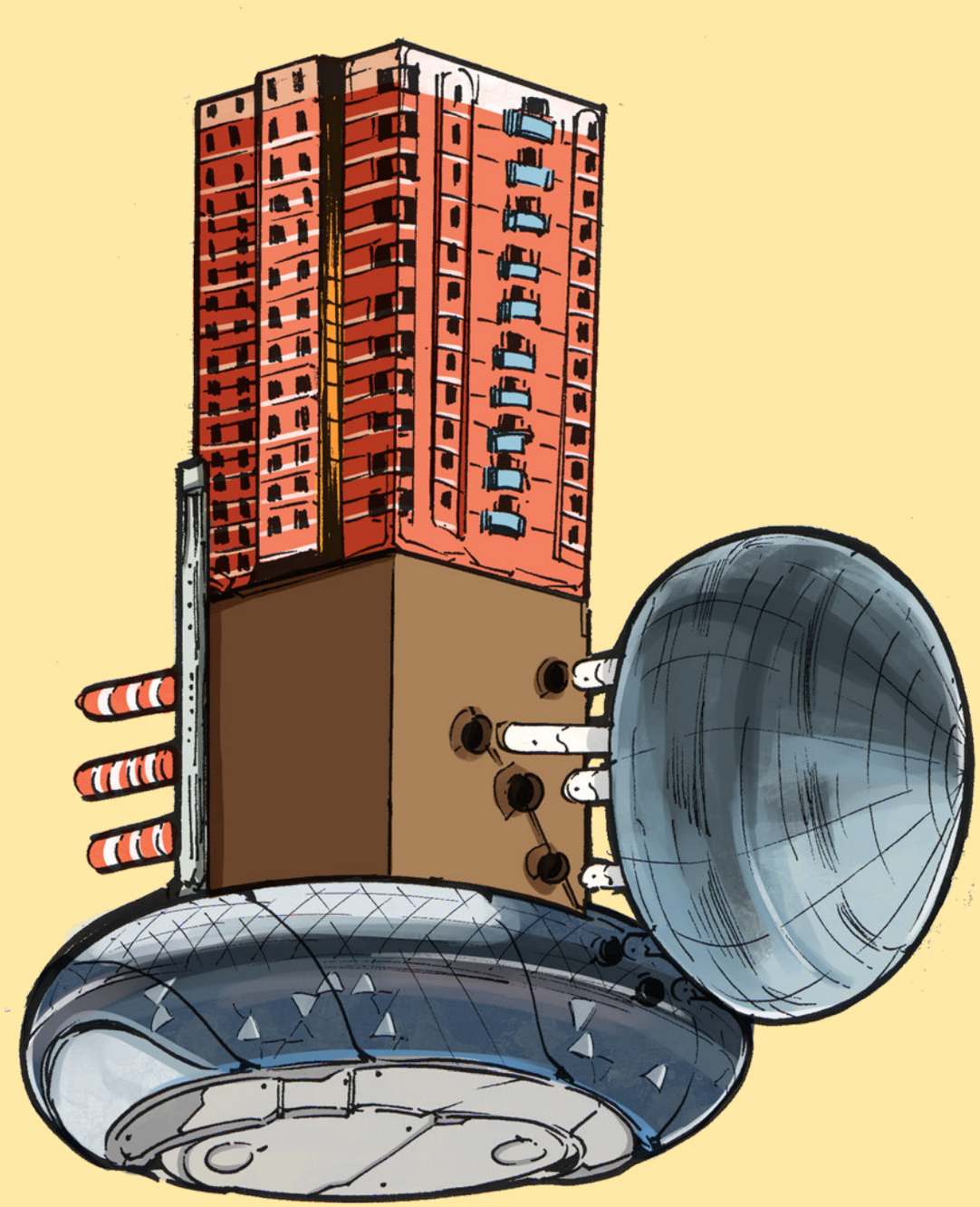
Very little of what we call "disruption" today is actually that disruptive – what we tend to witness is mostly an *optimisation* of existing processes using technology. Nothing wrong with that; it should be done and can yield benefits.

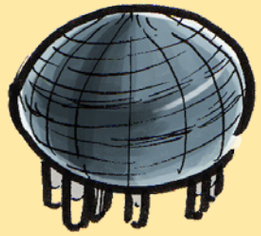
True business model disruption, on the other hand, requires a confluence of factors. First, recognition that incumbents are seldom the source of that *disruption*. The mindset and organisational shifts required are massive. Some bets must be placed on startups and new companies best placed to lead in a new space. Second, timing is key – investments are needed for technologies as they head into Gartner's "trough of disillusionment" rather than when they are climbing the "slope of enlightenment".

Our strengths position us well for the B2B space in ASEAN and we should develop platforms that allow us to connect to and facilitate this source of growth. Singapore's reputation as a trusted location for business and its connectivity will remain important, but a comprehensive digital strategy to leverage the opportunities in ASEAN is also necessary to ensure future success.

MR JAMES CHAN
Founder and Executive Chairman
Silicon Straits

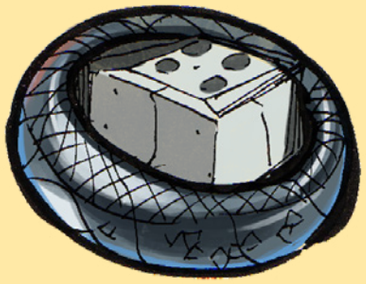
For Singapore to design its future success, we need a change of metrics – it's not enough to just score FDI and create X% value-add over Y years anymore. We need to figure out how to make ourselves "cool" to the world again without losing what makes Singapore unique. To do so, it is crucial that the structure and organisational behaviour of government evolves to become more nimble and agile, and embraces the DNA of the Internet. Given the shortening cycles in technology and business in our globalised world, we need to evolve EDB into a "FDB" (Future Development Board) that will enable us to sow new interpersonal and state-company relationships with these disruptors, so that Singapore can continue to maintain its first-mover advantage. Doing so would also help attract our best and brightest back to Singapore, who have become used to challenges they've experienced after leaving Singapore and living in high-speed innovation environments like Silicon Valley.





Could the "Joseph Schooling" model be applied to Singapore companies? To ensure our local companies are globally competitive, we groom them in Singapore first, and then embed them in a foreign ecosystem to train them up.

Singapore should not get lost in its own success.



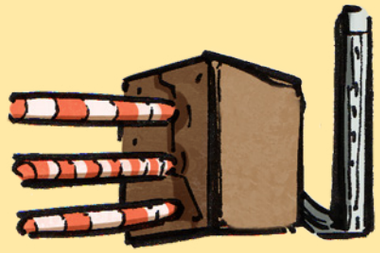
Singapore's tough, but there is a sense that it isn't as tough as it was before (when it first gained independence). The same applies to our firms – we need to build resilience back in our businesses, and let them fail if they are unable to compete locally, or in overseas markets.

MS FANG EU-LIN
Sustainability Leader and Risk Assurance Partner, PwC Singapore

MR ABHIJIT GHOSH
Partner, Tax Markets Leader, PwC Singapore

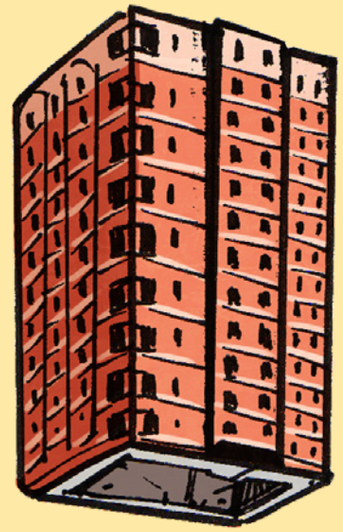
MR RICHARD SKINNER
Strategy Leader, PwC Singapore

MR ALYWIN TEH
Government & Public Services Leader, PwC Singapore
Singapore Consulting Leader, PwC South East Asian Consulting

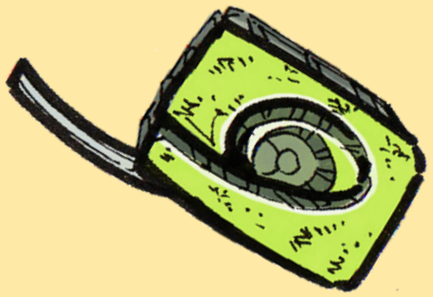


We should focus on inserting the 'Singapore blood' into the foreign ecosystem, and less on whether our local companies might be acquired.

We need to bring Singapore out of Singapore



ASEAN offers Singapore a hinterland from which we can benefit from enormously. Singapore should leverage the growth opportunity in its own backyard, which is plentiful in resources; Singaporean businesses should secure land leases in our neighboring countries and help build up the necessary infrastructure, thereby creating a win-win situation for everyone.



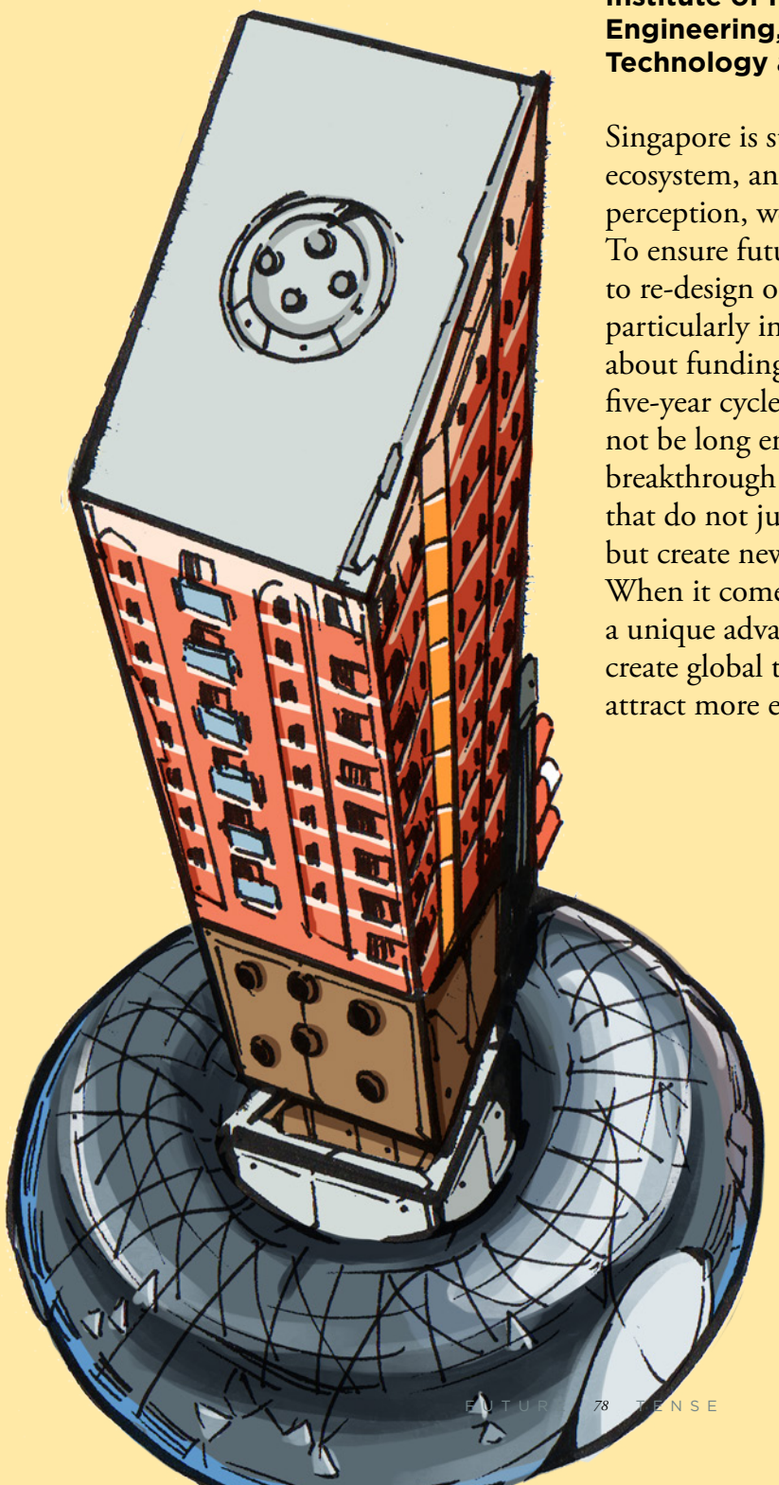
Our Southeast Asian neighbours are at a different stage of development than we are – most of them do not have the resources needed to drive development. Singapore has an advantage here – we could provide the resources they require to help them develop.

PROF JACKIE Y. YING

Executive Director
Institute of Bioengineering and Nanotechnology

Significant public funds have been invested over the past 25 years to encourage MNCs to establish their R&D operations in Singapore. However, an over-reliance on MNCs to help commercialise research may be problematic, as much of the value created by local researchers may not be captured locally and maximally through MNCs. To capture the full value of local research, vibrant Singapore-grown enterprises are essential and the public sector needs to proactively nurture and invest in a pipeline of SMEs that have the potential to develop and scale. Furthermore, the government's role in R&D should go beyond funding research in the public sector to ensure that intellectual property generated by research institutes is successfully commercialised by SMEs, and not just be licensed to MNCs. To support this, we need to create an environment that strongly rewards inventorship, supports spin-offs and entrepreneurship, and reverse the culture of risk aversion that is affecting Singapore's ability to bridge research and job creation.

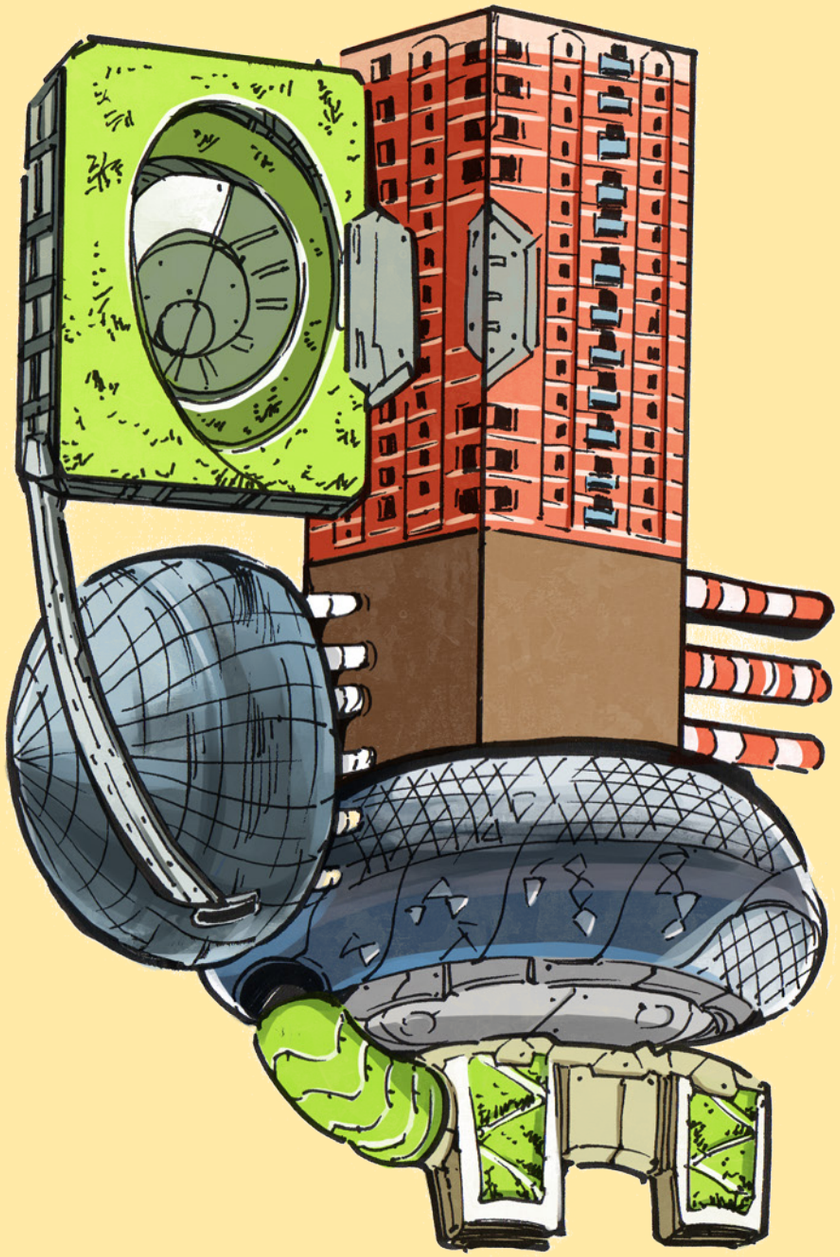
Indeed, we now run the risk of pushing the research institutes to do too much short-term research that serves the industry's near-term goals, instead of adequately funding research that is transformative and disruptive. The real fruits of long-term research investment can only be harvested if we have an unbroken value chain to market.



DR BENJAMIN TEE

Scientist
Institute of Materials Research and Engineering, Agency for Science, Technology and Research

Singapore is still young as an innovation ecosystem, and despite the common perception, we are an innovative country. To ensure future success, we may need to re-design our existing approach, particularly in terms of how we think about funding cycles and talent. The five-year cycle we are familiar with may not be long enough to incubate potential breakthrough innovations, i.e. those that do not just solve existing problems but create new opportunities altogether. When it comes to talent, Singapore has a unique advantage in being able to create global teams, but there is a need to attract more experienced individuals.



MR HIAN GOH
Partner
NSI Ventures

What sets startups apart from SMEs is ambition – this is what makes them an integral part of the next chapter in Singapore's economic development. While the startup ecosystem in Singapore currently has a critical mass of venture capitalists, funding is not the only element needed to nurture successful startups – talent is equally important, and startups need hustlers to sell, hackers to code and hipsters to design user experiences. To groom a pipeline of startups ready to capitalise on the wave of growth taking off in Southeast Asia, closer attention will also need to be paid to incubators and angel investors, as they have a better understanding of what startups in their formative stages need.

MS NATALYA TWOHILL
Founder
Kiddet

The Singapore system has worked well over the past fifty years, but our one-size-fits-all approach to problem-solving needs to change. Singapore's vulnerability in the past gave our Pioneers a hunger to think outside the box and develop solutions to problems they faced. As Singapore has matured, this hunger has dissipated. Restoring Singaporeans' ownership of the problems we face as a society and a country is crucial to ensure future success as it allows for solutions to emerge organically. For example, in education, discussions around interventions are often centred on students, when the issues ought to be owned by teachers and parents too. This is particularly crucial since the requirements to enter the workforce are changing alongside the attitudes and expectations of students, parents and teachers.

DR HO CHAW SING

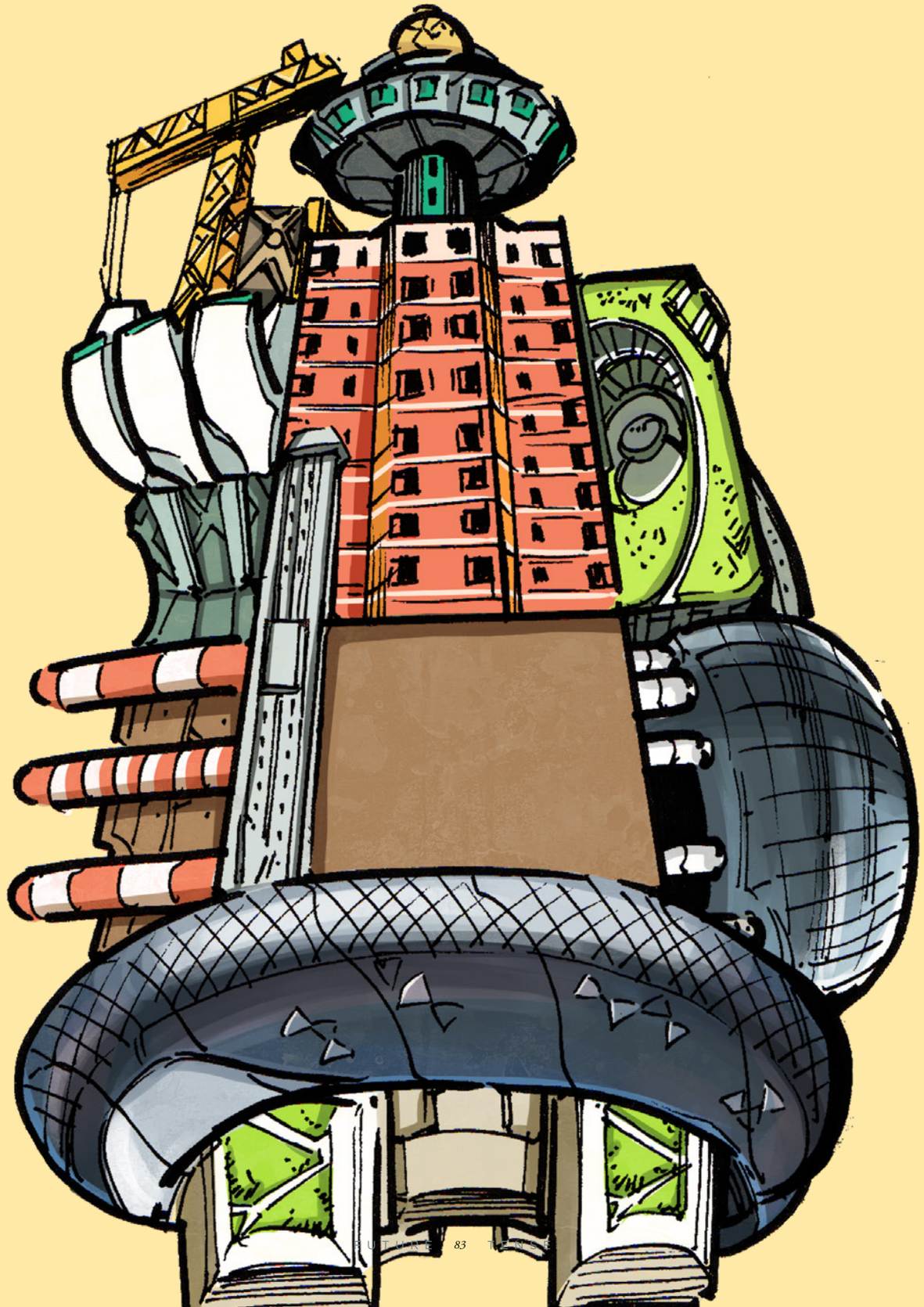
Managing Director
National Additive Manufacturing Innovation Cluster, Nanyang Technological University

Singapore's current model of governance has delivered for the past 50 years, but it has also generated its share of side-effects. Future success will depend on how we manage these side-effects. For example, in education, we need to continue moving away from pre-judging children based on academic indicators and focus on developing creativity, entrepreneurship and willingness to take risks. The next generation of Singaporeans should also be equipped with the ability to un-learn and re-learn quickly, and to connect with and influence people – these abilities will help them remain competitive in a rapidly changing environment. Even as we face up to technological change, the emphasis must remain on developing our people so that they can harness technology for society's benefit rather than be swept away by it.

PROF LOCKNIE HSU

Professor, School of Law, Singapore Management University

Educators often teach in the way they were taught – for better or for worse – and this has implications for our ability to train a workforce that is future-ready. The conversation on how to make tertiary education better prepare graduates for the workforce has typically focused on students and industry, but should really also examine the role of educators and their pedagogy. We need to ensure that educators themselves are best geared toward such preparation of students. As business models and world trends continue to evolve, they will impact not only undergraduates, but also the educators who are responsible for training them. Overhauling entire degree programmes can be a challenge, but the way individual courses are designed, updated and taught can be improved more easily. The educators' aim should be to ensure that students develop deep problem-solving skills along with their technical knowledge, both of which will be vital in future jobs.



DR PAULIN STRAUGHAN

Associate Professor
Department of Sociology, National University of Singapore

Having achieved success based on conventional metrics, Singapore should now think about the other aspects of what it means to be successful. I propose three such aspects for further exploration – first, how can Singapore become a more inclusive society where every individual is enabled to make a contribution back to society and be rewarded for that contribution? Second, how can trust between the government and Singaporeans be strengthened to build resilience? Lastly, how should Singapore sustain a sense of optimism so that citizens remain committed and invested in the future of Singapore? The challenge of designing Singapore's future success lies in maintaining a balance between ensuring a top-ranked position based on conventional metrics and the need to gradually incorporate other aspects of success.

MS GRACE SAI

Co-Founder and Chief Executive Officer, The HUB Singapore

Singapore's government is rare as it has a genuine desire to provide the best for its people. To ensure Singapore's future success, we should focus on forming more human to human connections. Singapore is strong because we all have a common mission, but the government could take a step back to let problems emerge and trust the population to solve them. For instance, having younger generations be aware of poverty in Singapore could result in more entrepreneurs rising up to solve these challenges.

MS AYESHA KHANNA
Chief Executive Officer
ADDO

A country's success is primarily driven by the ability of its population to innovate and cope with change. In the case of Singapore, designing future success will be about finding ways for younger Singaporeans to build resilience. We often criticise the young for being naïve, but naivety is bad only when it chips away at resilience. Singapore needs to think about how to develop its current education and skills ecosystem into one that motivates younger people to solve problems, reduces fear of taking risks, and provides opportunities to learn how to cope with failure. Developing a self-motivated workforce with problem-solving skills would enable Singapore to become a true gatekeeper for talent, where a small core of talent based here can manage a global team.

MR BASIL C. BITAS
International Research Fellow
International Academy of the Belt and Road (Hong Kong)

Singapore's future success will not be realised through technical and professional expertise alone, especially in this age of interconnectivity, where the importance of interpersonal relationships and interdisciplinary networks is becoming more critical. We will need to invest in our students and young professionals in a manner that allows them to become more broadly gauged and nimble going forward. For example, it is essential to encourage citizens and those living and working in Singapore to have a sense of belonging not just to Singapore, but more broadly to ASEAN as well. Furthermore, to institutionalise and reinforce the bridge between classrooms and the workplace, it will become increasingly important to create practical opportunities for students to identify and "exploit" important, but often non-obvious relationships to promote effective problem-solving. An expanded analytical toolbox and greater sensitivity to interdisciplinary linkages will create competitive advantage. Cultivating a practical, multi-faceted perspective is key as the problems and opportunities of the 21st century economy do not arise in a single academic silo or discipline.

WE WOULD LIKE TO THANK THE THOUGHT LEADERS WHO GENEROUSLY SHARED THEIR TIME WITH US

Mr Basil C. Bitas
International Research Fellow, International Academy of the Belt and Road (Hong Kong)

Mr James Chan
Founder and Executive Chairman, Silicon Straits

Ms Fang Eu-Lin
Sustainability Leader and Risk Assurance Partner, PwC Singapore

Mr Abhijit Ghosh
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Chief Executive Officer, Government Technology Agency of Singapore

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Singapore Consulting Leader, PwC South East Asian Consulting

Ms Natalya Twohill
Founder, Kiddet

Prof Jackie Y Ying
Executive Director, Institute of Bioengineering and Nanotechnology

PITSTOPS AND PLANNING: TRACKING THE TURNS BETWEEN FORMULA ONE AND FUTURES WORK

Aaron Maniam

THREE LEVELS OF TIME

When I started my current posting in MTI, a well-meaning career mentor told me that it would involve a marked change from futures work, which I had done for several years in what was previously the Strategic Policy Office at the Public Service Division. Several friends also commented that the detailed coordination for the annual Formula One Grand Prix Race, a key project in my current portfolio, was far removed from the more long-term, strategic work required in futures.

The distinction is valid, but recently I had the pleasure of meeting the engineers and technology experts from a few F1 teams, who reminded me that perhaps the two worlds are not as far apart as we might think.

They shared how the work of a successful racing team spans three types, or dimensions, of time:

- Real Time or Race Time – where drivers make split-second decisions that can spell the difference between winning and losing
- Right Time – the time between races, within which engineers, mechanics and other experts can modify different parts of a car, or the complex system of machinery supporting it, for maximum efficiency
- Design Time – the time between multiple races, or even between competition seasons, during which decisions about funding, budget allocation and research priorities are made

Like many of the different time horizons that organisations use for planning (ranging from quarterly to multi-year), the boundaries between these Times are porous in practice. They overlap and synergise – each feeding into and fed by the others. A single event in one can echo into the others. For clarity in this essay, however, I treat each Time as conceptually distinct.

The key priorities in Real Time are speed and survival; accidents and crashes bring no benefit to a team. Right Time involves optimisation, while Design Time is a space to build resilience amidst complexity, by formulating strategies that are robust to a range of technological and competitive eventualities. The car driver is the key protagonist in Real Time; in Right Time engineering teams hold sway; in Design Time the decisions of team managers and strategists are vital. The dominant mindsets of each time are also different: execution is key in Real Time; critical examination of known knowns and unknowns in Right Time; more open-ended exploration of unknown unknowns and potentially wild swings in Design Time. Naturally, as one moves from Real to Design Time, the length of reaction space available also increases.

FUTURES WORK AND TIME

Futures work is essentially an attempt to conquer what some might call the tyranny of time. When futurists like Peter Schwartz, formerly from Shell and the Global Business Network, exhort us to take "the long view", they are essentially extolling the virtues of imagining what might happen tomorrow, in order to make better decisions today. The emphasis on long-term perspectives might lead one to the easy conclusion that futures practitioners are most at home in Design Time; policy planners more generally operate in Right Time; while those in more operational jobs, like police officers or engineers managing machinery with quick processes, are more naturally adept with the stresses and pressures of Real Time.

To a degree, this is a fair conclusion. The value of futures comes precisely from the space that it gives decision makers to contemplate possible scenarios and imagine different "Real Times" from the one we inhabit – something best done if we are not vested in preserving the status quo and the assumptions or mental models underpin it.

Some members of the current Shell scenarios team even point out that separation between the dwellers of Real/Right and Design Time is not just necessary, but also desirable – futures practitioners need to be "tolerated but not embraced" by the rest of their organisation if they are to facilitate the genuine questioning of deeply-held beliefs.

BRIDGING TIME

We also need to remember that ultimately, everyone in an organisation is on the same side and subscribes to a common vision – just as each member of a F1 team, from driver to engineer to team manager, first and foremost wants to win. In corporate-speak, there is "alignment of purpose".

This means that the practitioners in each temporal domain need to interact and exchange ideas far more often, and more substantively. We may each have different talents and competencies – futurists at imagining 20-year scenarios; policy planners at coordinating in the five-year time frame; and Statutory Board subject matter experts at managing ground-level project implementation – but we can also acknowledge the ways in which the perspectives of other Times enrich our own.

For instance, good use of Design Time enables better decisions in Real and Right Time. This is why, like every F1 driver, we go through periodic planning processes, like Retreats (or Advances, depending on one's agency), where we discuss and debate how we might respond to different contingencies in a changing operating environment.

Equally, Real and Right Times provide data for better, more actionable Design Time. Purely academic or conceptual Design Time serves no one, and needs to be informed by perspectives and information relating to ground realities and implementation. For F1 teams, this might mean reviewing performance and progress in periodic increments (say, every six months) and reviewing the entire strategy over longer cycles (say, one to two years).

If we are creative, we can even find ways to compress Design Time into simulated Real and Right Times, through processes like drills, table-top exercises, war games and simulations. These are staples of any F1 driver's training, allowing them to rehearse options for Real and Right Time in safe environments rather than costly actual settings. Militaries and uniformed services across the world understand the value of such "serious games", as does the Applied Simulation Training Laboratory in Singapore's own Civil Service College.

Such simulations bring value far beyond analytical insights about options; they also help us to develop and sustain the "muscles" for Right and Real Time decisions. Some years ago, I was told by Canada's former Secretary to the Privy Council, the indefatigable Jocelyne Bourgon, that during crises and emergencies (some of the most intense Real Times imaginable!), we should learn how to "walk slower". Others frame this in the aphoristic "slow down to speed up". This advice is both wonderfully practical, and informed by the idea that during the intensities of Real and Right Time, we benefit from creating pockets of Design Time – decompressing and expanding the space available to us to make decisions.

TEMPORAL ATHLETES

Healthy organisations, particularly complex ones like governments, benefit from having workforces with a spectrum of skills. At one end, they need experts in different Times, who develop the instincts, habits, knowledge and methodologies particular to Real, Right and Design Times. At the other end, it is also useful to have at least a few individuals who can toggle between the three Times. Like Harvard Professor Joseph Nye's "tri-sector athletes", who combine literacies across the public, private and people sectors, organisations would do well to nurture ""temporal athletes" who are literate and agile across the three time domains. They can help ensure cross-pollination and mutual exchange as our organisations do their best to navigate turbulent and changing times.

With gratitude to Eddie Choo, Oday Kamal, Kay Chew Lin and Tan Huei Ming for very helpful critique and comments on an earlier draft.

WHY SMALL IS BEAUTIFUL: A VIEW FROM BIOTECH ON PUTTING SMES FIRST

Jackie Y. Ying

Singapore has invested significant public funds over the past 25 years to develop a hub that would attract multinational corporations (MNCs) to establish their research and development (R&D) operations here. From the relatively modest S$2bn for the first National Technology Plan (1991–1995) to S$19bn for the current Research, Innovation & Enterprise 2020 Plan, a total of S$60bn has been committed overall. The government has also focused its national R&D efforts over the years to establish a broad knowledge base in cutting-edge research and increase the portfolio of intellectual property (IP).

However, an over-reliance on MNCs to help commercialise research may be problematic, as much of the value that has been created by local researchers may not be captured locally and maximally through MNCs. Due to its small size, Singapore is usually not the main target market of these MNCs, for which the modus operandi would be to license a technology, develop their own know-how and even patent technologies around local IP. To further strengthen Singapore's R&D ecosystem, it is then crucial that a new strategy be adopted to capture the full value of local research by creating vibrant Singapore-grown enterprises with advanced capabilities.

Currently, Singapore's small and medium enterprises (SMEs) have substantial capabilities in manufacturing, but few of them have the background and know-how to effectively leverage IP and commercialise the cutting-edge research produced by the biomedical sector. In addition, the biomedical sector typically requires major investments with very high risk. While the medical technology (medtech) industry may have lower barriers to entry, SMEs would still need to bring their technologies through clinical validation, and develop unique capabilities and new products to compete and survive in the global market. The hurdles in developing medical technologies, pharmaceuticals and biologics are significant. Product development involves not only engineering, but also scientific breakthroughs and clinical translation. New technologies for in vivo applications need to be demonstrated for stability, toxicity and efficacy through small and large animal studies, followed by preclinical and clinical trials. To truly capture the great rewards of biomedical research, sustained, long-term investments need to be made in home-grown SMEs.

The majority of Singapore's biomedical researchers currently work in publicly-funded institutions. It would be imperative to encourage some of them who have developed exciting research platforms to spin off companies so as to establish a broad base of SMEs that have capabilities in cutting-edge biomedical technologies. The public sector needs to proactively nurture and invest in the SMEs so that they have the chance to survive and create Singapore-based medtech and biotech MNCs. In terms of funding, spin-offs currently rely on venture capitalists or angels, but this means that they typically receive investments only if technologies are market-ready. It is important that the government presents another source of funding for spin-offs to develop and commercialise innovative research. Such investments would encourage and incentivise more researchers to create spin-offs, and help create a larger number of successful start-ups.

The U.S. has built up numerous spin-offs to MNCs through a two-pronged approach of funding both the research institutions and the spin-offs. Essentially all the major U.S. funding agencies (e.g. National Science Foundation, National Institute of Health, Department of Defense, and Department of Energy) support spin-offs through Small Business Innovation Research (SBIR) programs. Phase I of such funding provides US$ 100,000–200,000 for development of new research concepts in 6–12 months, while Phase II provides US$1-2mn for 1-2 years to develop prototypes and animal studies/preclinical trials. Unlike venture capital, these SBIR grants come with no strings attached, and the U.S. has used this approach to seed the growth of a very large number of spin-offs. The investment in SBIR is recouped through tax dollars gained as these start-ups evolve into larger companies and generate jobs.

For example, the start-ups established in Cambridge, Massachusetts by the faculty and graduates of the Massachusetts Institute of Technology (MIT) have led to tremendous growth in the biotech industry and spurred the transformation of Kendall Square into a vibrant research hub. MIT spin-offs like Genzyme, Biogen and Millennium Pharmaceuticals help to attract highly skilled professionals and businesses to the state. Today, they have grown to become prominent names in the industry. Pharmaceutical giants Pfizer, Novartis and Takeda have also set up their R&D operations in Cambridge to leverage the high concentration of research talent and cutting-edge technologies there.

The Singapore government's role in R&D should now go beyond funding research in the public sector, e.g. through the A*STAR research institutes (RIs), universities and hospital research centres. It needs to ensure the IP from public sector research is successfully commercialised by SMEs and not just be licensed to MNCs. Spin-off companies not only need support to scale up, prototype, validate and commercialise their technologies, but also to develop new research ideas that can lead to new products. The funding level needs to go well beyond what is currently provided through SPRING Singapore's Technology Enterprise Commercialisation Proof-of-Concept (POC) and Proof-of-Value (POV) funding schemes. The funding should not only be open to supporting medical technologies, but also the development of pharmaceuticals and biologics. The gap in funding SMEs for technologies toward in vivo applications needs to be plugged.

Very few SMEs in Singapore have been able to reproduce the kind of success seen in Massachusetts or California. The reality is that relatively few researchers possess the passion and willingness to take risks in order to commercialise the technologies developed through their research. It is therefore important that we create an environment that strongly rewards inventors, supports spin-offs and entrepreneurship, and reverse the culture of risk-aversion that is affecting Singapore's ability to bridge research and job creation. Indeed, we now run the risk of pushing research institutes to do too much short-term research that serves industry's near-term goals, instead of adequately funding research that is transformative and disruptive. Over the past 15 years, we have built up significant research capabilities and IP. However, the real fruits of long-term research investment can only be harvested if we have an unbroken value chain to market. Providing incentives for spin-offs and research funding for SMEs would help to ensure we have more Singapore-based MNCs, especially in biotech and medtech, in the coming decades for our future economy. ⊣

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FUTURES GROUP AT 10

Reflections by Management and Alumni

MANAGEMENT

The idea of setting up a unit in MTI dedicated to futures work arose in 2005. As Permanent Secretary, my request of the Futures Group was simple – its role was to look ahead of the curve and to identify one or two big ideas per year that we could act on. A small and indefatigable team, the Futures Group delivered on this over the years. I recall the team researching the arrival of Big Data back in 2010, at the point when the term was just beginning to enter mainstream vocabulary. It was a project that illustrated not just exploring the future, but more importantly, also taking a hand in shaping it – it helped to catalyse explorations into the applications of real-time urban data in Singapore.

As we look ahead, it is clearer than ever that strategic foresight has an important role to play in a world where uncertainty is now a norm. Given the short-term pressures that decision-makers are under, I hope that the Futures Group will continue to help policy-makers keep the long-term in view, and go beyond, to nudge others towards perceiving less obvious aspects of the future. This will allow us to better prepare for the future. Among agencies in the Singapore Public Service, the Futures Group in MTI has been one of the frontrunners in the adoption of strategic foresight. As the group marks its 10th anniversary, I am most heartened that the practice endures and the nexus to policy making has been strengthened.

Peter Ong
Head of Civil Service
Former Permanent Secretary, Ministry of Trade and Industry from 2005 to 2009

The Futures Group has played an important role in challenging MTI's conventional thinking and testing the robustness of the ministry's strategies. By creating a safe space for divergent views, the Futures Group has supported the policy units and Statutory Boards to remain vigilant to uncertainties surrounding their work. For example, the Group produced an analysis on automation of knowledge work in 2013 that challenged conventional wisdom at the time about the nature of jobs in the future. That research study sparked discussions and effort across the whole of Government to prepare Singaporean companies and workers for that future.

Foresight work is always challenging, as it is difficult to measure its outcomes tangibly. The Futures Group must therefore draw on the processes and methods that have served it well over the years and continue translating its research for policy units.

I wish the MTI Futures Group continued success in the years ahead.

Ow Foong Pheng
Permanent Secretary, Ministry of National Development
Former Permanent Secretary, Ministry of Trade and Industry from 2011 to 2016

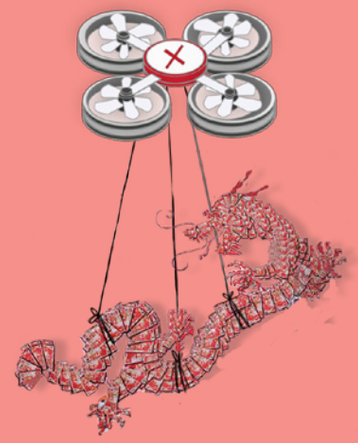
As a young civil service officer, I was taught that we must strive to be in time for the future – see as far ahead as we can; make plans to seize opportunities that come our way; and prepare for the inevitable storms that hit us from time-to-time. For our tiny red dot, this is a critical survival strategy.

The MTI Futures Group is our endeavour to see further, for the economic domain and beyond. It is a small setup, but with an extensive and diverse output. The briefs and presentations were often insightful, sometimes peculiar, but never boring. They expanded our horizons, and forced us to look beyond the immediate challenges to also focus on important developments further away. Most of all, they reminded me that it is a very large world, with many exciting prospects that Singapore can pursue, and we are only limited by our knowledge and imagination.

In the coming years, I hope the Futures Group will continue to perform these crucial roles – acting as our lookout for both opportunities and dangers, and reminding us all of the world of possibilities out there, just beyond the horizon.

I wish the MTI Futures Group a happy 10th Anniversary.

Ng How Yue
Permanent Secretary, Ministry of Law
Former Second Permanent Secretary, Ministry of Trade and Industry from 2011 to 2014



I was Deputy Secretary (Industry) when the MTI Futures Group was formed 10 years ago. The idea was to set aside dedicated resources – freed from the distractions of other day-to-day responsibilities - to look at the future, so that we would not be blind-sided by new developments. The focus was on futures impacting the economy, which differentiated it from other futures groups in the public sector. It was decided that for better economies of scale, the Firefly family would pool resources to form a Futures Group at the MTI level.

I am very pleased that 10 years on, the MTI Futures Group continues to play a useful role in informing the Firefly family on emerging trends and possible implications. Looking back at a set of slides on "The Future of Talent" produced in 2007, the Futures Group had with prescience flagged out the rise of "Free Agents". This has become very pertinent with the growing gig economy that we are witnessing today. The slides also mentioned "Hobbynomics" and "prosumers", which I find especially relevant in the context of today's energy sector, where solar panels are turning electricity consumers to producers too.

It is through identifying growing trends and new possibilities that the Futures Group helps broaden perspectives and enrich policy discussions in the Firefly family. I look forward to more good work and interesting reports from the Futures Group in the years to come.

Ng Wai Choong
Chief Executive, Energy Market Authority
Former Deputy Secretary (Industry), Ministry of Trade and Industry from 1991 to 2007

The space that was created for the MTI Futures Group to operate allowed it to play an important role in the economic planning process. The Futures Group generated future possibilities using a cross-disciplinary approach. Its work stretched boundaries and questioned existing norms. To connect the concerns of today's policy makers to the distant possibilities of tomorrow, FG developed communication tools, articulating its insights through the use of maps, animation, and videos.

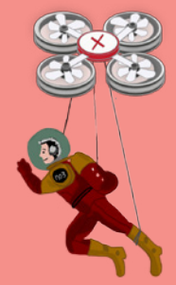
Some of FG's work generated heated debates. But even where FG's insights were hotly disputed, for example on whether the centre of trade and travel would move north towards Indochina, the very debate within the MTI family created an awareness of future possibilities and risks when subsequent events unfolded. That in itself is valuable. In building up a community of 'futurists', FG helped to change the way policy makers think. As we celebrate MTI FG's 10th anniversary, my wish is that it builds on its work and continues to contribute effectively to the policy making process.

Kwek Mean Luck
Solicitor General, Attorney-General's Chambers
Former Deputy Secretary (Industry), Ministry of Trade and Industry from 2009 to 2012

"Wolf! Wolf!" – This is one amongst many challenges and dilemmas the Futures Group faces. It is a tough job. To do it well, FG has to sense-make and separate information from data (and ideally actionable information), toggle between probable and plausible, connect the dots across disciplines, challenge assumptions and mindsets, and get stakeholders' attention when it matters. It is both an art as it is a science. It is difficult to define success, but easy to nit-pick on the narratives. I say this because I know, through my previous involvement in NSCS' Risk Assessment and Horizon Scanning (RAHS) programme.

Futures work is not unlike R&D. Not all work will be commercialised, but definitely all research and discussions go into a better understanding of emerging issues and how our lives may be disrupted. For MTI, and the public service, futures work is a necessity. As someone had described it, it is like driving. You need to keep an eye on the rear-view mirror, side-view mirrors, the dash board and more importantly on the road ahead, if there is one. Indeed, Singapore is in un-ventured territory in many aspects and there is no clear roads ahead.

Lee Ark Boon
Chief Executive Officer, IE Singapore
Former Deputy Secretary (Trade), Ministry of Trade and Industry from 2013 to 2016



In 2008, the Futures Group produced a 5 minute video clip entitled “The Rise of the Rest”. Borrowing an idea from Fareed Zakaria, we wanted to present a number of trends about developing and emerging economies in order to provoke discussions about the opportunities and challenges of engaging economies like India, China and the Middle East. Since it went on Youtube in 2008, it has had over 34,000 views[1]. Producing the clip felt like a bit of a “skunkworks” in those days. It’s hard to imagine, but just 8 years ago, government agencies’ social media presence was much thinner than what it is today. So the team at the Futures Group had to take some risks – risks with the process, since we had little experience with this form of communication, and risks with the message, since there was still a strong sense of western “triumphalism” at that time.

Today, government agencies have much stronger social media and communications capabilities. Our progress in these areas over the last 8 years makes a video clip like “The Rise of the Rest” seem quaint, even antiquated or naïve. But I think of that clip as a milestone for the Futures Group and for myself. We learned to communicate better, to push our ideas in a way that invited curiosity and questioning, and to think much harder, in an edgier and more provocative way, about what mattered for Singapore.”

Keith Tan
Deputy Secretary (Policy), Ministry of Defence
Former Director of Economics and Strategy Division from 2008 to 2010

I joined MTI in 2010. My first port of call was the Futures and Strategy Division.

I realised soon after I joined that my understanding of what futures work entailed was flawed. I had harboured the illusion that futures work is about accurately predicting the future. In that I soon came to realise that oracular powers aside, no tools or formulae can accurately predict the future. The value from futures work comes not from prediction, but from the process of generating new insights from emerging trends and mapping possible implications, to augment and complement regular policy formulation and catalyse new areas for examination. More fundamentally, I realised that futures cannot be thought of as a distinct category from “the present”. As the author William Gibson famously once said, “The future is here, it's just not evenly distributed.”

All of this is a round-about way of saying that by its very nature, Futures work will always be ahead of its time. This is one of its strengths and also potentially a vulnerability.

It is a strength if the findings from futures work are applied to inform actions to preposition ourselves for the emerging trends which are flagged as potentially of significant impact, before they make their way into the mainstream. An example of this is 3-D printing or additive manufacturing, which the Futures team identified in 2011 as a potentially disruptive technology which could have a major impact on manufacturing in Singapore, through overturning the traditional approach of “manufacturing-for-many” to “manufacturing-for-few”, or even “manufacturing-for-one”. The public research community, notably A*STAR, has been building capabilities to be ready for this. This focus has been enhanced in the Research, Innovation and Enterprise Plan for 2016-2020 (RIE2020), where additive manufacturing has been identified as a key horizontal enabler for the advanced manufacturing and engineering domain. However, Futures work is also vulnerable because looking too far ahead risks straining stakeholder credulity because there are then too many unknown unknowns that lie in between. The challenge in my view is therefore to either spot trends which are developing at an unusually high rate and likely to make landfall in the midterm (3-5 years appears to be a sweet spot), or to identify seemingly unconnected “fringe” developments which are already present, which could interact in non-linear ways to generate pervasive impact.

This role of creating possibilities is what makes Futures work entirely part and parcel of what we do in MTI. How Futures work goes about doing this is what makes it different from anything else at MTI.

Bernadette Foong
Director, Research and Enterprise Division, Ministry of Trade and Industry
Former Director of Futures and Strategy Division from 2010 to 2012

ALUMNI

Setting up the Futures Group was a rare opportunity to assemble a team from scratch. The arrangement was for MTI HQ and the statutory boards to each provide an officer, and MTI was fortunate to have Dawn Yip to head the team. Dawn and I spent much time discussing the profile of officers needed to make the team work. We wanted a mix of disciplines beyond the usual engineering and economics (we wished that we had an anthropologist!). We wanted a variety of work experiences: overseas, the private sector or the people sector. We wanted different personalities. We requested the statutory boards' HR departments to nominate "good officers with interesting perspectives". I suppose that they would have appreciated more precise specifications but we did not wish to prescribe further for fear of missing out on suitable officers. There were drawn out discussions with the HRs departments on candidates, until they finally requested us to recruit directly instead! Eventually, when the team was assembled, the meetings were riotous, with heated debates, arguments and personality clashes. And then I was certain that the painstaking recruitment process was well worth it.

Cheang Kok Chung
With FG from 2006 to 2008

Three lessons are particularly memorable from my time with the Futures Group. First, that good foresight work is often like immunisation – it triggers a short-lived, painful reaction to build resistance, but not enough to kill. Decision makers often work with what they know, but foresight practitioners need to be different, and must see themselves as scouts that look for "known unknowns" and "unknown unknowns". Second, the future is a space for competing insights. The Future Group's advantage here comes from operating close to policy formulation. Insights, however, can be forgotten in the daily operational grind, and this is why over the years FG focused on products – from slides and animations to the *Future Tense* publication – that give form to ideas so that they can exist and propagate. Third, not everyone is suited for playing in an undefined space like foresight. Preparedness to play in such a space is path dependent – many implode and drown in this undefined space, which is why it is important to hire well and train well. Having said all this, after nearly nine years with FG, and reflecting on where my earlier assumptions on how foresight are wrong, and what I can do better, this discovery process is what keeps me going. I am still a child playing on the long shoreline of foresight, and these discoveries keep me coming back to it every day.

Lee Chor Pharn
With FG from 2006 to 2016

A decade already? Time does fly. I remember fondly the pioneering days with the Futures Group when we were an eclectic bunch researching on trends that vary from future skills to corporate social responsibility and food farms in China. In many ways, FG set the tone then for futuring work in other agencies. 10 years later, FG has matured in its research capability and delivery, and its great work has been most informative and thought-provoking. I hope to see FG continue to push boundaries and set new standards within MTI and the civil service for better informed policies. Today, I find myself still looking to FG for inspiration.

Lee Hwee Chen
With FG from 2006 to 2008

When the Futures Group was first set up, then-PS Peter Ong set us the target of coming up with a couple of good ideas every year. It sounded simple, even risible. But it wasn't. Our primary audience was MTI's CEO Forum, comprising the heads of some of Singapore's largest and most sophisticated statutory boards, and our team was just six persons strong. The ideas had to be fresh yet not fanciful, stimulate yet not shock, push us forward yet not risk the whole house. This to me is the calling and challenge of strategic foresight anywhere: to shift mental maps in ways that favour long-term survival and success despite our finite resources. It's not easy work, but I'm grateful and proud that Singapore has invested in it.

Dawn Yip
With FG from 2006 to 2007

Doing strategic foresight is ultimately about making better collective decisions for our shared future. As a practitioner, I see my role as an advocate for the future. The future has no voice and it is often left out of many important conversations. This can lead to short-term thinking and anxiety about the uncertainties ahead. We may not know what the future holds but we can be better prepared for it.

Giving the future a voice by doing strategic foresight means four things to me.

First, it means intentionally building up the anticipatory capacity in people, communities, organisations even nations to think critically about trends, emerging issues, and weak signals.

Second, it means bringing these insights together to craft alternative futures to expand the possibility space of what the future might hold.

Third, it means including as many stakeholders into the conversation about the future as possible in order to create energy and ownership over our shared future.
Last, it means engaging in a creative process to build our desired future. The future is not something that gets foisted on us. It is to be shaped and created.

Cheryl Chung
With FG from 2007 to 2011

MTI's work helps drive Singapore's economy and it is very important that we constantly look ahead and ready ourselves for the next wave of opportunities and potential pitfalls. The Futures Group began at a time when few agencies had a dedicated foresight unit. As one of the earliest government foresight units, we went through many trials and experiments to define who we are, our role in MTI, and how we should conduct our work. It was a perennial challenge to articulate plausible implications of the trends in the horizon. Our roles as strategists required gutsy imagination and creativity while staying rooted in economic realities and workings of the civil service. I'm glad the Futures Group has evolved and constantly reinvented itself to where the team is today. Happy 10th anniversary!

Sim Phei Sunn
With FG from 2007 to 2010

Futures work attracts the optimists. I guess you do need to have a certain optimism to explore the future—it is easier if you imagine the future to be a better place than the present. I can imagine how it could be draining if you have to keep visiting a place that you imagine to be dreary. But I've discovered that it's also important for people involved in futures work to be solidly anchored in the present. Creating or anticipating the future is important, but it's meaningless if you can't convince people to come along for the ride.

Auyong Hawyee
With FG from 2011 to 2013

Trying to value-add to MTI's already extensive policymaking capabilities was a daunting task. Policy divisions possess deep expertise and are highly attuned to happenings in their individual areas of work. The role of foresight was then to connect the dots in areas that were more remote in terms of impact and where the linkages were less apparent. In my two years with the Futures Group, I felt great satisfaction seeing some of the pieces the team produced going on to spark the formation of workgroups and inform policy.

Nathan Peng
With FG from 2011 to 2013

The main similarity is the need to work with multiple stakeholders. My experience in the Futures Group has helped me in my private sector role, enabling me to see the bigger picture, identify opportunities across different business units and engage with diverse stakeholders. Given a complex and rapidly changing business environment, a key challenge facing both government agencies and private sector companies is to maintain a strategic long term view while being agile and nimble. Not every organisation can have a dedicated foresight team like FG. However, building anticipatory capabilities is important, as it enables an organisation to make some sense of the uncertainty and hopefully identify opportunities and risks ahead of its competitors. With this in mind, I intend to start a small foresight "SWAT team" in my current firm.

Lawrence Wong
With FG from 2011 to 2014

I had a great time at the Futures Group – I learnt so much from the team back then. It was a privilege to be able to work on cool topics like advanced manufacturing; my research project eventually gave me the opportunity to go to NTU and visit an ABB facility to see the cutting-edge manufacturing technologies that were gaining ground at that time. Knowing how to better assess emerging trends was another skill that I found useful – I think FG's value-add, and what the team should stay focused on going forward, is to help create the narrative(s) that give context to the issues happening around us.

Choo Shiqin Eddie
With FG from 2012 to 2013

I have always been fascinated, and to a certain extent awed, by how the Futures Group was able to conjure up the forward-looking and insightful pieces of work published in Future Tense. Therefore, when the opportunity for a rotation came along back in 2013, I grabbed it and asked for a transfer to FSD. Even though I wore two hats, being part of both the strategic planning and futures teams, I had a couple of opportunities to work on foresight pieces. The process was not easy – reading and consuming information widely, quickly and with a fair amount of depth was a given. Even more challenging was the ability to tear through the information web and try to connect the dots, in order to stitch together the seemingly disparate pockets of patterns into a probable trend that could impact Singapore's industry landscape over the next 10 to 15 years. In my opinion, having strategic foresight in MTI and in the government as a whole serves to augment the policy assessments that the government has of Singapore's immediate and near-term macro environment and would definitely put Singapore in a better position to confront and overcome upcoming threats and challenges.

Chua Seow How
With FG from 2013 to 2014

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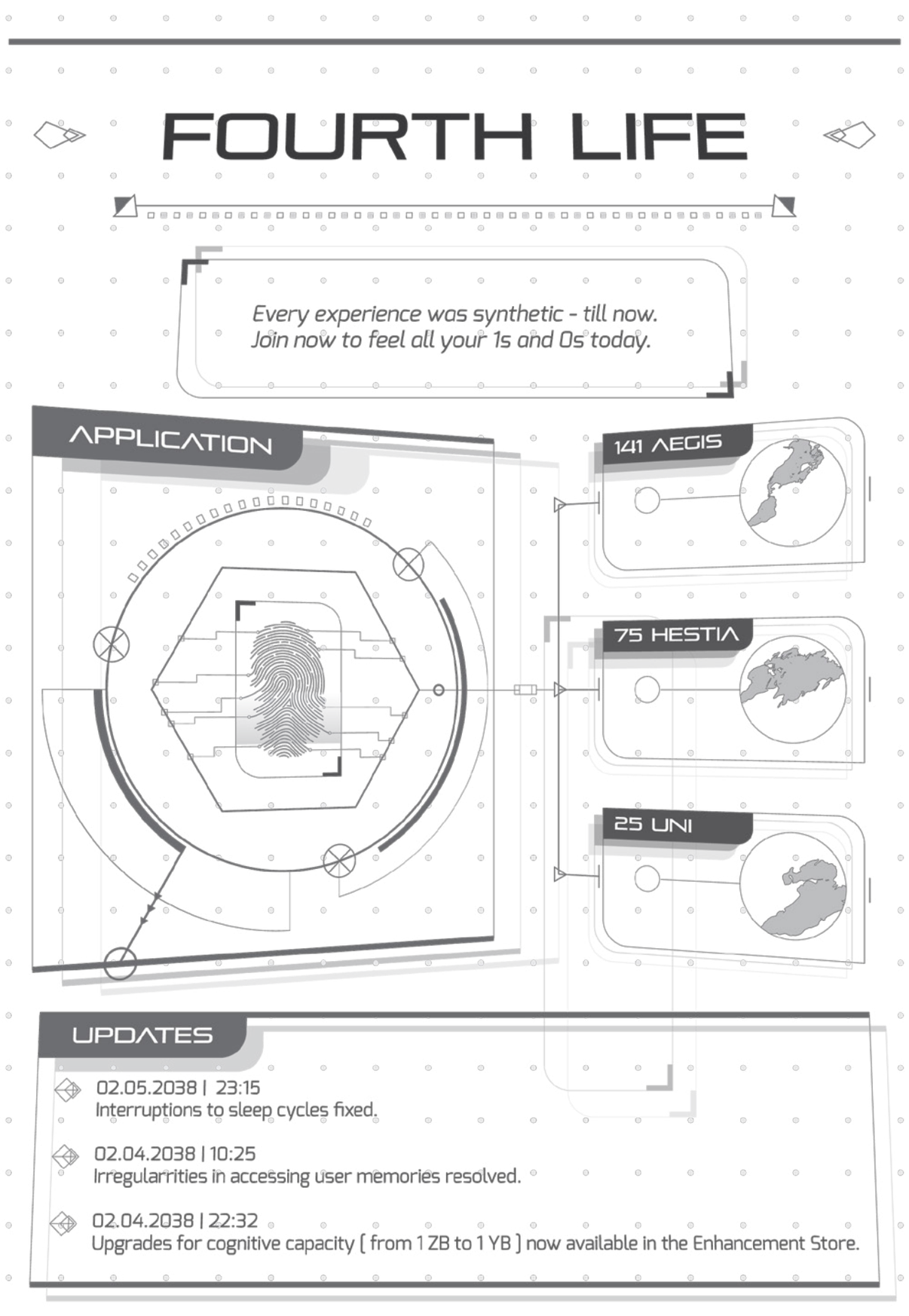

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