NAVIGATING COMPLEXITY THROUGH IMAGINATION
THE IMPERATIVE FOR ADAPTIVE GOVERNANCE

Understanding Complexity in Our Modern World

We inhabit an era of the Anthropocene – where human activity has become a prime driver of Earth's ecosystems. This has resulted in what is sometimes called a VUCA world: one marked by **V**olatility, **U**ncertainty, **C**omplexity, and **A**mbiguity. Others prefer another acronym – BANI – meaning **B**rittle, **A**nxious, **N**on-linear, and **I**ncomprehensible. The OECD has even embraced its own TUNA – not the sandwich – but **T**urbulent, **U**ncertain, **N**ovel, and **A**mbiguous.

What seems to be common to such efforts to describe the world today is the feeling that we know what the problem is: the world is unpredictable, and it changes fast. But we do not know what to do about it.

Where earlier generations may have experienced change as gentle velocity, we now feel the lurch of acceleration. We have less and less time to understand, to react, and to respond. Technological advances are the poster child of change today, much of it following the accelerating tempo of Moore's Law, which sees computing power doubling every two years. Globalisation, urbanisation, and climate change are also intensifying. Furthermore, their effects combine in complex ways, producing outcomes that are extremely hard to foresee. This is the world of the polycrisis, where "the shocks are disparate,

but they interact so that the whole is even more overwhelming than the sum of the parts." In a similar vein, then Senior Minister Tharman Shanmugaratnam described the perfect long storm of "a confluence of lasting structural insecurities – geopolitical, economic and existential – each reinforcing the other."

The *butterfly effect* is one important manifestation of this. Small disruptions propagate rapidly across networks of highly interconnected systems, turning minor disturbances into major crises.

You may remember the *Ever Given* incident, which happened in March 2021 during the Covid-19 pandemic. A single container ship grounding in the Suez Canal created a week-long traffic jam of over 400 vessels at both ends of the waterway. The effects cascaded through semiconductor shortages already strained by Covid-19, rippling across global supply chains for months. The limitations of existing infrastructure led to the incident being described as a "worst-case scenario that many saw coming". It was a *black elephant* – a risk visible to everyone but ignored until it became a crisis.

Phenomena like the butterfly effect and the black elephant emerge from the interconnectedness of the world. Lenin is reputed to have observed that "Everything is connected to everything else", a view echoed in history by the likes of Leonardo Da Vinci, and the Chinese philosopher, Lao Tzu, more than two thousand years ago.

This interconnectedness creates complexity, with thousands and millions of agents interacting with each other in invisible and unpredictable ways. Unlike the Cartesian worldview with Newtonian characteristics of cause leading to predictable effect, in the VUCA world, surprising outcomes emerge from the dynamic interactions of these countless agents within the system. Climate change does not simply make things warmer or cause sea levels to rise – it creates feedback loops that also alter weather, disease patterns, ocean currents, agricultural yields, migration, and political stability.

Complex *vs* Complicated Problems

Complex problems differ fundamentally from complicated ones. Building a jet engine is complicated – requiring extensive engineering expertise but following known principles. Its operation follows well-understood physical laws. On the other hand, complex systems are not amenable to such a Newtonian analysis. They produce outcomes that are *wicked problems*. They resist such analytical approaches. There is no clear definition of the problem, because there are many views of what the problem is. Some of these views conflict with others. Unsurprisingly, there is also no agreement over the solution to the problem, because of divergent preferences for outcomes.

Climate change exemplifies this *wickedness*. Solutions in one domain can exacerbate problems in another. Carbon pricing might reduce emissions but could disadvantage certain industries or populations. Nuclear power offers low-

carbon baseload electricity but raises concerns about safety and waste disposal. Each intervention in the system creates ripple effects that must themselves be managed.

Complex systems also exhibit *emergent* properties – behaviours arising from component interactions that cannot be predicted from understanding components in isolation. In other words, you only know what is going to happen when it happens. For example, the 2008 global financial crisis emerged from the interaction of housing policies, financial instruments, regulatory frameworks, and risk models in ways that few anticipated.

Why Traditional Analysis Falls Short

In such a complex world, traditional analytical approaches reach their limits. Nobel economist Thomas Schelling once observed, "One thing a person cannot do, no matter how rigorous his analysis, is to draw up a list of things that would never occur to him." This is a fundamental cognitive limitation. Linear thinking, extrapolation from historical trends, and Cartesian models all assume that the future will resemble the past in fundamental ways. But causality has its limits. The methods that we often use to analyse and understand complex systems fail to take into account a simple fact. Complex systems can and do undergo phase transitions – sudden shifts to entirely new patterns – that render historical precedents irrelevant. In other words, complex systems experience shocks and surprises of the black swan variety.

The Random Walk Theory from financial markets offers insight. Just as past stock movements cannot reliably predict future prices, past social and political patterns may provide limited guidance for unprecedented challenges. As the Danish philosopher Søren Kierkegaard said, "Life is understood backwards, but must be lived forwards."

The Covid-19 pandemic demonstrated this clearly. Singapore, having actively prepared based on its SARS experience, found itself surprised by aspects of the pandemic that exceeded planning assumptions, such as economic lockdowns, social isolation effects, and information management challenges.

Imagination as Navigation Tool

The mismatch between complexity and traditional analytical tools calls for a different approach – one that moves beyond historical data and logic into possibilities. It is here that imagination can serve as a primary tool for navigating uncertainty. Unlike analysis, which works backward from data to understanding, imagination works forward from understanding to possibility. It allows us to envision unprecedented scenarios, connect disparate elements in novel ways, and prepare for futures bearing little resemblance to the present.

The challenge lies in distinguishing explicit knowledge – information that can be codified and transmitted – from tacit knowledge embedded in complex systems where roles, technologies, emotions, and behaviours interact

unpredictably and in emergent ways. When explicit knowledge falls short, what remains is the intuitive grasp of patterns and relationships which cannot be fully codified. Imagination bridges this gap, allowing leaders to extend limited explicit knowledge into the "what if" space, rehearsing possibilities before they occur. Much leadership requires tacit knowledge that can only be acquired through experience, pattern recognition, and imaginative preparation.

The Pattern Recognition Imperative

Gary Klein's famous research on firefighter decision-making provides crucial insights. Firefighters do not work through logical decision trees. There is simply no time, and the complexity – if not the chaos – of each situation demands a distinct approach. So, firemen apply the first experiential pattern resembling their current situation. The more experienced the fireman is, the larger his library of patterns – or his heuristic repository – built up through training, simulations, and real fire-fighting experience, and embedded in memory. Similarly, government leaders need extensive repertoires of crisis management patterns, stakeholder engagement scenarios, and adaptive response frameworks. These cannot be acquired through theoretical study alone but require experiential learning – in other words, real-world experience.

Barriers to Imagination

If individuals are capable of imagination, institutions must learn how to not suppress it. Governments face particular challenges in enabling and deploying imagination. This is because bureaucratic organisations prioritise predictability, consistency, and risk management – qualities that conflict with imagination's uncertainty, lack of boundaries, and experimental characteristics. Sociologist Max Weber's ideals of following rules, clear hierarchies, and standardised procedures are important features of modern governments as they provide stability and accountability. But they can also inhibit the creative thinking needed to address novel challenges.

Ideas typically flow vertically and upward through multiple layers of review, each tending toward risk aversion and conformity with existing policies. Those who propose unconventional approaches risk being seen as unrealistic. The result is organisational groupthink – the tendency to suppress dissent and converge on conventional wisdom.

Cognitive biases further compound this problem. For example, the availability heuristic leads officials to overweight recent or memorable events when assessing risks. The 2007 review of safety guidelines for Fukushima used data from a 1938 earthquake, dismissing a much larger earthquake in 869 CE as "too historical" despite archaeological evidence to the contrary. This temporal parochialism or shortsightedness – the inability to see beyond human timescales

and to imagine other feasible scenarios – led to defences for Fukushima that were adequate for more recent experience but inadequate for the full range of possible events occurring over longer timeframes. The tragedy of course was that the Tōhoku earthquake unleased a tsunami that corresponded closely to the earlier and larger earthquake.

Cultivating Creative Tension

In a complex world that is populated by wicked problems, what is often required is the imagination and creativity that generates breakthrough thinking and innovative ideas. Mavericks play an important role in this. They challenge conventional wisdom and generate game-changing ideas through a necessary tension between divergent viewpoints. But many, if not most, organisations find it too difficult to deal with such contrary perspectives. The few organisations that tolerate mavericks often feature informal information-sharing cultures where knowledge flows freely, combining vertical hierarchy with the horizontal reach that is necessary for innovation.

As the author and CEO Margaret Heffernan observes,

> "When it comes to really great leadership you can't plan for what you don't know. And so you'd better have more clever people, more freedom to invent and experiment, than you think you'll ever need."

Yet most governments struggle with this balance. Strong leadership and constant oversight are required to overcome natural tendencies toward silo thinking. The rare exceptions occur in organisations that deliberately cultivate high-trust cultures and protect space for experimental thinking.

Innovation Through Autonomous Units

DARPA – the legendary Defense Advanced Research Projects Agency of the US Department of Defense – demonstrates how organisational design can enable breakthrough innovation within highly bureaucratic institutions. Through a system of programme managers with mandates to experiment with radical ideas – insulated from standard procedures while connected to resources – DARPA has produced the Internet, GPS, and quantum computing.

The key insight is that innovation and imagination require what the late Clayton Christensen – who wrote the seminal *The Innovator's Dilemma* – described as "autonomous organizations charged with building new and independent businesses around disruptive technology". These units must be removed from standard operating procedures while remaining connected to resources and mission. They need different success metrics, longer time horizons, and tolerance for failure that would be unacceptable in operational units.

Singapore has employed similar approaches. The Ministry of Defence's Future Systems Directorate, established in 2003, challenged military orthodoxy by generating frictions and tensions, and experimenting with new ideas and concepts that led to the creation of what is now referred to as the 3rd generation Singapore Armed Forces – or the 3G SAF.

The Monetary Authority of Singapore's regulatory sandbox creates controlled environments where companies can test products that might not comply with existing regulations, enabling rapid learning about emerging challenges before they become critical. This experimental approach has enabled Singapore to stay ahead of fintech developments.

The Imperative of Experimental Culture

Experimental capacity represents a crucial element of adaptive governance. As President Tharman Shanmugaratnam observed at the recent opening of the Singapore Parliament,

> "Above all, we must foster an outgoing and experimental spirit among our enterprises and people. It is how we can grow leading firms, and secure good jobs and rising incomes for Singaporeans."

This experimental – and expeditionary – spirit extends beyond economic development to encompass the fundamental challenge of governance itself:

navigating unprecedented complexity when established approaches may prove inadequate.

The imperative has become urgent as technological change accelerates. Traditional approaches prioritising exhaustive planning and perfect execution are giving way to rapid iteration and continuous adaptation. Senior Minister Lee Hsien Loong observed at the recent Defence Science and Technology Agency's 25th Anniversary,

> "Success increasingly belongs not to organisations developing perfect solutions through exhaustive analysis, but to those deploying imperfect solutions rapidly and improving them through iterative learning."

This represents a profound philosophical shift: that in complex, rapidly changing environments, the pursuit of perfect solutions may itself become a form of failure – not because perfect solutions are undesirable, but because the time required to develop them may exceed the window of opportunity for effective action.

Safe-Fail Experimentation

So, rather than demanding certainty before acting, adaptive organisations – including governments – encourage bounded experiments that can provide learning even when unsuccessful. This *safe-fail* – as opposed to fail-safe – approach recognises that small-scale experiments can reveal system dynamics

and unintended consequences before committing to large-scale interventions. The distinction is critical: fail-safe means you risk nothing but also achieve nothing, with no progress. Safe-fail experimentation acknowledges that if experiments succeed, they can be expanded. If they fail, the damage is contained and lessons are learned.

The courage to embrace experimentation requires what may be the most difficult psychological shift for successful organisations: the willingness to set aside tried and tested approaches in favour of unproven concepts that may have no precedent. This demands a fundamental reorientation from risk aversion to risk management, from optimisation to exploration.

Building Reserves of Imagination as National Strategic Infrastructure

If imagination can be cultivated within organisations, it can also be developed at the national level. Here imagination functions as a sort of cognitive redundancy – and it could be argued – a critical component of national resilience. Just as Singapore maintains financial reserves to weather economic storms and diversifies its water supply through the Four National Taps, nations should cultivate reserves of imagination to adapt when established patterns prove inadequate.

Singapore's approach to building redundancy in critical infrastructure exemplifies this principle. The nation's water strategy – local catchment,

imported water, NEWater, and desalination – seemed expensive to critics focused on immediate needs, yet proved invaluable against political tensions threatening single-source dependencies. Similarly, defence capabilities, including National Service and Total Defence, and economic diversification reflect an understanding that spare capacity becomes essential during crisis.

Pattern Recognition as Strategic Reserve

The same logic applies to cognitive infrastructure. Pattern recognition represents perhaps the most critical form of cognitive reserve – a repository of accumulated wisdom and experience that can be rapidly deployed when new challenges emerge. The utility of these cognitive reserves became evident during Singapore's response to Covid-19. The government's ability to rapidly designate it as a national crisis reflected pattern recognition derived from the SARS experience and years of scenario planning and cross-agency collaboration. The swift deployment of multiple agencies and development of innovative solutions demonstrated cognitive reserves in action – the ability to rapidly reconfigure resources and approaches when facing unprecedented challenges.

Singapore's national scenario planning process helps to systematically builds these pattern libraries through regular exercises bringing together diverse perspectives from within and outside government. This process embeds futures

and foresight vocabulary and thinking patterns across cohorts of civil servants, creating cognitive infrastructure that transcends individual expertise.

Conducted every few years as a whole-of-government effort, these national scenarios connect planners and policy makers to key challenges while making them more aware of assumptions, biases, and blind spots. The durability of certain scenario insights demonstrates their value – geopolitical scenarios focusing on major power relationships have proved resilient, while climate scenarios led to the establishment of dedicated institutions for long-term planning.

The Centre for Strategic Futures, which I advise, is at the centre of this approach. Insulated from immediate operational pressures where long-term thinking can flourish, it sees in its mandate the need to cultivate individuals with different disciplinary backgrounds, cultural perspectives, and thinking styles, recognising that insights into the future are not the monopoly of single agencies or government alone. Through its sixteen-year track record of bringing together diverse perspectives to challenge conventional thinking, its longevity speaks to the importance Singapore attaches to foresight as part of the government's cognitive infrastructure.

Over the years, its alumni have moved into ministries and agencies throughout government, creating a distributed cognitive capacity. Today, many senior civil servants have experience in futures thinking through their

involvement in whole-of-government activities like national scenario planning. Through these, they have built strong relationships and social capital that transcend organisational boundaries.

Foresight helps make people aware of the ambiguities and the uncertainties, the challenges as well as the opportunities, in a future that is essentially unknowable. It does not predict the future, but it awakens the imagination. It is almost an article of faith today that the long-term future of the country depends on the quality of its strategic plans and policies, and the ability to cope with uncertainty, change and complexity.

In this regard, Mr S Rajaratnam's 1979 observation is remarkably prescient,

> "There are practical men who maintain that such speculations are a waste of time and they have no bearing at all on solutions to immediate day-to-day problems. This may have been so in earlier periods of history when changes were few and minute and were spread over decades and centuries ... [Because] we are not only living in a world of accelerating change but also of changes which are global in scope and which permeate almost all aspects of human activity ... [and since] change is about the future then only a future-oriented society can cope with the problems of the 21st century."

Diversity as Cognitive Redundancy

Cognitive reserves require diversity rather than depth of expertise alone. Complex environments demand multiple ways of understanding problems that prevent single points of failure in thinking. This is cognitive redundancy. Singapore's foresight practices deliberately eschew focus on deep expertise, instead complementing it with systematic searches for different views. No perspective is rejected because it is not mainstream; no possibility is ruled out because it makes decision-makers uncomfortable.

This diversity functions like redundancy in critical infrastructure systems. Just as the Four National Taps protect Singapore from single points of failure in water supply, cognitive diversity protects against single points of failure in thinking.

The government's practice of engaging people from different organisations, both within and outside government, creates what James Surowiecki calls *collective intelligence* – or more colloquially, the wisdom of crowds, the phenomenon where groups of diverse individuals can make more accurate decisions than even the smartest individuals within the group.

This is one of the reasons why the Singapore government, perhaps more than most, systematically engages with global expertise through advisory boards and collaborations. Arguably, this approach extends cognitive capacity

beyond national boundaries even while maintaining focus on specific national challenges.

Whole-of-Government as Cognitive Architecture

The horizontal flow of information across government agencies represents another dimension of cognitive infrastructure. Singapore's *whole-of-government* approach breaks down vertical silos to encourage spontaneous horizontal information flow, enlarging and enriching the worldview of all component agencies.

This architectural approach reflects the principle of matching organisational complexity to environmental complexity. As Singapore's counter-terrorism strategy recognises, "it takes a network to fight a network". Complex environments require organisationally complex responses capable of surfacing hidden connections and emergent patterns early. Complex challenges require coordinated responses beyond traditional ministry boundaries.

Imaginative Capacity for Discontinuous Change

Perhaps most fundamentally, cognitive reserves enable preparation for futures that bear little resemblance to present conditions. Nikola Tesla's 1926 vision of wireless communication demonstrates imagination's role in envisioning unprecedented scenarios. His astonishingly farsighted description of a world where "the whole earth will be converted into a huge brain" and

people could “communicate with one another instantly, irrespective of distance” through devices carried “in his vest pocket” required imaginative leaps far beyond analytical extrapolation from existing trends. Not many have this imaginative capacity, yet we should aim to learn from them.

One group of people who have such cognitive gifts are science fiction writers. They can imagine complex futures and then present these in compelling stories that cannot otherwise be described in straightforward narratives. This is a reason why the Centre for Strategic Futures tries to engage such writers in its explorations of the future.

Systematic Investment in Cognitive Infrastructure

These reserves of imagination cannot be built overnight. They require sustained investment comparable to physical infrastructure. But these are not costly capabilities either to establish or to run. The real cost is that imagination and fresh ideas can and do create discomfort within bureaucratic organisations that tend towards the status quo. This discomfort then leads to the false argument that maintaining such capabilities is a waste of money, an unnecessary extravagance when there are other pressing needs. But they can be largely embedded into training systems, processes and organisation at marginal cost. Indeed, this systematic approach has created pervasive foresight capacity throughout the Singapore government – not merely specialised expertise but a mindset towards the future that informs planning and policymaking at all levels.

This could become a new way of conceptualising strategic reserves – moving beyond purely financial or material assets to include the cognitive infrastructure necessary for adaptive governance. And their value has been demonstrated in Singapore's experience during SARS, the 2008 global financial crisis, and Covid-19 when cognitive reserves enabled rapid adaptation where established approaches proved inadequate.

Leadership for Complexity

Navigating complexity demands leaders comfortable with ambiguity, willing to experiment with unproven approaches, and skilled at building coalitions around shared purposes rather than detailed plans. This requires leaders who are future-fit – able to make decisions under uncertainty, adapting based on emerging information, and maintaining direction while adjusting tactics.

As Dr Goh Keng Swee observed, "The only way to avoid making mistakes is not to do anything. But that will be the ultimate mistake." Leaders must cultivate cultures distinguishing acceptable failures that generate learning from unacceptable failures that undermine essential functions.

Successful leaders of change make their people brave enough to express opinions, change behaviour, take risks, and learn from failure. They tolerate mavericks – even if they do not embrace them – because all future-fit

organisations need people who challenge conventional wisdom and generate game-changing ideas.

The Imperative for Adaptive Governance

Complexity makes imagination not a luxury but a governance necessity. Linear thinking, risk aversion, and bureaucratic inertia – while perhaps serving some useful functions – are inadequate for navigating discontinuous change and emergent challenges. As Andy Grove famously observed, "Success breeds complacency, complacency breeds failure, and only the paranoid survive."

But paranoia alone is insufficient. We need disciplined imagination that can envision better futures while preparing for challenging ones. This requires courage to set aside past practices and adopt new concepts showing little immediate evidence of success.

Governments must systematically cultivate imaginative capacity as a strategic reserve comparable to financial reserves – an investment that appears unnecessary and an indulgence during normal times but proves essential during disruption. Nations must invest in cognitive redundancy the same way they invest in economic diversification or military capability – as insurance against uncertain futures. This requires treating cognitive infrastructure with the same seriousness as physical infrastructure, understanding that reserves of imagination enable adaptation when established patterns prove inadequate. This

fundamental shift demands new organisational forms, different performance metrics, and leadership approaches balancing operational excellence with adaptive capacity.

The future belongs to those who can dream with eyes wide open, experiment safely with radical ideas, and maintain flexibility when the unexpected inevitably occurs. In an age of artificial intelligence, imagination may prove our most valuable contribution to governance. The question is not whether we can afford to cultivate imagination in government, but whether we can afford not to treat it as the strategic reserve it truly is – cognitive infrastructure essential for navigating an increasingly complex and uncertain world.

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