

SCIENCE, TECHNOLOGY AND SECURITY RESEARCH: THE POTENTIAL ROLE OF THINK TANKS LIKE RSIS

Policy Report
January 2018

Cung Vu

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Introduction

Science and technology (S&T) is essential to the development of human civilisation. From ancient times, people have learned by observation and trial and error, and this is the heart of the scientific discipline. They learned that every plant has the ability to reproduce for crop cultivation, allowing them to end their hunting-for-food nomadic life and switch to settled communities. They planted wheat and barley, which can be used to make porridge, bread, and beer. They learned to extract metal from ores to produce tools. They domesticated cattle for farming. Their inventions and discoveries, ranging from the wheel, paper-making, silk harvesting, and the clock, to abstract mathematical concepts such as algebra and arithmetic are still being utilised today.

S&T has helped countries to develop and maintain their powerful positions on the world stage. For instance, in the United Kingdom, various discoveries such as that of gravity by Isaac Newton, evolution by Charles Darwin, hydrogen by Henry Cavendish, penicillin by Alexander Fleming, and DNA by Francis Crick have made the country one of the most powerful in the world. Today, the British company Rolls Royce is still the leading player in the aerospace industry, while GlaxoSmithKline is among the top pharmaceutical companies in the world. Another example is the United States, which leveraged S&T to become the superpower it is today. Towards the end of World War 2, the United States created many organisations, such as the National Science Foundation, National Aeronautics and Space Administration (NASA), Defense Advanced Research Project Agency, and many others to foster scientific research and development at the federal level. As a result of these efforts, we are now reaping the benefits of the computer, the Internet, the global positioning system, the smart phone, and artificial intelligence, among others.

Currently, everyday services such as healthcare (vaccines, drugs, diagnostic and therapeutic treatments), finance (business transactions, banking), transportation, and utilities, to name just a few, are all dependent on information and communication technology (ICT). In the future, there will be many challenges, including new infectious diseases, food, water, energy and environmental crises, cyberattacks, as well as terrorism, all of which need innovative solutions. S&T will play an important role in addressing these challenges.

Science, Technology, and Security (STS)

Science and technology in itself is neutral. It brings benefits to support the advancement of human beings. But, it also generates threats or creates risks such as climate change, infectious diseases, as well as kinetic destruction and cyberattacks. The benefits of S&T have been studied and discussed elsewhere and are not the focus of this paper.

As science and technology generates threats or creates risks, one should assess its role in security holistically. Besides looking at science and technology from the conventional military and homeland security viewpoint, one needs to examine it from the economic, diplomatic, ethical, societal, and policy angles.

Military

During the Cold War, technologies such as nuclear bombs, intercontinental ballistic missiles, and satellites were developed for national defence and security. S&T continues to be deployed to address new asymmetric and unpredictable threats. The use of unmanned and autonomous systems, newly engineered materials, quantum sciences, and data analytics helped in the development of unbreakable encrypted communications and hypersonic weapons.

Homeland Defence

Science and technology can fulfil the roles of moving people, goods, and services across and within borders as well as protecting civil rights and homeland security. Remote sensing and detection, biometrics, data sharing and integration, modelling and simulation, and risk analysis, including analysis of cyber threats and threats to critical infrastructure, allow actionable information to be delivered to the appropriate homeland defence authorities.

Economy

National security depends on a robust economy, with sound manufacturing and solid supporting infrastructures. Good supply chains, electric power, transportation, and communications are required to maintain a healthy

manufacturing sector. As we move towards the digital economy, the Internet-of-Things will have a profound impact on data generation, collection, analysis, and dissemination for various applications. And, cyber security will be critical for balancing economic interests, national security, and civil rights.

Diplomacy

Science and technology is apolitical and has no boundaries as it builds knowledge by seeking the truth or verification. Scientists have been cooperating with each other around the world, breaking down national barriers to promote better scientific understanding, prosperity, and peace. Like the arts, culture, and sports, science is another diplomatic tool complementing traditional state-to-state diplomacy.

Security and Risk

Like two sides of the same coin, S&T could generate risks and protect security, and both risks and security are intertwined. Risks must be managed properly to protect security. For example, guns could be used to defend ourselves in the wild, but they could also be used to kill ourselves. Coal power plants generate electricity, but they also generate greenhouse gases, contributing to climate change. ICT enables the Internet-of-Things, but it also creates cyber security issues. Therefore, any emerging technology must be examined from both the security and risk perspectives to assess its potential implications.

Ethics and Society

As we enjoy the benefits of S&T, we need also to pay attention to the ethical aspects of emerging technologies in our society. For instance, genetically modified organisms have generated discussions of safety and ethics. As emerging technologies have been growing exponentially, many issues need to be placed on the table for policymakers to understand their implications. For example, automated Twitter bots can be generated to post on social media to influence public opinions; the merging of automation, artificial intelligence, and robotics can create robots that are as intelligent as humans; genomic-based personalised medicine can generate security and privacy risks.

Role of S&T in Decision and Policymaking

Science and technology is one of the key factors driving economic growth and security. Policy and decision-makers, whether in business or the public sector, must understand the implications of S&T to make informed and intelligent decisions such as allocating resources appropriately, providing adequate training, or setting directions for research. Failure to recognise the many implications of S&T has destroyed many businesses, a prime example being Kodak's failure to recognise the implications of digital photography. The irony is that Kodak invented the first digital camera, but management's reaction was, "That's cute but don't tell anyone about it"¹. Another example is the Swiss watchmaking industry. Being too dependent on their excellent craftsmanship and precision machining, the Swiss watch industry ignored the quartz watch and was almost wiped out of business, until they changed their strategy to market their watches as luxury jewellery items geared toward higher-end customers.²

Communication Gap Between the S&T and Policy Communities

The members of both the S&T community and the policy community are broad and diverse. Therefore, in order for them to communicate effectively, it is important that there is mutual understanding of behaviours.

It is understandable that there is a communication gap between the two communities. The academic community tends to focus on the "How?" and the policy community on the "So What?". The issue of the driverless car well exemplifies the differences between the two communities. The scientific community focuses on technological developments such as state-of-the-art sensors and algorithms to quickly analyse all the collected information in order to generate instructions to operate the car. The policy community, on the other hand, focuses on issues such as whether driverless cars might be the solution to transportation problems or whether

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- 1 Chunka Mui, "How Kodak Failed." *Forbes*, January 18, 2012. <https://www.forbes.com/sites/chunkamui/2012/01/18/how-kodak-failed/#45064b246f27>
 - 2 "How the Watch Industry Will Save Itself." *Techcrunch*, January 19, 2015. <https://techcrunch.com/2015/01/19/how-the-watch-industry-can-save-itself/>

they might create security risks if terrorists were to exploit them to carry explosives or weapons. On the question of timescale, while the academic community tends to have a long-term horizon, policymakers must make decisions very quickly, and sometimes based on the only information available at hand, which could be incomplete. Typically, scientific discovery takes a long time as one must observe, collect data, verify, and then repeat experiments to make sure the results are reproducible. In contrast, policymakers do not have the time to wait and may have to make decisions notwithstanding missing information. The S&T community focuses on technical information, while policy makers focus on political, economic or security implications. Policymakers tend to come from various backgrounds and, as they are elected and represent different constituents, public opinions or concerns are important factors in their decision-making. Energy is another example of the divergent concerns of the two communities: the scientific community, after conducting an energy study, indicates that the energy supply is not sufficient to sustain economic growth; the policymakers then decide, based on political or security implications, whether to increase the import of fossil fuels, look for new sources of energy, such as nuclear energy, or support renewable energy, such as wind, solar or biomass, to meet the energy demand.

Another factor contributing to the communication gap between the two communities is the incentives. Members of the S&T community receive rewards for their expertise and the number of publications they put out, but not for public communication and engagement. In contrast, policymakers need broad perspectives and integration skills.

The main differences leading to a communication gap between the two communities are summarised in the table below.

S&T Community	Policy Community
Tends to focus on the “How?”	Tends to focus on the “So What?”
Thinks of the long term	Makes decisions quickly, sometimes on incomplete information
Focuses on technical information	Decisions based on implications (political or economic implications, needs of constituents, etc.)

In the United States, some efforts have been made to narrow the gap by introducing programmes to entice young engineers and scientists to join the public service so that policymakers can benefit from their technical insights. Professional societies such as the American Association for the Advancement of Science (AAAS)³ and the Institute of Electrical and Electronics Engineers (IEEE) provide stipends and the recipients work in government for limited terms. This approach also provides a pipeline of technical workers for government. For seasoned academics, the Jefferson Fellowship⁴ provides a mechanism for well-respected members of academia to serve in the government for a year. The university pays their salaries while the government pays for all other expenses incurred during their terms of service. Upon completion of their terms, the academics return to their universities and work as consultants to government for five years.

Who Provides S&T Advice to Policymakers?

Policymakers obtain inputs and advice on S&T from many groups: government departments, special committees, honorific organisations, universities and colleges, industries, professional societies, the public, think tanks, and others. Based on the information gathered, policymakers then make informed and intelligent decisions.

Scientific advice provided to policymakers comes from many sources and varies from country to country. For example, in the United Kingdom, the Government Chief Scientific Adviser⁵ (GCSA) provides science, engineering, and technology advice to the prime minister and her Cabinet. The GCSA consults with departmental chief scientific advisers and other experts in relevant fields. The GCSA also co-chairs the Prime Minister's Council for Science and Technology. The Government Office for Science, responsible for giving scientific advice to the prime minister and members of the Cabinet, supports the GCSA to ensure that government has access to the best scientific evidence and strategic long-term thinking to make

3 Science & Technology Policy Fellowships. <https://www.aaas.org/program/science-technology-policy-fellowships>

4 Jefferson Science Fellowship Program. <http://sites.nationalacademies.org/PGA/Jefferson/>

5 Government of the United Kingdom, "Chief Scientific Advisers and their officials: an introduction." https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/426307/15-2-chief-scientific-advisers-and-officials-introduction.pdf

policies and decisions. The Council for Science and Technology also advises the prime minister on cross-cutting science and technology policy issues.

The honorific organisation, the UK Royal Society⁶, provides S&T advice to the government. Its fundamental goal is to promote and support excellence in science for the benefit of humanity. It supports international collaboration and demonstrates the importance of science to everyone.

Think tanks such as the UK's Chatham House⁷ provide advice to the government. Chatham House engages government, the private sector, civil society and its members in public debate and closed-door discussions on international issues. It organises conferences, workshops, and roundtables, and it is able to bring together world leaders and the best analysts in their respective fields from across the globe.

In the United States, the S&T decision and policymakers reside in all three branches of government: the legislative, executive, and judiciary.

In the legislative branch, committees and caucuses are involved in S&T policies. Committees include both the House Committee on Science, Space and Technology⁸ and Senate Committee on Commerce, Science, and Transportation⁹. Caucuses or working groups are voluntary alliances of members of Congress which operate without line item appropriations. Examples of caucuses include the Biomedical Research Caucus and the Congressional Internet Caucus.

In the executive branch, the Office of Science and Technology Policy¹⁰ (OSTP) provides the president and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy; national security; homeland security; health;

6 Royal Society of the United Kingdom, "Strategic Plan 2017–2022." March 2017. <https://royalsociety.org/~media/about-us/governance/royal-society-strategic-plan-summary-2017-2022.pdf?la=en-GB>

7 Website of Chatham House. <https://www.chathamhouse.org/about>

8 Website of US Committee on Science, Space, and Technology. <https://science.house.gov/>

9 Website of US Senate Committee on Commerce, Science, and Transportation. <https://www.commerce.senate.gov/public/>

10 Website of US Office of Science and Technology Policy. <https://www.whitehouse.gov/ostp/about>

foreign relations; and the environment. Within OSTP, the National Science and Technology Council¹¹ (NSTC) coordinates S&T policies across the federal research and development enterprise. NSTC establishes clear national goals for federal S&T investments in areas spanning virtually all the mission areas of the executive branch. It prepares research and development strategies that are coordinated across federal agencies. Other offices, such as the Office of Management and Budget, the Council of Economic Advisers, and the Council on Environmental Quality, also support the White House in policymaking.

In the judiciary, the Federal Judicial Center¹² provides literature, training, and videos on scientific and engineering topics to help guide judges in managing cases centred on S&T issues. The American Association for the Advancement of Science (AAAS) provides a service known as the Court Appointed Scientific Experts (CASE)¹³ service to assist federal and state judges, administrative law judges, and arbitrators in identifying highly qualified scientists and engineers to serve as technical experts.

Outside of government, there are many organisations which provide advice to American decision and policymakers. Among these are congressionally chartered honorific organisations, of which the main one is the National Academies¹⁴, which consist of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and their operating arm, the National Research Council. The National Academies provide independent, objective analysis and advice to the nation and undertake other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognise outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

There also are many think tanks in the United States that provide policy

11 Website of US National Science and Technology Council. <https://www.whitehouse.gov/ostp/nstc>

12 Website of the US Federal Judicial Center. <https://www.fjc.gov/node/12506>

13 American Association for the Advancement of Science write-up on Court Appointed Scientific Experts service. <https://www.aaas.org/page/court-appointed-scientific-experts-case>

14 US National Academy of Sciences. "Advising the Nation. Advancing the Discussion. Connecting New Frontiers." <http://www.nationalacademies.org/brochure/index.html>

analysis and advice. Many of these are non-profit organisations and some are funded by interest groups. Some focus on a particular discipline, some promote a particular point of view on policies, while others claim to be neutral. Some think tanks are well rounded and cover many policy areas, including S&T policies in some cases.

Some universities and colleges also are active in S&T policies and maintain satellite offices in Washington, DC, to monitor White House and Congressional activities that might affect their institutions.

Role of the Think Tank

Think tanks are organisations that provide discussion fora, policy research, and perspectives on specific topics to stimulate public debate and allow policymakers to make informed policy decisions. They often play a brokerage role between the academic and policy communities by synthesising policy-relevant knowledge created by academics and articulating it in language accessible to policymakers, thus narrowing the communication gap between these communities.

There are close to 7,000 think tanks across the world. These vary in size, focus, and funding support. The United States alone has more than 1,800 think tanks¹⁵. It is followed by China, with more than 400 think tanks, and the United Kingdom, with close to 300 think tanks. In the United States, think tanks conduct research on policy problems and provide policy solutions, advise on immediate policy concerns by testifying in Congress or interacting with media, and conduct assessment studies of governmental programmes. Some advocate certain policies. Staff of think tanks are often brought into government to serve as political appointees for the duration of a presidential term or the duration of a specific assignment.

15 McGann, J. G. "2016 Global Go to Think Tank Index Report". University of Pennsylvania, January 26, 2017. http://repository.upenn.edu/cgi/viewcontent.cgi?article=1011&context=think_tanks

Role of RSIS in STS

There are many think tanks in Singapore and they rank well against their counterparts around the world. This is according to the Think Tanks and Civil Societies Program (TTCSP)¹⁶ of the University of Pennsylvania, which compiles annual surveys of the world's think tanks and ranks them in several categories. The tables below highlight the rank order of Singapore's think tanks. The ranking is not perfect as it is only based on survey results from participating think tanks. The information also is sometimes outdated.¹⁷ Nevertheless, the University of Pennsylvania's ranking is still the most comprehensive ranking of think tanks available.

As can be seen from the table on the top Science and Technology think tanks, none of Singapore's think tanks, including IDSS, is listed and it is time institutions like RSIS are empowered to conduct serious STS research, given the rapidly evolving and complex security landscape.

Rank	Top Think Tanks Worldwide (Non-US)
53	Singapore Institute of International Affairs (SIIA)
67	Institute of Southeast Asian Studies (ISEAS)
68	Centre on Asia and Globalization (LKY)
72	Asia Competitiveness Institute (ACI)
82	Institute of Defence and Strategic Studies (IDSS)

16 Ibid.

17 For example, the Institute of Defence and Strategic Studies (IDSS) is still being singled out although it is now a constituent part of the more recently established S. Rajaratnam School of International Studies (RSIS). Likewise, the report still refers to the Institute of Southeast Asian Studies, which was renamed the ISEAS-Yusof Ishak Institute some time back. and it erroneously identifies the institute as affiliated to the National University of Singapore (NUS). It also contains an error in the table that ranks the top social policy think tanks, with ISEAS being ranked twice.

Rank	Top Think Tanks Worldwide
83	Singapore Institute of International Affairs (SIIA)
95	Institute of Southeast Asian Studies (ISEAS)
99	Institute of Defence and Strategic Studies (IDSS)

Rank	Top Think Tanks in Southeast Asia and the Pacific
3	Institute of Defence and Strategic Studies (IDSS)
11	Singapore Institute of International Affairs (SIIA)
12	Institute of Southeast Asian Studies (ISEAS)
14	East Asian Institute (EAI)
31	Asia Competitiveness Institute (ACI)
34	Institute of Policy Studies
45	Centre on Asia and Globalisation (CAG)
50	Political Risks Assessment Group, Institute of Policy Studies

Rank	Top Defence and National Security Think Tanks
105	Institute of Southeast Asian Studies (ISEAS)

Rank	Top Domestic Economic Policy Think Tanks
54	Singapore Institute of International Affairs (SIIA)

Rank	Top Foreign Policy and International Affairs Think Tanks
46	Institute for Defence and Strategic Studies (IDSS)
85	Institute for Southeast Asian Studies (ISEAS)
88	Singapore Institute of International Affairs (SIIA)
96	Centre on Asia and Globalization (CAG)
125	Asia Competitive Institute

Rank	Top International Development Think Tanks
73	Singapore Institute of International Affairs (SIIA)
79	Asia Competitiveness Institute (ACI)
97	Centre on Asia and Globalization

Rank	Top Science and Technology Think Tanks
	None from Singapore. More information is in the Table of Top Science and Technology Think Tanks below

Rank	Top Social Policy Think Tanks
41	Institute of Southeast Asian Studies (ISEAS)
53	Institute for Policy Studies
87	Institute of Southeast Asian Studies (ISEAS)

Rank	Best University Affiliated Think Tanks
13	Asia Competitiveness Institute, Lee Kuan Yew School of Public Policy, National University of Singapore (NUS)
23	East Asian Institute (EAI), NUS
29	Centre on Asia and Globalisation, Lee Kuan Yew School of Public Policy, NUS
31	Institute of Southeast Asian Studies (ISEAS), NUS
36	Institute of Defence and Strategic Studies (IDSS), S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University
83	Institute of Policy Studies, Lee Kuan Yew School of Public Policy, NUS

Rank	Top Science and Technology Think Tanks
1	Max Planck Institutes (Germany)
2	Information Technology and Innovation Foundation (ITIF) (United States)
3	Center for Development Research (ZEF) (Germany)
4	Battelle Memorial Institute (United States)
5	Institute for Future Engineering (IFENG), FKA Institute for Future Technology (Japan)
6	RAND Corporation (United States)
7	Science Policy Research Unit (SPRU) (United Kingdom)
8	Institute for Basic Research (IBR) (United States)
9	Consortium for Science, Policy, and Outcomes (CSPO) (United States)
10	Information and Communication Technologies for Development (ICT4D) (United Kingdom)
11	Technology, Entertainment, Design (TED) (United States)
12	Council for Scientific and Industrial Research (CSIR) (South Africa)
13	African Technology Policy Studies Network (ATPS) (Kenya)
14	International Institute for Applied Systems Analysis (IIASA) (Austria)
15	Energy and Resources Institute (TERI) (India)
16	Lisbon Council for Economic Competitiveness and Social Renewal (Belgium)
17	Fondation Telecom (France)
18	Technology Policy Institute (TPI) (United States)
19	Research ICT Africa (RIA) (South Africa)
20	Santa Fe Institute (SFI) (United States)

Rank	Top Science and Technology Think Tanks
21	Institute for Science and International Security (ISIS) (United States)
22	African Centre for Technology Studies (ACTS) (Kenya)
23	Samuel Neaman Institute for Advanced Studies in Science and Technology (SNI) (Israel)
24	Telecom Centres of Excellence (TCOE) (India)
25	Jigsaw (FKA Google Ideas) (United States)
26	Eudoxa (Sweden)
27	Fundacion Innovacion Bankinter (Spain)
28	Keck Institute for Space Studies (KISS) (United States)
29	Kansai Institute of Information Systems (KIIS) (Japan)
30	Science and Technology Policy Institute (STEPI) (Republic of Korea)
31	Center for Global Communications (GLOCOM) (Japan)
32	Fundación Idea (Mexico)
33	National Institute of Advanced Industrial Science and Technology (AIST) (Japan)
34	World Security Institute (WSI) (United States)
35	Unirule Institute of Economics (China)
36	Tech Freedom (United States)
37	Bertelsmann Foundation (Germany)
38	Institute for the Encouragement of Scientific Research and Innovation of Brussels (ISRIB) (Belgium)
39	Centre for Studies in Science Policy (CSSP) (India)
40	Centre for International Governance Innovation (CIGI) (Canada)
41	Lowy Institute for International Policy (Australia)

Rank	Top Science and Technology Think Tanks
42	Moscow State Institute of International Relations (MGIMO) (Russia)
43	Turkish Economic and Social Studies Foundation (TESEV) (Turkey)
44	Breakthrough Institute (United States)
45	Brookings Institution (United States)
46	Peterson Institute for International Economics (PIIE) (United States)
47	Tanzania Commission for Science and Technology (COSTECH) (Tanzania)
48	Evidence-Informed Policy Network (EVIPNet), World Health Organization (Switzerland)
49	Adam Smith Institute (United Kingdom)
50	Belfer Center for Science and International Affairs (United States)
51	Centro de promocion de Tecnologías Sostenibles (Bolivia)
52	Center for Economic and Social Development (CESD) (Azerbaijan)
53	Fraser Institute (Canada)
54	Center for Study of Science, Technology & Policy (CSTEP) (India)
55	Bankinter Foundation of Innovation (Spain)
56	Institute for Innovation and Development Strategy (China)
57	Centre for Science and Environment (CSE) (India)
58	China Association for Science and Technology (China)
59	Consejo Internacional de Ciencias Sociales (ISSC)
60	BRICS Policy Center (Brazil)

Rank	Top Science and Technology Think Tanks
61	Consejo Latinoamericano de Ciencias Sociales (CLACSO) (Costa Rica)
62	Council on Energy, Environment And Water (CEEW) (India)
63	Development Alternatives (India)
64	Edge Foundation (United States)
65	ICT4D (United Kingdom)
66	Africa Academy of Sciences
67	Institute for Basic Research IBR (United States)
68	Manhattan Institute (United States)
69	Perimeter Institute (Canada)
70	Yachay (Ecuador)

As mentioned earlier, technological change is affecting every aspect of human civilisation. S&T has advanced at an accelerated rate, and policymakers find it challenging to keep pace with its implications. Moreover, the knowledge and data provided by the S&T community are diverse and sometimes seem contradictory, depending on the field of research and the different perspectives where opinions come from. Therefore, there is a need for an organisation that can integrate S&T knowledge and provide a coherent view in language that can be understood by policymakers.

As an autonomous school within Nanyang Technological University, RSIS focuses on strategic and international affairs. RSIS has a dual role, one as a think tank and the other as an educational institution. As a think tank RSIS, has five centres and three programmes focusing on diverse areas, from defence and national security to terrorism. Recognising the importance of STS, on 1 September 2017, RSIS launched the Future Issues and Technology (FIT) programme, which works with relevant RSIS centres, programmes, and researchers to better identify emerging issues and technologies that have a strategic impact on policy as well as potential disruptive national security implications. This was followed on 1 October 2017 by the launch of the Science and Technology Studies Programme (STSP). RSIS could play a key role to bridge the scientific community, the public, and the policy and decision-makers for Singapore. Specifically, RSIS should work on an STS initiative to address the common issues described below.

1. Policy coherence

Government departments tend to each place more emphasis on their immediate tasks, i.e. tactical preoccupation. To avoid such short-term thinking and encourage government-wide coordination, a think tank could provide a helicopter view of the nation's long-term security goals and strategic policies.

- (i) Functional specialisation. By design, each department/agency is responsible for addressing problems in its own functional area, whether it be defence, health or education. Each has a distinct mission to execute and specific tasks to be performed. Even though the various departments may try to work in concert with one another, the bottom line is that the missions of their respective departments have the first priority and everyone else's missions are considered secondary.
- (ii) Tactical level versus strategic level. Each department tends to be preoccupied with tackling day-to-day problems, with little time to plan for long-term solutions or to anticipate problems that could emerge in the future. In the United States, one area where efforts have been made to counter the tendency to think short-term is defence. Here, Congress in 1996 required the Department of Defense to conduct quadrennial defence reviews to force them to think strategically, 15-20 years into the future. This practice has since led to similar quadrennial review efforts being conducted by the Department of State, the Department of Energy, and the Department of Homeland Security.
- (iii) Competition for a slice of the same budget. Since the various departments and agencies need to fight to secure a sizeable allocation of what are usually tight government budgets, each tends to push hard for its own agenda. There is little or no incentive for any one department or agency to push for the others' agendas or to take into account the wider interests of society.
- (iv) Looking at the trees and missing the forest. One example is the drug issue in the United States: drug addiction, abuse, and trafficking

have overwhelmed the justice system, overburdened the healthcare system, caused a loss in productivity, and damaged the environment. As a result, the drug issue involves the Department of Justice's Drug Enforcement Administration, the Department of Health, the Department of Labor, and the Environmental Protection Agency. To address this problem, one has to take a holistic approach and cannot just assess the situation from a single department's position.

- (v) Failure to look at cross-cutting technologies that transcend departmental divides. Many policy challenges such as climate change, cyber security, and food security are cross-cutting. In the United States, one example where such cross-cutting challenges are being addressed is the issue of energy. The US Department of Energy considers energy as a system in its Quadrennial Energy Review instead of organising reviews around the traditional agency structure. A think tank could play a critical role as an honest broker with an unbiased agenda to assess and articulate long-term and cross-cutting scientific and technical issues. It can not only provide advice to government and other decision and policymakers, but also enlighten the wider public.

2. Promotion of public awareness and education

General knowledge of S&T among the public is generally shallow. A think tank could produce commentaries and papers and hold public forums that a layman would easily understand. In short, it could educate and promote public awareness, thus contributing to greater social resilience.

RSIS has held public talks and seminars as well as published commentaries and policy papers to raise public awareness on issues of military strategy, terrorism, national security, non-traditional security, and multilateralism. RSIS could take on an additional role of engaging the public, particularly the layman, in STS to deepen the understanding of its implications.

- (i) The public may not have a full understanding of the implications of S&T. A think tank could foster dialogue among technical experts, policymakers, and the general public on topics such as cyber security and privacy, fake news, genetically modified organisms, artificial intelligence, and unmanned vehicles. It is critical for scientists and technical experts to make their research accessible to the public as well as to the policymakers so that the latter can be aware of the potential implications. To illustrate, this paper will take a look at two contemporary topics: Big Data Analytics, and Automation and Artificial Intelligence.
- (ii) Big Data Analytics: As computing power improves and memory storage becomes less expensive, it is much easier to collect, store, and analyse data with a view to improving efficiency, growing the economy, and providing security. In our daily lives, information on our spending habits is collected through business transactions and analysed by marketers so that they could tailor their marketing strategies to our individual desires. When we order prescription drugs from the pharmacy in some countries, our data is shared and cross-checked instantaneously against multiple databases to make sure that the drugs we are buying do not have adverse interactions with other drugs we are currently taking (through doctors' databases), that the drugs are covered by our insurance (through our health insurance databases), and that the drugs are not on the controlled substances list (through the databases of appropriate drugs enforcement agencies). Our activities on the Internet and social media are also being tracked. Our movements are tracked by sensors and video cameras installed in public places. However, the use of all this "Big data" raises many questions: How is the data being used? Have we benefited from such collection or are we being exploited? Who controls the data, and is it secured or protected? How does it affect our privacy? Who ensures data quality, integrity, and interoperability? A think tank could help in providing a public forum to help both the public and policymakers deal with these issues since this is an area where sound policy is needed.
- (iii) Automation and Artificial Intelligence. Automation has been utilised increasingly to improve our standard of living. While it has displaced

some jobs it has also generated new ones. The petrol station is one example. Before the 1970s, all petrol stations had attendants to fill tanks and provide other services to customers. With the rise of automated payment systems, self-service petrol stations were introduced in the 1970s, making it hard today to find pump attendants. With the savings from eliminating pump attendants, the station owners set up side-businesses to sell drinks, snacks, and other goods, which require the hiring of staff to manage the stores. Motorists saved money because they are now filling their tanks themselves, and they can use the savings to spend on other goods, thus generating other businesses. Robots appeared in the assembly line in the 1970s to replace welders, assemblers, and other tradespeople and make better quality and cheaper vehicles. The displaced workers had to be retrained to do something else. Autonomous systems will likely become a ubiquitous part of everyday life. Self-driving vehicles could revolutionise ground transportation, and inexpensive commercial drones and submersibles could have many potential uses.

Cheaper and better ICT has enabled the advancement of artificial intelligence (AI), whose full implications are yet to be understood. IBM has been investing in the Watson digital personal assistance system¹⁸ and Apple in its own version, Siri,¹⁹ Microsoft has been investing in research labs for AI and robotics. It is possible to envisage visits to AI doctors for diagnosis in the future. With access to big data, AI could possibly replace not only manual workers but also white-collar workers. The implications are complex and need to be studied in depth. The development of AI was considered important enough to induce the White House to release a report titled “Artificial Intelligence, Automation, and the Economy”²⁰ in December 2016. The objective of the report was to recommend what could be done to help families and communities displaced by AI to get back on their feet and develop new skills so that they could share the benefits of advanced technology and thrive in the transformed economy.

18 IBM Watson. <https://www.ibm.com/watson/>

19 Apple's Siri. <https://www.apple.com/ios/siri/>

20 Obama White House archives, “Artificial Intelligence, Automation, and the Economy.” December 2016. <https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/Artificial-Intelligence-Automation-Economy.PDF>

(iii) Public opinion is critical.

Public opinion is integral to the functioning of a democratic society and forms a critical component of the policymaking process. Public opinion helps to shape many policy issues, such as healthcare and education. There will increasingly be a need to conduct surveys and analyse public opinion on relevant S&T topics for the benefit of policymakers. A think tank could help in fulfilling that role. Public opinion on S&T is diverse and varies from country to country. For example, in the United States in 2016, the majority of Americans continued to see substantially more benefits than harm in S&T and had relatively high levels of confidence in the scientific community. Views on specific S&T issues, including environmental, energy, and emerging technologies, are more varied²¹. For instance, Americans are divided on the nature and severity of climate change. Slightly more than half the American public worry about climate change. Fewer than 4 in 10 think it will cause a serious threat to their way of life and only about 6 in 10 Americans believe that climate change is occurring. Americans are relatively less concerned about the climate change issue than citizens of most other countries.²² For example, in 2013, 40 per cent of Americans told the Pew Research Center that they thought “global climate change” was a “major threat” to the United States, in contrast to 54 per cent of both Canadians and Europeans.

3. Practice and philosophy

A think tank could investigate the capacity requirements, including personnel, budget, and assets needs, on top of resource allocation strategies for public agencies.

- (i) Think tanks could assist government in S&T policy as well as support planning and the coordination of activities. Without the burden of

21 US National Science Board. *Science and Engineering Indicators 2016*. Chapter 7. Arlington, Virginia: National Science Foundation, 2016. (NSB-2016-1). <https://www.nsf.gov/statistics/2016/nsb20161/uploads/1/10/chapter-7.pdf>

22 Pew Research Center. “Climate Change and Financial Instability Seen as Top Global Threats.” June 24, 2013. <http://www.pewglobal.org/files/2013/06/Pew-Research-Center-Global-Attitudes-Project-Global-Threats-Report-FINAL-June-24-20131.pdf>

day-to-day tactical issues, a think tank could provide scientific and technical analyses and assessments with respect to major policies, plans, programmes, resource allocation, and budget for policy and decision-makers. Think tanks could also help governmental departments in the coordination of research and development programmes and human resources.

- (ii) Science diplomacy. Think tanks could help the government in building international relationships. Science diplomacy is one of many important diplomatic tools to build trust between nations. Whether working in climate change or renewable energy technologies, scientists have built relationships across borders and have contributed to the soft side of diplomacy.

Recommendations

Given the exponential growth of emerging technologies with potential security implications, it is strongly recommended that all stake-holders in Singapore, whether in government, the private sector, or academia, work closely and urgently together with RSIS to address the challenges of Science, Technology and Security. Holistically, security ranges from traditional defence and homeland security, to economic, ethical, and societal aspects. It is complex and no organisation can address it alone. The various stake-holders must explore and engage in any potential collaboration opportunities domestically and internationally to fulfil the responsibility they owe to the public and society.

About the Author

Dr Cung Vu is a Visiting Senior Fellow, RSIS, NTU. He has over 35 years of experience in industries, academia and government, was listed in Who's Who in Science and Engineering and has thirty-eight world-wide patents. Dr Vu is currently a consultant, following his retirement from the US government, focusing in Science and Technology (S&T) in National Security, S&T in Maritime Security, Cyber Security, Emerging Technologies, Renewable Energy for Rural Community and in the Asia-Pacific region. His previous positions include Associate Director at the Office of Naval Research Global in Singapore; Chief Science and Technology Advisor at the National Maritime Intelligence-Integration Office; Branch Chief, Advanced Technologies of the Defense Warning Office; Senior Program Officer of the National Academies. Dr Vu spent more than 20 years in private sector. He received his Ph.D. and B.S. in Chemical Engineering from Monash University, and University of Sydney respectively, both in Australia.

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