
Singapore's Defence Industry: Its Development and Prospects

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Since the end of the Cold War in 1989, the partial globalisation of the arms industry has led to a process of defence industrial consolidation and rationalisation, particularly in Europe. As Richard Bitzinger noted, this resulted in the emergence of mega defence conglomerates, such as Lockheed Martin, Northrop Grumman, Boeing, BAE Systems, Thales and DASA (now part of EADS). The large number of competent and motivated sellers in the West, in conjunction with the removal of Cold War ideological barriers to the sale of arms to any willing buyer, however, created a buyers' market in arms. At the same time, the globalisation of the arms industry has only been partial, as autarky remains the norm. According to Bitzinger, in the case of the United States, for instance, its defence industry remains, "a highly insulated sector that dominates the world's arms market through the force of massive US defence spending and an export juggernaut".¹

This has serious implications for the emerging arms industries in smaller states, such as Singapore, Israel, South Africa, Sweden and Australia, as they need, in the context of a much more competitive environment, to access markets, development funding and technologies that would enable their arms industries to survive. Some, such as Australia, have responded by allowing their own arms industries to be taken over by European and US conglomerates. Others, such as India and China, both emerging great powers, have poured huge resources into sustaining and expanding their own independent arms industries.

Yet, some small states, such as Israel and Singapore, have managed to sustain their indigenous arms industries, by various means such as developing competitive advantages in niche areas in defence and through diversification into commercial non-defence sectors. The definition of "small" states is contested but most attempts at defining them have sought to answer the question in terms of capabilities, that is, the possession of power resources in absolute or relative terms.² Thus, how a small city-state such

¹ R. Bitzinger, 'Globalisation Revisited: Internationalizing Armaments Production', in A. T. H. Tan (ed.), *The Global Arms Trade* (London: Routledge, 2010), pp. 208-9.

² B. Thorhallsson and A. Wivel, 'Small States in the European Context: What Do We Know and What Would We Like to Know?', *Cambridge Review of International Affairs*, vol. 19, no. 4 (December 2006), p. 653..

as Singapore, with a population of about 5 million in 2012, has managed to sustain a defence industry makes it an intriguing case study.

According to the respected Stockholm International Peace Research Institute (SIPRI), Singapore's government-owned ST (Singapore Technologies) Engineering is ranked 49 amongst the world's largest defence firms in 2010, with arms sales of US\$1.75 billion. Reflecting its successful broad diversification into the civilian sector, however, this represents 40 per cent of its total sales for 2010. While ST Engineering's sales figure pales in comparison with the major players in the global arms industry, being a fraction of the top-ranked company, Lockheed Martin (United States) which had sales of US\$35.73 billion in 2010, it has done relatively well, considering that the top 100 arms producers (excluding China) are dominated by US firms. Some 47 US firms dominate the top 100, with major European industrial powers contributing 27 companies to the list, and Russia another nine companies. In the top 50 list, there are only three defence firms from small states which outrank Singapore. They are: Israel Aerospace Industries (ranked 37), Elbit Systems of Israel (ranked 35) and Saab of Sweden (ranked 28).³ According to ST Engineering's annual report in 2011, it had revenues of S\$5.99 billion, profits before tax of S\$655.2 million and an order book of S\$12.3 billion, though a large portion of this is for non-military products and services, given the diverse non-military businesses that it operates.⁴

Singapore's defence industry is thus a useful case study of how a small state has been able to establish and sustain a defence industry. Given the brutally competitive global arms market, how has Singapore managed to develop an arms industry and what are its problems and prospects? Are there lessons for small state defence industry from the Singapore experience? This article will therefore examine how Singapore's defence industry became established, its key components, the main factors that contributed to its growth, and assesses its problems and prospects. The article concludes with the possible lessons for other small states.

The caveat here is that statistics on Singapore's defence industry, such as details and composition of various arms deals, or any kind of state subsidy, are not publicly available. However, some information on arms sales is available through indirect secondary sources, which gives an indication of the types of arms sales involved. ST Engineering is also a publicly-listed

³ Stockholm International Peace Research Institute (SIPRI), 'The SIPRI Top 100 Arms Producing and Military Services Companies, 2010', <<http://www.sipri.org/research/armaments/production/Top100>> [Accessed 8 June 2012].

⁴ Singapore Technologies Engineering Ltd (ST Engineering), *Simply Smarter*, Annual Report 2011, <<http://www.stengg.com/AR2011/download.html>> [Accessed 8 June 2012]. The exchange rate for the Singapore dollar to the US dollar on 30 June 2011 was 0.813749. See X-Rates Historic Lookup, <<http://www.x-rates.com/cgi-bin/hlookup.cgi>> [Accessed 8 June 2012].

company which publishes annual reports according to the disclosure rules of the Stock Exchange of Singapore.

Growth and Development

Competence bloc theory identifies the “competencies necessary ... to generate, identify, select, expand and exploit profitable new combinations in the state space”.⁵ The competent actors include: competent customers, inventors, innovators, entrepreneurs, industrialists, venture capitalists and skilled labour. These constitute a competence bloc, which emerges once it has attracted competent actors in large numbers such that the process of generation, identification, selection, expansion and exploitation of business ideas is able to function well.⁶ Competence bloc theory has been further developed, for instance, by Gunnar Eliasson in his case study of the Swedish military aircraft industry. According to Eliasson, advanced product development distinguishes itself by being surrounded by a “cloud of technology spillovers”, available to external users depending on their competence. More significantly, Eliasson concludes that

while the value of the cloud to society may be greater than the development investment, the value captured by the producer is often not sufficient to make the product privately profitable.⁷

The case of Singapore illustrates the growth and development of a competence bloc within defence industry, though this is state-directed and revolves around a key competent customer, namely, the armed forces, as well as inventors, innovators, entrepreneurs and skilled labour that are found amongst its defence scientists and scholar officers. The government also plays the roles of industrialist and venture capitalist, providing the necessary strategic direction as well as state funding. The resultant defence industrial capacity has led to a “cloud of spillovers” available to other external customers. As this spillover is not sufficient to justify the economic returns of the initial development investment, Singapore’s defence industry has also actively expanded into a range of non-military commercial activities. This however, exposes it to the risk of business loss inherent to any commercial activity.

After Singapore’s ejection from the Malaysian Federation in 1965 in the midst of heightened political and ethnic tensions, and given the context of Confrontation with Indonesia from 1963-1965, the government made the defence of Singapore one of its top priorities, as the fledging city-state hardly possessed any military capability at the time. In contrast, it was surrounded by much larger states, namely Malaysia and Indonesia, relations with which

⁵ D. Johansson, ‘The Theory of the Experimentally Organized Economy and Competence Blocs: An Introduction’, *Journal of Evolutionary Economics*, vol. 20 (2010), p. 189.

⁶ *Ibid.*, pp. 189-91.

⁷ G. Eliasson, ‘Advanced Purchasing, Spillovers and Innovative Discovery’, *Journal of Evolutionary Economics*, vol. 21 (2011), p. 121.

were tense at the time and which have since ebbed and flowed depending on political developments. The sometimes contentious relations and the mutual deterrent relationship between, in particular, Singapore and Malaysia is already well-documented and is not within the scope of this essay, suffice to cite Tim Huxley's observation that "the SAF's order of battle appears to be designed for the possibility of war with Malaysia".⁸

While the Singapore Armed Forces (SAF) was established and universal conscription put into place, a parallel early effort was also made to ensure basic defence self-sufficiency through the establishment of a local defence industry. The early ambitions were limited and realistic, and involved the production of ammunition and small arms, the maintenance and repair of weapons systems, the building of patrol boats for the navy, and the refurbishment of military aircraft. One of the earliest defence companies was Chartered Industries of Singapore (CIS), which was established in 1967. CIS produced ammunition, small arms, mortar rounds, artillery shells and tank rounds, as well as license-produced the M16 assault rifle, and later, the SAR-80 assault rifle. CIS was later acquired, in 2000, by ST Engineering.

In 1974, a holding company, Sheng-Li Holding, was established to better strategically oversee the development of Singapore's defence industrial capacity.⁹ In 1986, the Defence Technology Group was also established to better coordinate the various defence research and development agencies.¹⁰ By the end of the Cold War in 1989, Singapore had three key companies which serviced the needs of the army, air force and navy. They provided crucial basic defence self-reliance, given continuing uncertainties over the US security commitment to Southeast and East Asia following the end of the Vietnam War in 1975, concerns which resurfaced amongst US allies in the region at the end of the Cold War.¹¹

The three companies serviced the various arms of the SAF. Singapore Technologies Corporation serviced the army and had three main divisions. The establishment of Chartered Industries of Singapore in 1967 was followed by Singapore Automotive Engineering in 1971. This company refurbished second-hand AMX-13 light tanks and modified V-150/ V-200 and M-113 armoured personnel carriers for the army's use. The third division

⁸ T. Huxley, 'Singapore and Malaysia: A Precarious Balance?', *Pacific Review*, vol. 4, no. 3, p. 204. A detailed discussion of the mutual deterrent relationship between the two countries can be found in A. T. H. Tan, *Security Perspectives of the Malay Archipelago* (Cheltenham: Edward Elgar, 2004), pp. 23-5, 49-60.

⁹ 'Company Overview of Singapore Technologies Holdings Pte Ltd.', *Bloomberg Businessweek*, <<http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=60896919>> [Accessed 8 June 2012].

¹⁰ R. Karniol, 'Singapore Reshuffles Defence Agency', *Janes Defence Weekly*, 26 April 2006, <<http://articles.janes.com/articles/Janes-Defence-Weekly-2006/Singapore-reshuffles-defence-agency.html>> [Accessed 8 June 2012].

¹¹ M. Yahuda, *The International Politics of the Asia-Pacific, 1945-1995* (London: Routledge, 1996), p. 144.

was Ordnance Development and Engineering (ODE), which was established in 1973, and produced mortars and 155mm howitzers for the army.¹²

Singapore's navy was serviced by Singapore Shipbuilding and Engineering (SSE), which was established in 1968.¹³ In the 1970s, the company license-built four of the six TNC-45 Sea Wolf-class missile gunboats which the Singapore navy ordered from Germany. The vessels were equipped with Israeli-made Gabriel anti-ship missiles.¹⁴ Three Sea Wolf class missile gunboats were also later built by SSE for Thailand's navy as the Prabparapak-class. In the 1980s, SSE also license-produced twelve German-designed FPB57 Fearless-class anti-submarine warfare vessels for the Singapore navy.¹⁵ In the late 1980s, SSE built six German-designed Victory-class missile corvettes for the navy, which were delivered in 1990-91 and which still serve the navy today.¹⁶

Singapore's air force was serviced by Singapore Aerospace, which was established in 1981. It undertook the overhaul and maintenance of various military aircraft, including engines and avionics. It also developed expertise in the maintenance and refurbishment of A-4 Skyhawk combat aircraft, which were acquired by the Singapore air force in 1975. In 1988, it successfully carried out an extensive upgrade of the aircraft, relaunching it as the A-4SU Skyhawk. The refurbished aircraft had new General Electric F404-100D engines, upgraded avionics and improved weapons delivery capability.¹⁷

The excitement generated by the debates in the United States over military transformation, specifically, over the so-called Revolution in Military Affairs (RMA) was followed closely by Singapore, particularly after the swift US conventional victories over Iraq in the First Gulf War in 1990. Singapore quickly embraced the RMA, since it promised to overcome its strategic weaknesses, such as lack of strategic depth, heavy external reliance on trade and resources, and the lack of standing military manpower due to the small size of its population. In 2000, Singapore's defence white paper asserted that Singapore would aim for an RMA with the objective of

¹² 'Singapore Technologies', *Singapore Infopedia*. <http://infopedia.nl.sg/articles/SIP_1042_2011-03-29.html> [Accessed 8 June 2012].

¹³ Association of Singapore Marine Industries, <<http://www.asmi.com/index.cfm?GPID=43>> [Accessed 8 June 2012].

¹⁴ Ministry of Defence, Singapore, 'Milestones of the Republic of Singapore Navy's Missile Gunboats', Factsheet, <http://www.mindef.gov.sg/imindef/news_and_events/nr/2008/may/13may08_nr2/13may08_fs.html> [Accessed 12 June 2012].

¹⁵ T. Hootan, 'Fast Attack Craft: Threats and Capabilities', *Asian Military Review*, March 2010, pp. 20-21. <<http://www.asianmilitaryreview.com/upload/201003140001391.pdf>> [Accessed 12 June 2012].

¹⁶ Ministry of Defence, Singapore, 'Republic of Singapore Navy—Assets—Ships', <http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/assets/vessels.html> [Accessed 12 June 2012].

¹⁷ Ministry of Defence, Singapore, 'The A-4SU Skyhawk', Factsheet, <http://www.mindef.gov.sg/imindef/news_and_events/nr/2000/jul/14jul00_nr/14jul00_fs.html> [Accessed 12 June 2012].

achieving battlefield superiority.¹⁸ In 2000, a reorganisation led to the establishment of the Defence Science and Technology Agency (DSTA) which replaced the previous Defence Technology Group.¹⁹ The DSTA would acquire weapons systems for the SAF as well as design, develop and maintain defence infrastructure.²⁰ The DSTA's work is complemented by the Defence Science Organisation (DSO), which was reorganised as the DSO National Laboratories in 1997.²¹ This was followed by the establishment, in 2003, of a Future Systems Directorate which manages a Center for Military Experimentation to explore new operational concepts for Singapore's RMA.²² The aim is to develop a "3G SAF" or Third Generation SAF, which will be based on state-of-the-art technology in the areas of precision strike, advanced networks and unmanned systems. The new 3G SAF would also provide the SAF with more flexible capabilities which will enable it to better undertake operations other than war, such as in counter-terrorism, peacekeeping and humanitarian assistance.²³

Around the same time, the phrase "defence ecosystem" began to be used to describe the close, interlinked relationship between the SAF, research and development agencies and defence industry.²⁴ In 2006, a new Defence Research Technology Office (DRTC) was established as the lead agency in defence research and technology, working closely with DSTA and DSO National Laboratories as well as defence industry within the context of Singapore's defence eco-system.²⁵

Thus, the SAF would establish requirements, while various agencies such as the DSTA, DRTC and DSO National Laboratories would evaluate these requirements and translate these into actual capabilities through either external acquisitions of weapons and electronics systems or through local development. The defence industry is responsible for producing and servicing these systems and their components, playing an increasingly

¹⁸ Ministry of Defence, *Defending Singapore in the 21st Century* (Singapore: Ministry of Defence, 2000), p. 10.

¹⁹ R. Karniol, 'Singapore Reshuffles Defence Agency', *Janes Defence Weekly*, 26 April 2006.

²⁰ Defence Science and Technology Agency, Singapore, 'An Overview of DSTA', <<http://www.dsta.gov.sg/index.php/About-Us/>> [Accessed 19 September 2012].

²¹ DSO National Laboratories, 'Our Story', <http://www.dso.org.sg/dso_story.aspx> [Accessed 19 September 2012].

²² Ministry of Defence, Singapore, 'Future Systems Directorate'. <http://www.mindef.gov.sg/content/imindef/mindef_websites/atozlistings/fsd/scme.html> [Accessed 8 June 2012].

²³ Ministry of Defence, Singapore, 'About the Third Generation SAF', <http://www.mindef.gov.sg/imindef/mindef_websites/topics/3g/what.html> [Accessed 8 June 2012].

²⁴ J. Grevatt, 'Briefing: Singapore's Defence Industrial Capabilities', *Jane's Defence Industry*, 6 December 2011, <<http://www.janes.com/products/janes/defence-security-report.aspx?id=1065931887>> [Accessed 8 June 2012].

²⁵ Defence Research and Technology Office, Ministry of Defence, Singapore, 'About Us', <http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/drtech/About_Us.html> [Accessed 15 June 2012].

important role as the SAF has also increasingly outsourced their maintenance.²⁶

Singapore's defence industry evolved in response to the need for better strategic management and integration within the defence ecosystem and in the context of the evolving RMA. In 1990, Sheng-Li Holdings was restructured and renamed Singapore Technologies (ST) Holdings. In 1994, it came under the control of the state investment company, Temasek Holdings. Singapore's defence industry was also steered towards commercialisation and diversification into non-military areas, in order to develop commercial activities that could cross-subsidise the maintenance of facilities meant for military production and maintenance. Through mergers and acquisitions, Singapore Technologies Holdings grew tremendously, branching into areas as diverse as tourism, infrastructure development, electronics, property, financial services, telecommunications and transportation, and establishing businesses in a number of countries. The success of ST Holdings in doing so can be explained in the context of the rapid economic development of Singapore since independence in 1965. By 1997, defence-related activities made up only 20 per cent of the turnover of ST Holdings, with the bulk of its operations focused on a range of non-military commercial businesses. Defence-related companies were consolidated into a key conglomerate, ST Engineering, which today dominates Singapore's defence industry.²⁷

ST Engineering is a publicly-listed company (though the state-run Temasek Holdings holds a controlling stake of about 51 per cent), and is run as a global business, with a number of subsidiary companies. It operates in the United States, for instance, through VT (Vision Technologies) System, which is headquartered in Virginia. It also has several non-military businesses in China, in the areas of aerospace, electronics and land systems. The four major companies of ST Engineering which form the core of Singapore's defence industry today consist of ST Aerospace, ST Kinetics, ST Marine and ST Electronics. In total, ST Engineering employs almost 22 000 people worldwide.²⁸ The company has rapidly grown, with turnovers of S\$1.47 billion in 1997 and S\$1.66 billion in 1998 (the two years of the Asian financial crisis), with pre-tax profits of S\$202.4 million in 1997 and S\$249.2 million in 1998. These figures rose to turnovers of S\$5.05 billion in 2007 and S\$5.34 billion in 2008 (the year of the Global Financial Crisis), with pre-tax profits of S\$638.1 million in 2007 and S\$540.7 million in 2008 (the year of the Global Financial Crisis). In 2011, ST Engineering reported a turnover or revenue of

²⁶ R. Karniol, 'Industry Briefing—Singapore: Defence Ecosystem', *Janes Defence Weekly*, 15 February 2006. <http://www.dso.org.sg/data/JDW_Feb15_Defence_Ecosystem_210220061215.pdf> [Accessed 8 June 2012].

²⁷ Singapore Technologies, *Singapore Infopedia*.

²⁸ ST Engineering, 'Corporate Overview', <<http://www.stengg.com/about-us/corporate-overview>>; ST Engineering, 'Global Presence', <<http://www.stengg.com/about-us/global-presence>> [Accessed 13 June 2012].

S\$5.99 billion, and pre-tax profits of S\$655.2 million.²⁹ Although full details have never been divulged, the company has reportedly sold defence products to a number of countries, such as Indonesia, Chad, Nigeria, the Philippines, the United Arab Emirates and Brazil since 2000, generating US\$1.75 billion in defence sales in 2010 alone.³⁰ Significantly, 60 per cent of its turnover in 2010 is in non-defence sales, indicating not just the success of its non-military commercial ventures, but the strategy of diversification and the use of non-military revenues to sustain its core military competencies. This appears to be its key strategy in remaining viable in an era of immense competition in the global defence industry.³¹

Key Components of Singapore's Defence Industry

According to the International Institute for Strategic Studies (IISS), Singapore's defence industry, while narrowly focused on certain products and services, is nevertheless "globally competitive in quality and technology terms".³²

ST Aerospace is the jewel in the crown, as it is the world's largest commercial provider of aircraft maintenance, repair and overhaul (MRO) measured in airframe man-hours.³³ It has facilities in the United States, Europe and Asia, and employs 8 000 people worldwide. Its MRO capabilities for commercial narrow and wide-body aircraft are extensive, covering aircraft made by the world's leading aircraft manufacturers, such as Boeing, McDonnell Douglas and Airbus. It has also collaborated with China to develop the EC120 light civilian helicopter.³⁴

The company provides support and maintenance for various aircraft operated by Singapore's air force, such as the C130 Hercules transport aircraft, Fokker 50 maritime patrol aircraft, Super Puma helicopters and F5 Tiger combat aircraft.³⁵ The company also provides support for the air force's training aircraft stationed overseas, and has more recently been contracted by the air force to provide pilot training. In 2007, the company won a contract to upgrade the air force's fleet of ten C-130B Hercules transport aircraft, with the objective of extending its service life by another

²⁹ ST Engineering, Annual Report 2000, 2009 and 2011.

³⁰ 'Singapore Gains Toehold in World Arms Industry', *DefenceNews.com*, 18 March 2012, <<http://www.defensenews.com/article/20120318/DEFREG03/303180003/Singapore-Gains-Toehold-World-Arms-Industry>> [Accessed 13 June 2012].

³¹ SIPRI, 'The SIPRI Top 100 Arms Producing and Military Services Companies, 2010'.

³² International Institute for Strategic Studies, *The Military Balance 2009* (London: International Institute for Strategic Studies, 2009), p. 458.

³³ CAPA Centre for Aviation, 'Profile of ST Aerospace', <<http://www.centreforaviation.com/profiles/suppliers/st-aerospace>> [Accessed 12 June 2012].

³⁴ ST Aerospace, 'Corporate Profile', 22 March 2011, <http://www.staero.aero/downloads/uploadedfiles/ST_Aerospace_Corporate_Profile.pdf> [Accessed 12 June 2012].

³⁵ *Ibid.*

twenty years.³⁶ ST Aerospace has also been awarded work by other air forces. It upgraded F-5 Tiger combat aircraft for Turkey and Brazil, and supports the US Air Force's entire C-130 Hercules transport fleet in Asia.³⁷ In the first quarter of 2012, ST Aerospace announced that it had secured US\$540 million worth of contracts, mostly relating to MRO work.³⁸

The company does not manufacture aircraft. However, it has produced a range of unmanned aerial vehicles (UAVs) which provide tactical reconnaissance capabilities to land forces. The Fantail 5000 is a vertical take-off and landing (VTOL) UAV weighing just 6.5 kg. The Skyblade III weighs 5 kg and is launched by hand and has an endurance of more than an hour. The Skyblade IV weighs 50 kg and has an endurance of 12 hours.³⁹ In 2010, it was reported that the Singapore army had acquired a number of Skyblade III UAVs for its land forces.⁴⁰

The second major component of ST Engineering is ST Kinetics. It was formed in 2000 with the merger of ST Auto and Chartered Industries of Singapore. ST Kinetics supplies ordnance to the Singapore armed forces and customers abroad. They include a range of 40mm ammunition and weapons systems (such as the Low Velocity Air Bursting Munition System), infantry mortar bombs and 155mm artillery ammunition. It produces small calibre weapons, such as the CIS 50 machine gun, the SAR 21 assault rifle and the Ultimax 100 Light Machine Gun, as well as a series of automatic grenade launchers. ST Kinetics also produces the 120mm Super Rapid Advanced Mortar System, the FH2000 155mm 52 calibre field howitzer, the air-portable Pegasus 155mm 39 calibre lightweight howitzer and the Primus 155mm 39 calibre self-propelled howitzer. It also produces the Spider Light Strike Vehicle, the tracked Bionix Infantry Fighting Vehicle (IFV), the all-wheel Terrex IFV which is a urban warfare armoured personnel carrier, and the Bronco All Terrain Tracked Carrier (ATTC), which is a capable all-terrain armoured vehicle.⁴¹

ST Kinetics has sold a number of its products to other armed forces overseas although full details are rarely disclosed. However, Britain did

³⁶ ST Aerospace, 'ST Aerospace Redelivers First Modernized C130 Aircraft to RSAF', Media Release, 21 September 2010, <http://www.staero.aero/www/mediacentre_newsarticle.asp?newsid=OTAwMDAwMDE5Mg&yname=MjAxMA&arc=bm8> [Accessed 13 June 2012].

³⁷ Karniol, 'Industry Briefing – Singapore: Defence Ecosystem'.

³⁸ 'ST Engineering's Aerospace Secures \$540M Contract for Aircraft Maintenance from US DoD', *DefenseWorld.net*, 16 April 2012, <[http://defenseworld.net/go/defensenews.jsp?n=ST Engineering's Aerospace Secures \\$540M Contract for Aircraft Maintenance from US DoD &id=6842](http://defenseworld.net/go/defensenews.jsp?n=ST%20Engineering's%20Aerospace%20Secures%20$540M%20Contract%20for%20Aircraft%20Maintenance%20from%20US%20DoD&id=6842)> [Accessed 13 June 2012].

³⁹ ST Aerospace, 'Unmanned Aerial Vehicles', <<http://www.staero.aero/www/serviceofferings.asp#ODAwMDAxMA>> [Accessed 12 June 2012].

⁴⁰ 'Singapore Army to Equip Six Units with Mini-UAV', *Defence Talk*, 30 November 2010, <<http://www.defencetalk.com/singapore-army-to-equip-6-units-with-mini-uav-30334/>> [Accessed 12 June 2012].

⁴¹ ST Engineering, 'Products and Solutions: Listing by Product Category', <<http://www.stengg.com/products-solutions/listing-by-product-category>> [Accessed 13 June 2012].

procure 100 Broncos at a cost of £150 million for use in counter-insurgency in Afghanistan. Modified in Britain as the Warthog, deliveries began in 2009.⁴² In early 2012, it was reported that ST Kinetics had secured an order to supply its 120mm Super Rapid Advanced Mortar Systems to “an overseas customer” in a contract worth US\$46 million.⁴³ In recent years, ST Kinetics has also reportedly sold 40mm weapon and ammunition systems to Britain, Sweden, Finland and Brazil.⁴⁴

Like ST Aerospace, ST Kinetics has also made a serious effort at diversification into commercial non-military sectors. Apart from military products and services, it makes construction equipment such as earthmovers, dump trucks, road construction equipment, trucks and trailers, which is marketed in the United States and other countries. It also provides automotive support services to a range of commercial enterprises in Singapore.⁴⁵

The third major component of ST Engineering is ST Marine. Formerly known as Singapore Shipbuilding and Engineering, the company has expanded and diversified beyond the building of naval vessels. It has developed significant capabilities in ship repair, overhaul, conversion and construction in various types of vessels. Today, it is a builder of various types of commercial vessels, such as tankers, container vessels and especially Offshore Support Vessels (OSVs) for the offshore oil and gas industry, for which it has won recent lucrative orders.⁴⁶ For instance, its US subsidiary, VT Halter Marine, was awarded a contract in 2011 worth S\$441 million to build eight OSVs for Hornbeck Offshore Services.⁴⁷

Nonetheless, it has continued to build naval vessels for both the Singapore navy and other navies. In 1997-2000, it built a fleet of four Endurance-class amphibious warfare ships for the Singapore navy. Although officially classed as Landing Ship Tanks (LSTs), these ships have well-docks to offload troops and equipment as well as a helicopter deck which could operate a heavy

⁴² 'From Bronco to Warthog', *Defense Update*, 19 December 2008, <http://defense-update.com/products/b/bronco_191208.html> [Accessed 14 November 2010].

⁴³ 'Unidentified Country Orders 120mm Mortars', *UPI.com*, 20 February 2012, <http://www.upi.com/Business_News/Security-Industry/2012/02/20/Unidentified-country-orders-120mm-mortars/UPI-13431329752452/> [Accessed 13 June 2012].

⁴⁴ 'Briefing: Singapore's Defence Industrial Capabilities', *Jane's Defence Industry*, 6 December 2011, <<http://www.janes.com/products/janes/defence-security-report.aspx?id=1065931887>> [Accessed 13 June 2012].

⁴⁵ ST Engineering, 'ST Kinetics: Products and Solutions', <<http://www.stengg.com/our-business/land-systems/products-solutions>> [Accessed 13 June 2012].

⁴⁶ 'ST Marine to Grow Offshore', *The Edge Financial Daily*, 2 February 2012, <<http://www.theedgemaalaysia.com/in-the-financial-daily/200319-st-marine-to-grow-offshore-sector.html>> [Accessed 13 June 2012].

⁴⁷ ST Engineering, 'Milestones, 2011', <<http://www.stengg.com/about-us/milestones>> [Accessed 13 June 2012].

Chinook helicopter, and are thus in reality Landing Platform Docks (LPDs).⁴⁸ More recently, it built under license the last five of an order of six Formidable-class frigates for the Singapore navy, which are a version of the stealthy Lafayette-class frigate designed by the French defence company, DCNS.⁴⁹ It also carried out a recent upgrade of the navy's Victory-class corvettes, which was unveiled in 2012.⁵⁰ The company also provides support services for the Singapore navy. This has included the building and operation of a submarine support and rescue ship to support the Singapore navy's submarine arm, and which unusually has been outsourced to ST Marine under a twenty-year contract.⁵¹

ST Marine continues to win overseas naval orders. In 2008, Thailand awarded the company a contract to build an Endurance-class LPD for its navy, in a contract worth US\$134 million.⁵² In 2012, it was reported that the company had won a contract worth S\$880m to build four Fearless-class patrol vessels and provide logistical support for Oman's navy.⁵³ In 2010, the company unveiled the design of a large 14 500 tonne helicopter support ship, known as "Endurance 160", which could be a future requirement for the Singapore navy. The vessel is a derivative of the Endurance-class LPD but is much larger, resembles a small aircraft carrier with a full-length flight deck, and has hangar facilities to accommodate aircraft such as helicopters. It also has a well-dock and can therefore launch landing craft. The ship would carry 140 crew plus 150 flight crew, as well as more than 400 troops. The design is similar to the Italian navy's San Giorgio-class and the South Korean navy's Dokdo helicopter assault ships.⁵⁴

The fourth major component of ST Engineering is ST Electronics, which plays an important role in sustaining Singapore's electronic warfare capabilities, which are the most advanced in Southeast Asia, and its communications and signals intelligence capabilities, which are some of the

⁴⁸ 'Endurance Class Landing Ship Tank (LST), Singapore', *Military-Technology.com*, <<http://www.naval-technology.com/projects/endurance-class-landing-ship-tank-lst/>> [Accessed 13 June 2012].

⁴⁹ 'DCNS Delivers Sixth and Last Formidable-class Frigate to the Singapore Navy', *PRWeb*, 29 August 2008, <<http://www.prweb.com/releases/2008/08/prweb1259124.htm>> [Accessed 13 June 2012].

⁵⁰ Ministry of Defence, Singapore, 'Upgraded Missile Corvettes', Factsheet, <http://www.mindef.gov.sg/imindef/news_and_events/nr/2012/may/15may12_nr/15may12_fs2.html> [Accessed 13 June 2012].

⁵¹ 'ST Marine Launches RSN Submarine Support and Rescue Ship', *Cyberpioneer*, 9 December 2008, <http://www.mindef.gov.sg/imindef/publications/cyberpioneer/news/2008/December/09dec08_news.html> [Accessed 13 June 2012].

⁵² 'Endurance Class Landing Ship Tank (LST), Singapore', *Military-Technology.com*.

⁵³ 'ST Engineering Awarded S\$880M Contract for Vessels from Oman', *DefenseWorld.net*, 10 April 2012, <[http://defenseworld.net/go/defensenews.jsp?n=ST Engineering's Awarded S\\$880M Contract for Vessels from Oman&id=6822](http://defenseworld.net/go/defensenews.jsp?n=ST+Engineering's+Awarded+S$880M+Contract+for+Vessels+from+Oman&id=6822)> [Accessed 13 June 2012].

⁵⁴ 'ST Marine Showcases Amphibious Ships at IMDEX 2011', *Warship Technology*, July/August 2011, p. 31.

most advanced in the world.⁵⁵ Its strengths, in integrated communications systems, mobile command-and-control systems, next-generation simulators and combat system integration, give it an important role in Singapore's evolving RMA, particularly its objectives of a network-centric and network-enabled 3G SAF.⁵⁶ Like other ST Engineering subsidiary companies, it has expanded into non-defence commercial applications, such as wired and wireless communication solutions, rail and traffic management systems, real-time C4I (command, control, communication, computing and intelligence) civilian solutions, modelling and training simulation, intelligent building management systems and homeland security solutions. The company employs 5,000 people worldwide.⁵⁷ It has also developed a particular strength in satellite communications, being a leading global manufacturer of Very Small Aperture Terminal (VSAT) products. In 2006, it controlled two-thirds of the world's VSAT market.⁵⁸

Key Factors For Growth

Although it has diverse non-military businesses, ST Engineering is still dependent on the SAF for much of its core military business. Despite sales of weapons systems and munitions abroad, harsh competition and autarky are realities in the global arms market. Full details are never divulged regarding its arms contracts with the SAF or of its overseas arms sales. However, according to the SIPRI Arms Transfers Database, arms exports from Singapore from 1990 to 2011 totalled US\$493 million (measured in constant 1990 prices). During the same period, Singapore imported US\$11.26 billion (in constant 1990 prices) of arms from abroad.⁵⁹ This not only shows that Singapore remains dependent on overseas sources for its arms, but also suggests that much of ST Engineering's range of defence products are, despite modest sales abroad, in fact mostly sold to the SAF. Singapore's defence industry has, however, benefitted from the priority given to defence and the sustained high defence expenditures since Singapore's independence in 1965. Defence spending in Singapore has been kept at relatively high levels since, underpinned by the sustained high economic growth which has resulted in the transformation of Singapore into a developed economy. This economic growth has given Singapore the resources to fund its defence, and enabled it to insulate defence from economic downturns and recessions. According to SIPRI, defence spending (in constant 2009 prices and exchange rates) was US\$6.96 billion in 2006,

⁵⁵ T. Huxley, 'Singapore and the Revolution in Military Affairs', in E. O. Goldman and T. G. Mahnken (eds.), *The Information Revolution in Military Affairs in Asia* (New York: Palgrave Macmillan, 2004), p. 198.

⁵⁶ R. Karniol, 'Industry Briefing—Singapore: Defence Ecosystem', *Janes Defence Weekly*, 15 February 2006.

⁵⁷ ST Electronics. 'Our Company—About Us', <<http://www.stee.com.sg/ourcompany/aboutus.html>> [Accessed 13 June 2012].

⁵⁸ Karniol, 'Industry Briefing —Singapore: Defence Ecosystem'.

⁵⁹ SIPRI, SIPRI Arms Transfers Database, <<http://www.sipri.org/databases/armstransfers>> [Accessed 19 September 2012].

US\$7.23 billion in 2007, US\$7.29 billion in 2008, US\$7.74 billion in 2009, and US\$7.76 billion in 2010. In comparison, much larger countries such as Thailand and Indonesia spent about US\$4.3 billion and US\$6 billion respectively on defence in 2010.⁶⁰ In 2012, Singapore's defence budget was S\$12.28 billion (about US\$9.7 billion), which constituted 24.4 per cent and the largest single item of the government's total budget for 2012.⁶¹

Another key factor has also been Singapore's perceptions of the strategic benefits of basic defence self-reliance. This self-reliant capability included the evaluation and modification of weapons systems for use, the integration of systems into a variety of air, sea and land platforms, the maintenance of weapons systems and platforms throughout their life-cycle, and the production of basic ordnance and weapons systems to equip the armed forces, such as infantry weapons, ammunition, artillery, armour, electronic warfare and communications equipment.

Ensuring basic defence self-reliance was and continues to be perceived to be of strategic necessity given the potentially unstable regional geopolitical environment. After all, Singapore's independence had occurred under unpropitious circumstances, as it was expelled from the Malaysian Federation amidst political and racial tensions in 1965. Singapore's acute sense of vulnerability was enhanced by its lack of strategic depth and small size, as well as being surrounded by much larger, potentially hostile neighbours.⁶² While Singapore could not achieve self-sufficiency across a range of weapons systems and platforms, limited self-reliance gave it greater flexibility, particularly in the sourcing or procurement of arms. Singapore has focused, for instance, on retrofitting and upgrading capabilities which include the integration of systems in existing platforms to either extend their service or to upgrade their combat performance. It has also developed its own ammunition base, and has developed its own range of small arms, artillery and armour. It has particular strengths in defence electronics and communications, leveraging off its highly-trained and technologically advanced work force. This strategic imperative of achieving some basic self-sufficiency coincided with concerns throughout the region regarding the US military commitment to the region, one which its allies had perceived to have kept the peace and underpinned regional stability throughout the Cold War. These concerns emerged in the aftermath of the US defeat in Vietnam in 1975, and resurfaced after the end of the Cold War in 1989.⁶³

⁶⁰ SIPRI, *SIPRI Yearbook 2011* (Stockholm: Stockholm International Peace Research Institute, 2011), pp. 208-9.

⁶¹ 'Singapore Gains Toehold in World Arms Industry', *Defense News*, 18 March 2012, <<http://www.defensenews.com/article/20120318/DEFREG03/303180003/Singapore-Gains-Toehold-World-Arms-Industry>> [Accessed 16 June 2012].

⁶² A. T. H. Tan, *Security Perspectives of the Malay Archipelago* (Cheltenham: Edward Elgar, 2004), p. 42.

⁶³ Yahuda, *The International Politics of the Asia-Pacific, 1945-1995*, p. 144.

An advantage of basic defence self-sufficiency is also its cost-effectiveness. For instance, the ability to refurbish and upgrade old equipment, epitomised by the refurbishment which resulted in the A-4SU Super Skyhawk combat aircraft in 1988, and the current refurbishment of C130B Hercules transport aircraft to extend their service life for another twenty years, are examples of self-reliant and cost-effective solutions in the face of increasingly expensive weapons systems and platforms.⁶⁴

The development of Singapore's defence industry has also benefitted from the presence of long-term strategic defence planning. This has been made possible by the political dominance of the ruling People's Action Party, which has been in power since 1959. In turn, this political domination has made possible an integrated and sustained approach to defence planning, epitomised by the concept of the "defence ecosystem". Although this concept was articulated much later in around 2003 in the context of Singapore's enthusiastic embrace of the RMA, the close integration between defence planners in the Ministry of Defence, defence scientists in the various research and development agencies, and the defence industry, was established at the founding of the SAF in the 1960s.

The close linkages between the SAF and the defence industry have been established by the cross-over of senior military officers upon their retirement or end of their military contracts. While this is not unusual in other countries, such as in the United States and Israel, the Singapore case is unique in that this is a conscious policy cultivated by the ruling party to ensure that the SAF is able to share its highly-trained manpower resources with the rest of society, such as in private industry, the public sector and in political leadership. This is achieved through generous SAF Scholarships (including the payment of a salary whilst on study leave) to attract the best and brightest to join the SAF. These are trained in the best universities in the world, including Cambridge and the Ivy League universities in the United States, where they obtain degrees in engineering and science.⁶⁵ Upon returning, the scholars are nurtured into senior military leadership in the SAF. Surprisingly, many senior officers are retired early. Until it was raised to fifty years of age in 2010, commissioned officers retired at 45 years of age.⁶⁶ However, a number of them then join the defence industry, ensuring that strong linkages with the SAF have been built up over the years. Indeed,

⁶⁴ Ministry of Defence, Singapore, 'The A-4SU Super Skyhawk'. See also ST Aerospace, 'ST Aerospace Redelivers First Modernized C130 Aircraft to RSAF'.

⁶⁵ Ministry of Defence, Singapore, 'SAF Overseas Scholarships', <<http://www.mindef.gov.sg/content/imindef/careers/scholarships/scholarships/SAFOS.html>> [Accessed 14 June 2012].

⁶⁶ 'SAF Regulars in High Demand After Retiring from Military', *Asiaone News*, 27 December 2011, <<http://www.asiaone.com/News/Latest+News/Singapore/Story/A1Story20111227-318436.html>> [Accessed 14 June 2012].

military officers have played a dominant role in the growth of Singapore Technologies Holdings.⁶⁷

The SAF has also built up a strong relationship with the defence research and development sector, where a number of SAF officers, themselves trained as engineers or in the various science disciplines, have also served.⁶⁸ As described earlier, this is coordinated through its Defence Research and Technology Office, which was established by the Ministry of Defence in 2006 as the lead agency in defence research and technology. The close relationships and linkages within the defence ecosystem have led to the smooth synergy in translating the operational demands of the SAF into actual capabilities. While the ecosystem concept is rational and promotes efficiency, an obvious danger is the lack of robust debate over defence policy choices and the promotion of groupthink. Crucially, the defence ecosystem is underpinned by the technical expertise of SAF officers and defence scientists who are often themselves trained as officers while serving compulsory national service conscription. As Brigadier-General Lee Hsien Loong (now Prime Minister) noted in 1989, the SAF

sought people who would know how to evaluate and buy the right equipment and weapons, and then modify, develop and upgrade them to suit the SAF's special requirements and tactics ... such people add value to our purchases and make every defence dollar spent on hardware count.⁶⁹

Technically-competent military leadership and defence scientists throughout Singapore's defence ecosystem do not necessarily mean that the best or wisest decisions will be made, but the development of Singapore's defence industry can at least be partly attributed to its presence.

The government of Singapore has disavowed any direct subsidy to support its defence industries. An early key objective is that Singapore's defence industries should eventually be viable economic entities and not end up requiring massive state subsidies to stay afloat.⁷⁰ This has been a long-standing policy of the government, as expressed in the Singapore Defence Industries charter in 1987, which makes clear that beyond contributing to defence, defence industries are required to undergo commercialisation and diversification in order to maintain their capabilities and economic viability.⁷¹

⁶⁷ T. Huxley, *The Political Role of the Singapore Armed Forces' Officer Corps: Towards a Military-Administrative State?*, Working Paper No. 279 (Canberra: Strategic and Defence Studies Centre, Australian National University, December 1993), pp. 10-11.

⁶⁸ *Ibid.*, p. 11.

⁶⁹ As cited in C. Manohara, 'Defence Procurement and Industry Policy—A Singapore Perspective', *Defence and Peace Economics*, vol. 9 (1998), p. 129.

⁷⁰ Yong Mun Cheong, 'The Military and Development in Singapore', in J. Soedjati Djihadwondo and Yong Mun Cheong (eds.), *Soldiers and Stability in Southeast Asia* (Singapore: Institute of Southeast Asian Studies, 1988), p. 282.

⁷¹ A. Chua, 'Singapore Technologies', *Singapore Infopedia*, <http://infopedia.nl.sg/articles/SIP_1042_2011-03-29.html> [Accessed 19 September 2012].

As Brigadier-General Lee Hsien Loong, the then Minister of Trade and Industry (now Prime Minister) stated in 1988,

we have to run the defence industry highly efficiently, almost ruthlessly ... it means we must use the capacity we have to do even non-defence business.⁷²

This reflected the apprehension that defence industries could become a huge economic liability, consuming scarce economic resources particularly at a time when Singapore was focused on sustaining its rapid economic development. Thus Goh Keng Swee, Singapore's defence minister in the 1960s and 1970s, set up Singapore Mint in the same complex as Chartered Industries of Singapore, as the same workshops were able to make both the small ammunition for the SAF as well as the country's coins. The idea that the defence industry should serve both military and civilian commercial sectors was firmly established from the beginning.⁷³

The focus on dual military-civilian competencies in the defence industry has fortuitously paid handsome dividends. The early establishment of capabilities in the maintenance, repair and overhaul (MRO) of military aircraft was aimed initially at servicing the needs of the air force as it built up its capabilities. However, the predecessor of ST Aerospace, Singapore Aircraft Industries, was able to find work in the 1980s, initially in the servicing of US Air Force C130 Hercules transport aircraft, and also the fast-growing number of civilian helicopters in Southeast Asia, the latter described as a "gold-mine" by an analyst writing in 1988.⁷⁴ The general economic development of Southeast Asia, and the growth in commercial aviation have benefitted ST Aerospace, which had sought from the start to capitalise on its dual-use capabilities. Today, its core competencies in MRO have led to ST Aerospace becoming the largest MRO provider in the world, measured in airframe man-hours. The company is certified to maintain and refurbish a range of Boeing, McDonnell Douglas and Airbus commercial aircraft and employs 8 000 people worldwide.⁷⁵

Similarly, ST Marine has also benefitted from its dual-use capabilities in an era of growth in the maritime industry. Globalisation has meant an increased reliance on seaborne trade, and the demand for energy resources has led to greater exploration and exploitation of offshore oil and gas fields. Singapore's strategic maritime location, along the busiest waterway in the world, namely, the Straits of Malacca, has also aided the development of its commercial shipbuilding and repair industry. In this context, ST Marine's

⁷² Yong Mun Cheong, 'The Military and Development in Singapore', p. 287.

⁷³ 'Goodbye Goh Keng Swee, 1918-2010', *Petir*, Special Issue, May/June 2010, pp. 25-6, <http://www.pap.org.sg/uploads/ap/6738/documents/petir_goh_keng_swee_may_june_2010.pdf> [Accessed 15 June 2012].

⁷⁴ Yong Mun Cheong, 'The Military and Development in Singapore', pp. 281-2.

⁷⁵ CAPA Centre for Aviation, 'Profile of ST Aerospace'.

capabilities in military maintenance, repair, overhaul and construction have proven useful in the repair, overhaul, conversion and construction of a range of commercial shipping vessels, such as containers, tankers and Offshore Support Vessels (OSVs), the latter becoming a very lucrative business as it has won several large contracts in recent years.

ST Kinetics has had a similar trajectory. For instance, its automotive services capabilities were initially focused on the repair, maintenance and overhaul of tanks and armoured personnel carriers. This has since expanded into civilian businesses, such as automotive support services for commercial enterprises, and construction equipment, including earthmovers, dump trucks, road construction equipment, trucks and trailers. Overall, the success of ST Engineering's non-military commercial businesses is reflected in the fact that 60 per cent of its turnover in 2010 is in non-military products and services.⁷⁶ This subsidises its military production and maintenance infrastructure, and enables the defence industry to survive.

Problems and Prospects

The partial globalisation of the global arms industry mentioned at the beginning of this article has meant that it is not yet a level playing field for everyone. The continued desire for defence self-reliance has meant that autarky remains a feature of the global arms industry. However, while emerging great powers such as India and China, and an established economic power such as Japan, can generously support their defence industries, smaller second-tier arms producers with much less state resources have had to face a complex and very competitive global arms market. These smaller producers cannot merely rely on their domestic arms market alone as these markets are too small to support a broad range of defence products. To survive, they have to develop niche products and attempt to market these globally, and, in the Singapore case, expand the non-defence civilian businesses of its defence industries to sustain its defence-related capabilities.

The somewhat protected markets in larger countries, however, have proven to be a significant protectionist barrier. For instance, the United States arms market, the largest in the world, remains heavily protected and resistant to external participation. It has thus proven difficult for external non-US defence companies to bid for US defence contracts, with the exception of some British firms.⁷⁷ At the same time, US defence firms continue to dominate the global market in arms, although this has been challenged in recent times by cheaper, relatively sophisticated weapons systems from Europe, Russia, China and smaller arms producers such as Israel. Some

⁷⁶ SIPRI, 'The SIPRI Top 100 Arms Producing and Military Services Companies, 2010'.

⁷⁷ R. Bitzinger, *The Defence Industry in the Post-Transformational World: Implications for the United States and Singapore*, Working Paper No. 150 (Singapore: S. Rajaratnam School of International Studies, Nanyang Technological University, 12 February 2008), p. 16.

smaller arms producers, such as Australia, have resolved the issue of survivability by allowing their domestic arms industry to be taken over by foreign interests. Thus, the three Australian defence firms which rank amongst the world's top 100 arms producers are subsidiaries of BAE Systems (Britain), Thales (France) and Raytheon (United States).⁷⁸ However, this would be inconceivable for states with a high perception of external threat, such as Israel and Singapore, which feel that they must preserve autonomous basic defence self-reliance given their much more vulnerable and potentially uncertain geostrategic circumstances.

Singapore's stated objective of not providing massive direct state subsidies to its arms industry has led to public stock offerings and diversification into non-military commercial sectors utilising dual-use civil-military technology. This, however, has meant that ST Engineering cannot focus primarily on the Singapore defence market but must compete externally in both the defence and particularly the non-defence commercial sectors to grow and to survive. It has thus expanded its global footprint, with acquisitions of various companies overseas as it attempts to find niche areas and open up foreign markets. However, the question must be how Singapore's defence industry can remain focused on its core primary mission, which is the servicing of Singapore's basic defence needs, when it has to develop such a wide range of non-military commercial interests, products and services. Given its range of commercial businesses, is ST Engineering a defence company with substantial commercial operations, or is it a commercial enterprise with interests in defence products and services? Will it, in the long-run, be able to do both well? In deploying its limited resources, which has priority, military needs or commercial concerns?

Another key issue is whether there are in fact forms of state support and subsidy, which could represent a not insignificant drain on resources for such a small city-state. While the Singapore Government has rejected any direct state subsidy in support of its defence industries, indirect forms of subsidy could be inferred from the close defence industry linkages with the state-supported defence research and development sector. In addition, high defence spending and the procurement of local defence products by the SAF could be regarded as indirect forms of subsidy. Moreover, much of the product of Singapore's defence industry is in fact sold to the SAF, and most of them would not be viable without SAF contracts. These are however, not unusual as they are normal practices for many countries, including the United States and Israel.

The more intriguing question is whether the government might intervene should there be, for instance, a global recession or economic downturn affecting its various businesses. After all, commercialising its operations and relying heavily on non-defence businesses is accompanied by heightened

⁷⁸ SIPRI, 'The SIPRI Top 100 Arms Producing and Military Services Companies, 2010'.

business risk inherent in any form of commercial enterprise. The various arms of ST Engineering are therefore not immune to long-run business risk. However, as a state-dominated enterprise with strategic core competencies required for defence, it would not be unreasonable to expect the state to step in if contingencies required it to do so, in order to preserve those core defence competencies. This however, leads to the problem known in economics parlance as the moral hazard, where a business or an institution might take greater risks than is necessary given the knowledge that it would not be held accountable or allowed to fail, or conversely, fail to make the necessary effort to compete effectively knowing that it would ultimately be sustained. The evidence thus far in fact suggests that the various arms of Singapore's defence industry have been competently managed and have been able to expand globally into new markets without suffering undue risks or losses. However, this cannot be taken for granted in the long-term.

Another problem relates to the fact that the closely integrated defence ecosystem relies on well-trained manpower through the SAF. The question, however, is whether Singapore's defence ecosystem can continue to attract top-rate local defence scientists and technologically-trained military officers in sufficient numbers to sustain it at a time when there is much greater competition for scarce top-level talent in a globalising world economy. Moreover, the imperative for the defence industry to diversify into non-defence sectors has put a premium on globally competitive commercial skills, which the military officers and defence scientists who permeate its defence ecosystem, including its defence industries, may not possess in abundance.

Ranged against these actual and potential problems are some obvious prospects. The continued commitment to fund defence, in the context of Singapore's sustained economic growth, means that there will be a growing local market for defence products and services. This also means that some form of local defence industry will ultimately be sustained. Moreover, the SAF is committed to finding cost-savings in the face of the rising cost of modern weapons systems, through the refurbishment and upgrading of weapons systems. These are precisely the strengths of Singapore's defence industry. The SAF's drive towards efficiency, through the outsourcing of logistics, training and non-sensitive military support functions have also led to further business opportunities for ST Engineering's various subsidiaries. Thus, ST Aerospace provides pilot training for the air force, while ST Marine has built and maintains the navy's submarine rescue and support vessel.

The future prospects lie in remaining nimble and exploiting commercial opportunities wherever possible. The globalising world economy has opened up just such opportunities, and Singapore's defence industry is a player just like any other in the non-defence commercial sector. In doing so, it can leverage off the competent dual-use research and development

capabilities that Singapore possesses. Through mergers and acquisitions, it has also been able to establish operations in new markets overseas. A good example of this is ST Engineering's acquisition in 2002, through its US subsidiary, VT Systems, of Halter Marine, which has helped the company develop its OSV commercial shipbuilding business in the lucrative oil and gas industry in the United States.

The key challenge is sustaining its defence businesses in the face of a limited local market and the difficulty in penetrating the protected arms markets of other countries, such as the United States, the world's largest arms market. Even with collaborative ventures with US firms, foreign firms will still have to contend with US export and technology transfer restrictions and the resistance in opening up the US defence industry to foreign contractors. As Bitzinger noted, the licensing of the production of foreign-designed armaments will continue to be an uphill battle in the United States, given the US military's traditional reluctance to embrace "not-invented-here" products.⁷⁹

Nonetheless, the Singapore defence industry's prospects in the United States will improve in tandem with Singapore's growing strategic relationship with it. Singapore is one of the United States' key allies in Asia and has been assiduously courted by the United States on account of its strategic location in the environs of the strategic Straits of Malacca, the most important waterway in the world, and its importance as a local ally in the war against global terrorism in a part of the world where Al Qaeda-linked groups operate amongst the world's largest population of Muslims. Singapore is also an important regional ally in the emerging strategic rivalry between the United States and China. Indeed, in tandem with its military pivot towards Asia, the Obama administration announced in 2011 that it would station its latest Littoral Combat Ships in Singapore.⁸⁰ These open up possibilities of improved defence cooperation, possibly leading to greater inroads by Singapore's defence industry into the lucrative US market.

Indeed, *Forbes* reported in 2007 that ST Engineering's subsidiary in the United States, VT Systems, was doing well, with its business deals there surviving scrutiny from federal regulators, namely the Committee on Foreign Investment in the United States. *Forbes* concluded that its prospects are good provided it does not acquire companies or bid for contracts which involve too much classified information.⁸¹ *Forbes* also noted that VT Systems, led by retired US general, John Coburn, who formerly headed the

⁷⁹ Bitzinger, 'The Defence Industry in the Post-Transformational World', pp. 15-6.

⁸⁰ 'US Expects to Base Ships in Singapore', *DefenceNews.com*, 17 December 2011, <<http://www.defensenews.com/article/20111217/DEFSECT03/112170306/U-S-Navy-Expects-to-Base-Ships-in-Singapore>> [Accessed 16 June 2012].

⁸¹ 'Singapore Defence Firm Thrives in U.S.', *Forbes*, 29 March 2007, <http://www.forbes.com/2007/03/29/singapore-beltway-defense-biz-washington-07forbes2000-cz_atg_0329beltway.html> [Accessed 16 June 2012].

US Army Material Command, had grown from a turnover of US\$61 million in 2001 to US\$1 billion in 2008.⁸²

An obvious way forward for Singapore's defence industry is also to engage in collaborative research, development and production ventures over new weapons systems with foreign defence firms. These will lessen the risks in research and development, gain access to new defence technology, and also share production costs. A recent example was the development of the Matador, a portable anti-tank weapon which replaced the previous Armbrust employed by the SAF's ground forces. The Matador was developed in collaboration with the German firm, Dynamic Nobel.⁸³ Another example is the collaboration between ST Kinetics with the private Australian defence firm, Metal Storm, in the development of the latter's patented 40mm rapid fire munitions.⁸⁴ French and Israeli press have also speculated that the new Iron Dome system in Israel designed to intercept short-range missiles and rockets was developed with funding from Singapore, primarily to fit Singapore's defence needs.⁸⁵ There has also been speculation that Sweden has considered Singapore (together with Norway and Poland) over collaboration on the new A26 submarine, which will be Sweden's next-generation submarine.⁸⁶

In doing so, Singapore's defence industry is also attempting to pick winners in the search for niche defence areas. Thus, while ST Aerospace might not have the capacity to actually design and build new fifth generation combat aircraft, which is the preserve of only the largest states in the world, it is developing UAVs, which have great future potential, given the expected eventual demise of manned combat aircraft. While its UAV products are currently basic, there have been reports of much greater ambition. For instance, it has reportedly been developing a range of more sophisticated UAVs, including a battle management LALEE (Low-Altitude Long Enduring Endurance) drone the size of a Boeing 737.⁸⁷

⁸² Vision Technologies Systems, Ministry of Defence, Singapore, 'John G. Coburn, Chairman and CEO', <http://vt-systems.com/vts/dsp_vts_contact.cfm?vts_contact=6&type=1> [Accessed 16 June 2012].

⁸³ Ministry of Defence, Singapore 'The Matador', <<http://www.mindef.gov.sg/weapons/matador/>> [Accessed 17 June 2012].

⁸⁴ 'Metal Storm Sets Weapons Commercialisation Path with ST Kinetics', *Defence Talk*, 25 February 2008, <<http://www.defencetalk.com/metal-storm-sets-weapons-commercialisation-path-with-st-kinetics-14881/>> [Accessed 16 June 2012].

⁸⁵ 'Was Iron Dome Defense System Actually Built for Singapore?', *Haaretz*, 25 March 2010, <<http://www.haaretz.com/print-edition/features/was-iron-dome-defense-system-actually-built-for-singapore-1.266629>> [Accessed 17 June 2012].

⁸⁶ 'A26 Nasta Generation Ubat (NGU), Sweden, Submarines—Submarines and Submersible Designs', *Jane's Underwater Warfare Systems*, 7 September 2011. <<http://articles.janes.com/articles/Janes-Underwater-Warfare-Systems/A-26-Nasta-Generation-Ubat-NGU-Sweden.html>> [Accessed 17 June 2012].

⁸⁷ Huxley, 'Singapore and the Revolution in Military Affairs', p. 193.

Conclusions

Singapore's defence industry could be said to be relatively successful, in the sense that it has survived despite Singapore's small size and in the face of a complex and very competitive global arms market. It has also been able, thus far, to fulfil its primary core mission, which is to service Singapore's defence needs and enable Singapore to achieve a measure of basic defence self-reliance.

While Singapore is not able to achieve self-sufficiency across a range of weapons systems and platforms, limited self-reliance has provided it with greater flexibility, particularly in the sourcing or procurement of arms. Capabilities in refurbishing old equipment mean that it would always be able to deploy basic land, air and naval warfare platforms. Coupled with the ability to produce a range of ordnance and small arms, this means that even without a great power patron or access to advanced technology, Singapore has the capacity to ensure its own basic defence. Ensuring basic defence self-reliance is seen as an imperative on account of the potentially unstable regional geopolitical environment. As noted at the beginning of this essay, Singapore has had a sometimes tense relationship with its much larger Muslim neighbours, which have, from time to time, displayed hostility towards it. Despite Singapore's very close alliance-like relationship with the United States, and its membership in the Five Power Defence Arrangements, it cannot be guaranteed that its great power allies would intervene to defend it from external threats.

The growth and development of Singapore's defence industry is the product of a mix of factors, including sustained high economic growth, relatively high defence spending, the presence of long-term strategic planning, the political dominance and longevity of the ruling party, the seamlessly integrated defence ecosystem, the technical expertise of SAF officers and the dual military-civilian competencies which have underpinned the success of its various non-defence commercial enterprises.

However, the relative success of Singapore's defence industry could well be unique, being a product of exceptional circumstances stemming from its contentious independence amidst heightened tensions, the impetus provided by its strong perception of a potentially unstable regional environment, and the opportunities afforded by the region's economic growth. Nonetheless, there could still be lessons that could be learnt by other small states. Singapore's case proves that it is indeed possible for small states to achieve basic defence self-sufficiency, provided the objectives are modest and realistic to begin with. The production of basic ordnance, such as ammunition and artillery shells, as well as small arms, are well within the capacity of a number of small states, while the capacity to maintain, repair and overhaul armoured vehicles, patrol vessels and combat aircraft and helicopters do not require massive investment by the state.

In particular, the ability to refurbish old equipment, improvise and adapt weapons systems from a variety of sources for use, and maintain weapons systems and platforms for operational use, provides strategic and military benefits. They include greater flexibility in terms of sources of weapons systems, greater freedom in the use of one's military forces, and the reduction of dependence on external powers, which could use defence reliance on them to exercise various forms of influence, such as the veto on the use of military power by the smaller state. Basic defence self-reliance is also a form of insurance, as it cannot be guaranteed that a great power ally would intervene to defend a small state in a crisis. In addition, basic defence self-reliance also sends a deterrent message to would-be aggressors that the small state involved has some independent capacity to make any attack against it a somewhat costly venture.

In addition, an integrated defence ecosystem with close collaboration between the armed forces, defence research and development, and defence industry, could contribute to rational and cost-effective solutions to a country's defence needs, since this should lead to more optimal and economic outcomes. In turn, this rests on the technical and technological capabilities of military officers and defence scientists, which a state must invest heavily in. From the Singapore experience, it also seems that despite indirect forms of subsidy such as a more or less guaranteed domestic market for its products, and funding for research and development, a defence industry's survival also requires it to be corporatised and run as commercial operations, in order to promote efficiency and supplement earnings to support a defence industrial base. This invariably means that there is the need to develop a range of non-defence commercial businesses. However, this leads to exposure to business risks and to the vagaries of the global market.

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