THE GLOBAL ARMS INDUSTRY IN 2030 (AND BEYOND)

Event Report

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Nanyang Technological University
S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES

Event Report

THE GLOBAL ARMS INDUSTRY IN 2030 (AND BEYOND)

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Military Transformations Programme,
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INTRODUCTION

The global arms industry is a dynamic phenomenon, a constantly moving target. It expands and contracts, it has phases of growth and prosperity and phases of crisis and decline, both on a historical and on a regional basis, and often the two are not in sync with each other. This makes sweeping generalisations about the current and future likely state of the global arms industry—and about the process of global armaments production in general—difficult. The 1990s were a period of relative downturn and contraction, while the first decade of the 21st century appeared to be one of stabilisation and growth. The question today is, will the global arms industry over the next 15 years resemble more the 1990s or the 2000s, or will it be something totally different? Will the expansion continue or is a contraction sure to follow, given the highly cyclical nature of this particular business sector? And in any event, bust or boom, how will the global arms industry evolve and transform, in terms of size, structure, ownership, etc.? How will such influences as dual-use technologies, globalisation, cyber, and the possible emergence of new major players affect the global arms industry?

With these thoughts in mind, the Military Transformations Programme within the Institute of Defence and Strategic Studies at the S. Rajaratnam School of International Studies hosted a one-day workshop on “The Global Arms Industry in 2030 (and Beyond),” held on 10 November 2014, in Singapore. The workshop brought together a diverse collection of expert analysts from Asia, North America, Europe and Australia to address the potential effects of various macro-economic and geopolitical drivers affecting the global arms industry out to 2030 and beyond, and to also explore how national defence industrial bases might—or might not—change over the course of the next 15 years or so.

The workshop was divided into two broad areas of exploration and discussion. The first section addressed several global factors that are affecting the arms industry, including the impact of dual-use technologies, globalisation, the impact of cyber-based technologies as a new form of “armaments,” and whether or not the development and production of nuclear weapons is a useful course of action. The second section comprised case studies of major arms-producing states or regions—such as the United States, Western Europe, Russia and China—and the potential rise of “new suppliers” with their potential impact on international arms trade.

DUAL-USE TECHNOLOGY AND THE GLOBAL DEFENCE INDUSTRY IN 2030

Kathleen A. Walsh[1]
U.S. Naval War College

There are three main factors that are likely to determine the direction of the global defence industry by 2030 and the role of dual-use technologies within it. These three factors are: (i) the future of the globalisation phenomenon; (ii) the rise of China and responses to it; and (iii) the changing character of warfare.

The primary factor determining the future of dual-use technologies as part of the global defence industry is the phenomenon of globalisation and whether it will continue to expand or contract. A globalised system of trade encourages wide-spread development of dual-use technologies that can be applied to military purposes with the added payoff of military advances able to be spun-off to commercial products. While it is possible for dual-use technology to play an integral part in military development without the existence of a globalised system of trade as an incentive, for this dependence to be an asset rather than mere necessity or liability rests on the degree to which advanced dual-use technologies are both reliably available and continuously advancing. Therefore, an increasingly globalised economic system promotes greater opportunity for dual-use technology development to contribute to the defence sector than reliance on national commercial and defence industries alone.

The idea that globalisation will fuel increased world economic trade indefinitely is not supported by history; each previous wave crested then petered out over time. The current era of globalisation—history's third such wave, according to World Bank analysis—is the result of the information technology revolution which touched off during the latter part of the 20th century. The question today, and in looking towards the defence sector in 2030, is how long will the current wave of globalisation persist? Will globalisation continue to increase, expand and adapt or will this phenomenon slow, shrink and evaporate?

1 The views here are those of the author alone and do not reflect official views of the U.S. Department of Defence, the U.S. Navy, or U.S. Naval War College.

What the global defence industry might look like in 2030 and the role played by dual-use technologies could look very different under these two opposing trend lines. Yet, either way, globalisation in 2030 will probably look significantly different than it does in 2014 or over the previous two decades, which means the role of dual-use technology in the global defence sector is likely to change as well.

The defence sector and dual-use technologies under expanding or contracting globalisation

If globalisation continues to expand, it is likely also to continue to change. The on-going third wave of globalisation sparked decades of outsourcing and offshoring, first of back-room IT services and low-tech production and assembly, later to more advanced manufacturing and globally distributed research and development (R&D). If globalisation continues as the engine of international business through to 2030, then new and more advanced forms of global outsourcing are likely to emerge. Following the global distribution of manufacturing and R&D, the next, more advanced stage of globalisation is already apparent in the growing levels of international scientific cooperation. This activity involves not only developed economies but increasingly also crosses developed-developing state lines. Internationally collaborative scientific efforts are driven in part by the difficult and costly nature of advanced scientific endeavours, by common interests in developing similar fields of scientific study, as well as by growing scientific competition by emerging science and technology (S&T) power centres such as China. Globalisation's continued expansion, therefore, could lead to further outsourcing and offshoring not only of more advanced forms of commercial business and R&D but also of basic scientific research. The global expansion of cooperative scientific, technological and industrial research, in turn, could lead to greater dual-use technology opportunities and, therefore, increased application of these technologies, processes and innovations as part of national and international defence industry development efforts.

If advanced scientific research also becomes more commoditised as a disaggregated, cross-boundary activity, this could lead some states to specialise in or to outsource select areas of scientific research. Other states might choose to simply buy access to (or in-source) certain fields of scientific research as an alternative to costly, long-term, national S&T investments across a broad-based spectrum of scientific study. Large economies like the United States, China and the European Union are likely still to invest in wide-ranging, fundamental S&T portfolios for the purpose of maintaining substantially independent national defence capabilities. As such, these economies are likely to become the source of any outsourced S&T to other states. But other, particularly smaller states might welcome the opportunity to acquire basic (possibly also applied) scientific understanding without the up-front investment costs, especially in areas of common scientific interest such as bio or nanotechnology. The result by 2030 of possibly much more globally distributed basic science and S&T collaboration could be wider development and distribution of dual-use technologies. Wider distribution of the fruits but not seeds of S&T, however, could lead to an even greater divide between defence industrial leaders and followers, or between discoverers and buyers. If so, the greater geographical distribution of basic science and of dual-use technologies might lead to more rapid and more geographically dispersed innovation. The latter, however, is likely to be in the form of incremental (versus radical) innovations. Such advances, wherever they might arise around the globe, would then feed into the defence sectors of the leading defence industrial states.

If, alternatively, the present wave of globalisation slows to a trickle or evaporates by 2030, the role of dual-use technologies in national defence sector development is likely to be much less than we've seen over the past few decades. Independent national defence industrial bases will become essential, and the global industry will be dominated by those economies both willing and able to develop a robust and indigenous defence industrial capability. This will lead to a greater divide between defence industrial base haves and have-nots. The haves will rely less on dual-use technology and more on domestic sources of science, technology and innovation, with more being sourced from purely military enterprises. This state-based approach, in turn, is likely to lead to slower, generational changes in the defence sector and possibly more radical forms of innovation overall. The have-nots in this scenario would be dependent more on domestic capabilities and those supplied by close allies and partners willing to share defence expertise and assets.

The outcome of either scenario, however, suggests that there would be little change in the economies most likely to play first-tier roles in the global defence sector: the United States, China and the European Union. What the differing scenarios impact most is everyone else, particularly the second and third-tier defence economies (e.g. Russia, India, Japan, Singapore, etc.). At present, it appears that the three main defence economies are continuing to bet on the continued expansion of globalisation and exploitation thereof, as promoted in the Pentagon's "New Offset" strategy, China's continued reforms towards perfecting a dual-use, civil-military integrated model for military modernisation, and the EU's continued export control reforms to promote greater defence cooperation.

The rise of China and changing character of warfare

China's rise or fall as an economic, diplomatic and military power is another key factor in terms of what the defence industry will look like in 2030. A rising China with expanding military capabilities is likely to enhance the spread of and potential for application of dual-use technologies for defence industrial purposes both at home and around the globe. This is because China's military modernisation development model is likely to maintain its reliance on dual-use technologies, at least until the PLA(N) is able to catch up and field more traditional, great-power military capabilities and platforms (e.g. blue water navies, aircraft carriers, and heavy lift aircraft). Alternatively, if China's economy were to collapse or some other calamity arises which substantially slows or reverses China's rise, the role of dual-use technologies as part of China's military modernisation efforts would likely also be diminished.

China's rise or fall will, in turn, substantially impact U.S. defence industrial planning. The United States and China, in particular, are each attempting to better leverage global dual-use technology opportunities for defence industrial purposes while trying simultaneously not to become too reliant on the other. This is a difficult endeavour given the leading role that both play in the global economy and the growing prominence China is achieving in scientific and defence-related high-tech industrial sectors.

Given the ambiguity and uncertainties inherent in the U.S.-China power competition, an action-reaction feedback loop has already developed between the two that is being played out at the level of military and defence acquisition strategies. As China adopts asymmetric responses (strategically, operationally and technologically) to try and thwart U.S. military advantages, the Pentagon is conceiving counter-asymmetric concepts such as Air-Sea Battle. This competition is likely to continue to play out over the next 15 years and will impact the role that dual-use technologies play in national and global defence industries. The more China attempts to employ dual-use technologies to achieve asymmetric advantages over U.S. capabilities, the more the Pentagon is likely to seek out dual-use-based counter-asymmetric solutions. This competition could hasten the pace of dual-use technology-based defence industrial innovations, acquisitions and deployments overall.

That is, until one or the other side decides to revert to a more traditional, nationalistic approach to developing its defence industrial base. The smart money is probably on China to succumb to such temptation first, particularly if Xi Jinping's recent policy reforms are, as many suggest, an indication of China's waning interest in foreign investment as a driving factor in its modernisation effort. For the moment, however, both U.S. and Chinese defence industrial development strategies call for greater access to and reliance on dual-use technologies as a key means of fostering advanced defence industrial development.

If the dual-use dominant development model persists (or is expected to) through 2030, this dynamic will continue to impact the character of warfare that the U.S., China and other states anticipate and plan for over the coming years. In other words, just as stealth technology led, in the information age, to development of anti- or counter-stealth capabilities and development of the Internet has led to offensive and defensive cyber capabilities, the future is likely to see more rapid development of dynamic-counter-dynamic and asymmetric-counter-asymmetric shifts in the character of warfare. Dual-use technologies play a key role in these sorts of shifts in that the ubiquity of dual-use technologies can make such shifts in the types of warfare possible and the technologies quick to develop and deploy.

THE ECLIPSE OF DEFENCE-INDUSTRIAL GLOBALISATION?

Richard A. Bitzinger
RSIS

Twenty years ago, following the collapse of Communism and the end of the Cold War, it appeared that the world's defence industry was undergoing a major reformation and restructuring along the lines of a more globally open and integrated process of developing, manufacturing and marketing arms. Major cuts in defence spending (the so-called "peace dividend") during the 1990s left the world with considerably more capacity and capability to develop and produce arms than it either needed or could reasonably afford. This state of affairs, in turn, forced a major retrenchment and consolidation among leading arms producers.

Additionally, as the costs of new-generation military programmes grew, cross-border cooperation made increasing economic sense. Through *ad hoc* partnerships, strategic alliances, joint ventures and even transnational mergers and acquisitions (M&A), arms manufacturers hoped to share the costs and risks of researching, developing and manufacturing new weapons systems, leverage their comparative advantages in certain arms-manufacturing niches, improve access to innovative foreign technologies, increase economies of scale in production and reduce wasteful duplication of effort in armaments production.

Against this backdrop, the globalisation of the defence industry seemed inevitable. As the global arms industry became smaller and more concentrated, defence firms increasingly went abroad in search of markets, risk-sharing partners and new business opportunities with their governments' approval. It appeared likely that the defence industry would become more integrated globally, as more armaments production—from research and development (R&D) to manufacturing and marketing—was carried out transnationally. Nevertheless, it can still be debated whether the process of globalisation has fundamentally altered the global arms industry in general.

In fact, while there has certainly been a considerable change within some of the global arms industry—particularly in Western Europe where much of the defence sector has become regionalised in terms of production or ownership—the bulk of the world's arms-producing infrastructure remains remarkably unchanged. The U.S. defence industrial base is pretty much the same as it was immediately after the Cold War: a highly insulated sector that dominates the world's arms market through the force of massive U.S. defence spending and an export juggernaut. What is even more remarkable is that much of the world's defence industry outside of Europe and America—the so-called "second-tier" of smaller and emerging arms-producing states—have continued to emphasise autarky in defence manufacturing, despite the enormous costs. In general, the globalisation process has not unfolded nearly as deterministically as one might have supposed 20 years ago.

Looking back over the past two decades, it is apparent that "the globalisation of armaments production" has not been nearly as transformative as predicted—at least, not across-the-board. Certainly the European defence industry has experienced a major, perhaps even fundamental, makeover. Increasingly, defence equipment is being procured and produced collaboratively, and more and more defence production is in the hands of international joint ventures (e.g. Eurocopter), multinational corporations (e.g. BAE Systems, Thales), or transnational firms (e.g. EADS). Nevertheless, ever after more than 20 years of defence industrial consolidation, the European arms market remains highly fragmented and domestic arms-manufacturing capabilities zealously sheltered. In 2012, less than 20 per cent of all procurement spending was dedicated to European collaborative programmes, according to the European Defence Agency. Clearly, protectionism—or "economic patriotism," to use a French term to describe national preferences when it comes to defence procurement—is still alive and well within the EU. Most procurement and military R&D spending within the EU is still concentrated in redundant and often competing national programmes, further eroding the overall buying power of European equipment budgets. The European arms market is beset with a number of duplicative and competing programmes. And where there is collaboration, there is too much emphasis on *ad hoc* cooperative programmes that do little to make the outlay of scarce defence dollars (or Euros) more cost-effective.

Outside of Europe, the globalisation process has advanced even less. Transatlantic armaments collaboration has largely stagnated. The U.S. defence industry, the beneficiary of several years of rising military spending by Washington, has had little incentive to "go global" in the manner of multinational joint ventures and overseas acquisitions, and many earlier initiatives to push for expanded international (and especially transatlantic) armaments cooperation have withered; the U.S. defence industry's idea of inter-nationalisation is simply to sell its wares off-the-shelf (or through licensing arrangements) to foreign customers. The British have made some inroads into investing in the U.S. defence industrial base, even that process has stagnated. The French have scored a minor success with the creation of the Thales-Raytheon joint venture to sell air-defence radars and command and control systems, and battlefield surveillance systems, but that's about it. Overall, transatlantic armaments collaboration is at its lowest point in decades.

Globalisation involving lesser arms-producing countries has also flattened. While some countries, such as Australia and South Africa, appear comfortable with the idea that much of their domestic industrial bases can be foreign owned, most others have flatly rejected this idea. Rather, these countries continue to be highly protectionist in armaments production, or at least continue to shield their defence sectors from foreign penetration. Some, such as China, India, and South Korea, are actually expanding their defence sectors, pumping considerable new resources into these industries, while others, such Israel and Singapore, are seeking niche areas where they can find lucrative export earnings.

So, have we reached a saturation point when it comes to the globalisation of the defence industry? It is possible, but it is equally likely that the global defence industry is simply in a period of strategic pause, and that it is still digesting the arduous experiences of the past 20-25 years of consolidation and rationalisation. Certainly, if defence spending worldwide falls again, pressures on governments and defence firms to consider radical solutions, such as additional globalisation efforts, could increase. Perhaps the globalisation process has not turned out to be as paradigm-shattering as one would have predicted 20 years ago, but at the same time the global defence industry is certainly a much different thing today—more integrated and inter-connected globally—than it was then. Moreover, the process of reform, readjustment and restructuring within the global arms industry is a dynamic one, and the globalisation process may take on renewed momentum in the future. In 15 years hence, therefore, we could find that the global arms industry could look as different from today as it was 15 years past—or, if protectionist impulses take further hold, it may not.

CYBER AND ROBOTICS TECHNOLOGIES

Caitríona H. Heinl
RSIS

In analysing the broad trends that might affect how the armaments industry looks in the near to medium future, there is little doubt that autonomous and cyber operations will become increasingly prevalent. Likewise, strategic defence and security reports explain that the character of state-on-state conflict is changing and asymmetric tactics like economic, cyber and proxy actions instead of direct military confrontation are likely to play an increasing part as both state and non-state actors seek an edge over those who mismatch them in conventional military capability.[2] It is likely that states will continue to pursue technological superiority for both economic and military reasons, and more sophisticated defensive as well as offensive cyber capabilities will be sought. Cyber operations will comprise advanced intelligence-gathering activities, advanced network security, and advanced cyber capabilities that could have capacity for kinetic impact. So far, cyber operations are primarily for intelligence-gathering reasons, the prevention of attacks on own networks and facilities, and for identifying those behind attacks on networks.

Militaries will seek developments in information and communications technologies (ICT) and increasingly automated as well as autonomous technologies, which is likely to have significant impact on the global arms industry. Most particularly where, as defence futures reports conclude, disciplines like cognitive science and ICT interact.[3] Solutions like quantum computing, simulation, artificial intelligence, virtual databases, cognitive/behavioural science, and the reverse-engineering or mapping of the human brain will also be especially relevant to advances in this space. Remotely piloted air and ground vehicles will soon be replaced by increasingly autonomous systems in all physical operating domains (air, sea,

2 HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, October 2010, p. 16.

3 DCDC, Global Strategic Trends. See also NATO CCD COE article.

undersea, land and space) and across the full range of military operations.[4] And, cyber operations, which are a rapidly advancing dimension, will intersect heavily with robotics, where cyber is likely to be the new high ground in future warfare, particularly since an actor who dominates in cyber can potentially shut down or take control over physical platforms like unmanned systems.[5] Moreover, further objects are due to become interconnected and therefore vulnerable to remote manipulation, so the way in which these co-developments play out will seriously impact on the pace and scope of the shift to unmanned and robotic systems.[6]

Militaries will seek such superior technology, including the most advanced civilian technology that can be adapted, to gain operational advantage.[7] Reports further argue that the U.S., for example, will be driven to increasingly autonomous systems out of operational necessity as well as the costs of personnel and the development of traditional crewed combat platforms that are increasing at an unsustainable pace.[8] They will obtain advanced computer security solutions in a number of ways: (i) by adapting advanced civilian technology that is available; (ii) from large computer security multinationals that are already in this space like McAfee, CISCO, Kaspersky, Symantec; and (iii) from the larger defence companies that are currently investing more heavily in developing and acquiring both expertise and technologies. Companies like BAE Systems, Lockheed, Boeing, and Raytheon seem to be increasingly present in this space. At the beginning of November for example, Raytheon announced the acquisition of cybersecurity firm, Blackbird Technologies. We are also seeing a number of successful large start-ups like CrowdStrike and FireEye. Several advanced solutions might also be found in small start-ups, smaller enterprises, or even research labs that are working on some of the component technologies that, if adapted or bought, could be used by the military. Militaries will most likely seek hardware, operating systems, and software from a number of sources. Likewise, there seems to be an increasing recognition in military thinking towards creating avenues of communication with smaller enterprises or individuals with solutions, which was not traditionally the case.

Increasingly automated and autonomous computational and robotic agents

Intelligent software is increasingly used in cyber operations and some argue that defence systems should be further adaptive and evolve dynamically with network condition changes by implementing dynamic behaviour, autonomy, and adaptation such as autonomic computing or multi-agent systems.[9] Such autonomous intelligent agents can purely be software operating in cyberspace (computational agents) or integrated into a physical system (robotic agents) where they underpin a robot's behaviour and capabilities.[10] Since intelligent agents can seemingly be used most efficiently in multi-agent formations, it is expected that this will be the main form of agent application in cyber operations.[11] While it seems that no state is using fully autonomous lethal robotics as yet, the technology seems to be available or is becoming available very soon and these are described as the next generation of weaponised technology after drones.[12] So far, between 50 and 80 countries are developing robots and/or have made operational use of robots in the battlefield. In South Korea and Israel for example, robotic sentries with the capacity to be armed have already been deployed.[13] Large private sector companies like Google are also

4 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 6.

5 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 23.

6 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 23.

7 UK Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security,* February 2012, p. 26.

8 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 6.

9 Igor Kotenko, "Agent-based modelling and simulation of network cyber-attacks and cooperative defence mechanisms", St. Petersburg Institute for Informatics and Automation, Russian Academy of Sciences, available at: http://cdn.intechopen.com/pdfs/11547/InTech-Agent_based_modeling_and_simulation_of_network_infrastructure_cyber_attacks_and_cooperative_defence_mechanisms.pdf, 2010.

10 Guarino, Autonomous Intelligent Agents.

11 Tyugu, Command and Control of Cyber Weapons.

12 Christof Heyns, Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions, "Lethal Autonomous Robotics", United Nations Institute for Disarmament Research (UNIDIR) Conference, http://www.unidir.org/programmes/security-and-society/lethal-autonomous-robotics, 23 May 2013.

13 Liran Antebi, "Who Will Stop The Robots"?, Military and Strategic Affairs, Volume 5 No.2, September 2013, p.63. See also: UNIDIR Resources, "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies", March 2014, p. 6.

becoming deeply involved in this space alongside the likes of DARPA.

Either civilian or custom-built advanced technical solutions will be needed for challenges such as verifying the outcome of multi-agent behaviour for all situations and the disabling of unwanted coalitions if agents have too much autonomy in decision-making, since the more intelligent software becomes, the more difficult it could apparently be to control. Solutions will also be required for the complexity of the agents' behaviour, misinterpretation of commands, loss of contact, their unintentional harmful behaviour, or unexpected and unpredictable actions.[14]

UNIDIR reports identify a lack of critical analysis on whether increasingly autonomous weapons systems will drive development of other weapons of concern, counter-measures or methods including cyber conflict.[15] That said, it is unclear whether these systems can, or will, in fact be developed. It seems there are no such weapons in the military environment yet because of operational and technological limitations.[16] However, this still seems to be an area of extremely high investment by both the private and military sectors.[17]

Increasing government concerns over supply chain security could also impact the shape of the arms industry in cyber and robotics technologies. Several governments are already calling for the complete supply chain of ICT security products to be located within the country to guarantee security, but to also develop national expertise so that tools and technologies can be created that are currently inaccessible or unavailable to some countries. Such developments, in the interests of national security, could affect the nature of the global supply chain.

Public and private sector considerations

Such technologies will often have a dual-use nature, in other words the same systems could be used for both military and civilian purposes. There will most likely be developments that arise in civilian fields such as medicine where they will then be adapted for military applications. Moreover, traditional disciplines that were once separate will now overlap with each other. For example, cognitive science and ICT for advanced solutions. We might even see larger defence and computer security companies acquiring smaller outfits that specialise in other disciplines to create such advanced solutions. We are already seeing such a pattern with the purchase of AI, machine learning, and robotics labs or small companies by Google.

Both the public and private sectors are driving these developments by investing heavily in R&D in pursuit of their own objectives. Stronger collaboration between the public sector and industry as well as academic research labs will most likely continue to identify solutions and technologies. Defence and security reports equally assert that there could be greater innovative application of readily available civil technologies, but this means that it might be easier for adversaries to buy high-technology products in the open market.[18] It is also likely that the open and black markets will continue to play a significant role in this space.

While both the public and private sectors are driving these technological developments, it is not certain how this will evolve. Advanced technology development for defence and security, which was "once the realm of government research organisations is now carried out almost exclusively in the civil and commercial sectors".[19] Governments may not be able to sustain deep expertise in all areas of science and technology, and the rapid pace of innovation means that new technology can often appear faster than it may be integrated.[20] Likewise, the public sector may not always match the speed of innovation in the private sector. For example, the civilian technology sector is unappreciated so far

14 Tyugu, Command and Control of Cyber Weapons. See also NATO CCD COE art.

15 UNIDIR Resources, "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies", March 2014, p. 8.

16 Gabi Siboni & Yoni Eshpar, "Dilemmas in the Use of Autonomous Weapons", Strategic Assessment, Volume 16 No.4, January 2014, p. 77.

17 UNIDIR Resources, "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies", March 2014, p. 10.

18 UK Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security,* February 2012, Executive Summary.

19 UK Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security,* February 2012, p. 38.

20 UK Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security,* February 2012, p.34 & 36.

in the context of its developing a more far ranging set of autonomous applications than the military.[21] Analysts argue that the "Robotic Age" is not being led by the American military-industrial complex but by companies producing goods and services that are driving key enabling technologies such as advanced computing, big data, autonomy, and AI.[22] However, these technologies could then be exploited to build increasingly sophisticated military systems.[23] Already, increasingly complex cyber solutions require close collaboration between government and industry, and it is likely that the same dynamic will continue as these technologies become all the more automated or autonomous.

Financial constraints on the government and decreasing defence budgets might further impact some governments in this space, particularly if cuts are made at the expense of national security or Science, Technology, Engineering and Maths (STEM) investments in R&D are reduced. In the U.S., given reduced defence resources, there could be a tendency to give preference to capabilities that are perceived as more affordable and good enough rather than making new investments in R&D or pursuing more expensive, advanced systems focused on potential future high-tech warfare.[24] However, countries like China (and Russia) are investing heavily in advanced technologies such as cyber capabilities, stealth and counter-stealth, and capabilities designed specifically to exploit perceived vulnerabilities in U.S.-made systems.[25]

Futures reports outline that the scale and pace of the innovative and industrial capacity of countries like India and China will outpace many Western nations in a matter of years, with China likely to attain and sustain global leadership in a number of technical areas including computer science.[26] As a case in point, China recently became the largest buyer of industrial robots, overtaking Japan for the first time with an approximately 60 per cent increase in a one-year period from 2012 to 2013.[27] A recent report by Microsoft concludes that by 2025, emerging economies will produce nearly 16 million graduates in STEM fields annually, which will be nearly five times greater than the 3.3 million per year from developed countries.[28] There is an imbalance in STEM graduate rates and emerging economies like China, India and Brazil show a different pattern to the U.S., for example, where only 4 per cent of undergraduate degrees are in engineering compared to 31 per cent in China.[29] This means there will be a heightened need for and competition surrounding technical talent, and there may not be enough STEM graduates to innovate or secure ICT services in the near future.[30] This trend might further impact the future shape of the arms industry for cyber and robotics technologies.

Shifts in demographics and projections of shortages, for example, of 83-85 million medium and high-skilled workers and a surplus of 90 to 95 million low-skilled workers could also impact this space.[31] Most states and corporations are already challenged in identifying, training and retaining large numbers of skilled individuals in ICT and cybersecurity. Such expected demographic trends could easily work against several countries.[32]

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21 UNIDIR Resources, "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies", March 2014, p. 6.

22 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 6.

23 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 6.

24 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 20.

25 Robert Work & Shawn Brimley, "20YY: Preparing for War in the Robotic Age", CNAS, January 2014, p. 20.

26 UK MoD, Out to 2040.

27 Tanya Powley, "China becomes largest buyer of industrial robots", http://www.ft.com/cms/s/0/a5cca8c0-e70c-11e3-aa93-00144feabdc0.html#axzz35X1ZGoLX, 1 June 2014.

28 Microsoft, "Cyberspace 2025 – Today's Decisions, Tomorrow's Terrain: Navigating the Future of Cybersecurity Policy", June 2014, p. 4.

29 Microsoft, "Cyberspace 2025 – Today's Decisions, Tomorrow's Terrain: Navigating the Future of Cybersecurity Policy", June 2014, p.11.

30 Microsoft, "Cyberspace 2025 – Today's Decisions, Tomorrow's Terrain: Navigating the Future of Cybersecurity Policy", June 2014, p.12.

31 Microsoft, "Cyberspace 2025 – Today's Decisions, Tomorrow's Terrain: Navigating the Future of Cybersecurity Policy", June 2014, p.11; See also World Economic Forum, "Stimulating Economies through Fostering Talent Mobility", 2010; and McKinsey Global Institute, "The World at Work: Jobs, Pay and Skills for 3.5 Billion People", 2012.

32 William Lynn III, former United States Under Secretary of Defence, "2010 Cyberspace Symposium – DoD Perspective", 26 May 2010.

NUCLEAR WEAPONS AND THE 2030 GLOBAL DEFENCE INDUSTRY

Paul M. Cole

Before one speculates on the future of nuclear weapons in the context of the global arms industry in 2030, it is instructive to reflect on the beginning and evolution of the Atomic Age:

- The interval between the first conceptual description of the atom and the scientific proof of the atom's existence was approximately 2,300 years.
- The interval between the theoretical statement of how uranium disintegrates and the first explosion of an atomic bomb was approximately six years.
- In the 70 years since the first explosion of an atomic bomb, evolution of the atomic era has been more of scale than of kind.

With the exception of thermonuclear weapons (aka "hydrogen bombs"), the thousands of atomic bombs in the world today all share fundamental design characteristics with the original Uranium (Little Boy) and Plutonium (Fat Man) bombs.

Nuclear weapons are complex mechanisms. Nonetheless, the components required to build a bomb and the skills necessary to assemble them have been understood for three-quarters of a century. In addition, the components are available in abundance. If one knows where to look or has the industrial base, financial resources and political will to produce them, nuclear weapons are easy to come by today. Imagine how much easier the task will be in 2030.

DIY nuclear weapons

The issue is much more complicated, but for the sake of this brief discussion paper, the nuclear weapons industry may be divided into five parts, viz. (i) Design; (ii) Weapons grade fissile and fusile material; (iii) Safing, Arming, Fuzing and Firing; (iv) Permissive Action Links (PAL); and (v) Delivery Systems. Design and weapons grade material are discussed briefly in the following sections.

Design: Both the theoretical knowledge and practical experience required to design and construct a nuclear weapon have been widely available for nearly a century. Bomb designs and declassified photographs of nuclear weapons have been posted on the Internet for many years. Soviet spies gave away the keys to America's atomic city 70 years ago. Weapon design is constrained by considerations of size, weight, safety and the availability of special materials. For a gun-type HEU bomb, no nuclear components need to be verified. Only the conventional (non-nuclear) components must be tested. Manhattan Project scientists were so confident in the performance of the "Little Boy" uranium bomb, for example, that the device was not tested before it was used. In contrast to the relative simplicity of the HEU bomb, the Pu-239 bomb design is very difficult. China, France, India, Israel, Taiwan, South Korea, Brazil, Singapore, the Russian Federation, Ukraine, the United Kingdom, the United States, South Africa, Sweden and other nations have built conventional weapons with design features that could be adapted to produce nuclear weapons. The DPRK appears to be intent on producing a Pu-239 warhead that can be delivered by a long-range ballistic missile. Iran appears to be intent on creating the infrastructure required to produce nuclear weapons.

Weapon grade fissile and fusile material:[33] The production and availability of weapons-grade fissile and fusile material, which was once a significant barrier to entry into the nuclear weapon club, is widely available today and will be more abundant by the year 2030. The same technology required to produce low enriched uranium (LEU) (2-5% U- 235) may be configured to produce highly enriched uranium (HEU) (80-90%). The processing required to extract, purify and compress Pu-239 is complex, huge, expensive, hazardous, dirty and difficult to conceal. The amounts of both HEU and Pu-239 stockpiled today are sufficient to produce thousands of nuclear warheads. In both cases, the amount of HEU and Pu-239 required to produce a nuclear weapon has dropped from tens of kilograms to between one and four. There is no compelling reason to conclude that the supply of weapons grade material will diminish between now and 2030. The majority of this material will be produced and stockpiled outside of the global arms industry.

2030: What we don't know, or cannot know

The list of things we don't know or cannot know about nuclear weapons in the global arms industry of 2030 is less precise and by definition less comprehensive than the list of things we do or can know. For the purpose of this short essay, consideration is given to the following questions:

- Does nuclear proliferation create or undermine global security?
- Why do nuclear-capable nations choose to not to acquire nuclear weapons?
- Will a non-state actor (aka, a "terrorist" organisation) acquire (aka, "steal") and explode a nuclear weapon by 2030?
- How many nations will be in the nuclear weapon club in 2030?

A brief discussion of each point follows.

Proliferation and global security: The question of whether nuclear proliferation creates or undermines global security is non-falsifiable; i.e. it cannot be tested. One cannot distribute nuclear weapons to ten nations and measure the results, then retrieve the weapons and re-distribute them to 20 nations and measure the results. One of the most prominent international relations theorists of the 20th century wrote in 1981: "Someday the world will be populated by ten or twelve or eighteen nuclear-weapon states. [I believe that] with more nuclear states the world will have a promising future."[34] In a speech before the UN General Assembly in September 1993, President Clinton said that nuclear weapons "destabilise entire regions." Neither assertion can be tested in any meaningful way. The Atomic Age, which must be lived forward, can only be understood in retrospect.

Nuclear-capable nations that have no nuclear weapons: The number of nations that are "nuclear energy states" is more than triple the number of "nuclear weapon states".

As shown in the following chart, it took 50 years for the number of nuclear weapon states to double from five to ten. In the early 1990's, my hypothesis to explain why of the 30 nuclear power states, only nine were nuclear weapon states, was based on the assumption that the greater the understanding and appreciation of nuclear strategy and the implications of nuclear weapon possession, the less likely a nation would be to acquire nuclear weapons. In my view, this hypothesis explains why Sweden abandoned a nuclear weapon programme that

33 Fissile describes fission material, such as highly enriched uranium (HEU). Fusile describes fusion material, such as deuterium, tritium or lithium deuteride.

34 Kenneth Waltz, "The Spread of Nuclear Weapons: More May Better," *Adelphi Paper No. 171* (London: International Institute for Strategic Studies, 1981).

Prime Minister Erlander claimed was “one turn of a screwdriver from a bomb.” Today, twenty years later, I am even more convinced that the factor that inhibits would-be nuclear proliferators is the fact that nuclear weapons are attractive, if not compulsory, targets for a would-be aggressor. Rather than deterring a strike, a nuclear weapon storage facility creates a target of extremely high value.

Terroristic acquisition and use of nuclear weapons: Between 1993 and 2013, there were 419 cases of smuggled or stolen nuclear materials worldwide. (Marina Koren, 2013). There is no documented case of the successful theft of an operational nuclear weapon, thus one must speculate on theft as the means to acquire a nuclear weapon. In the 1965 James Bond movie *Thunderball*, the evil SPECTRE stole two nuclear weapons from the Royal Air Force, and then demanded a ransom from NATO of £100 million (about US$2.75 billion) in flawless, uncut diamonds in exchange for the bombs. SPECTRE’s threat was that if the ransom was not paid on time, then the two nuclear weapons would be detonated. Miami Beach was one of SPECTRE’s targets. The plot did not end well for SPECTRE. The perpetrators were tracked down in a massive manhunt and killed, most of them by harpoon. Though hypothetical, and all theft scenarios are hypothetical, this is another example of how acquisition of nuclear weapons turns the owner into an urgent target of the highest value. In my view, in the unlikely event that a terrorist organisation acquires a nuclear weapon, the window of opportunity for any coherent use will be extraordinarily brief. In addition, it is difficult to imagine a modern Permissive Action Link (PAL) weak enough to be successfully by-passed by even the most sophisticated organisation. (Unlike in the movies, nuclear weapons are not detonated by digital countdown clocks.)

How many nations in the nuclear club by 2030? I predict there will be 10 members of the nation-state nuclear club in 2030, an increase of one from today’s membership. The number of nuclear weapon states has a weak association with the state of the global arms industry at any particular time.

Conclusion

The global defence industry for nuclear weapons in 2030 will appear, in my opinion, to be remarkably similar to today’s conditions. In the seven decades since the nuclear Genie got out of the bottle in the 1940’s, barriers to entry into the nuclear weapon club have been progressively lowered. It is easier today to build a nuclear weapon than it was in 1945. By 2030, the task will be even simpler. The crucial question going forward is not why countries have acquired nuclear weapons; rather, the salient question is why countries perfectly capable of doing so will continue to forego the option. In short, nothing is inevitable until it occurs.

RUNNING FASTER TO STAY IN PLACE: U.S. DEFENCE EXPORTS IN 2030

Jonathan D. Caverley
Massachusetts Institute of Technology

This speculative memo describes a tremendous amount of churn in the global defence industry, but suggests that the ultimate outcome will still be a stable, American-dominated high-end arms market; and a growing, lower-tier market of American-influenced foreign competitors. This arrangement will be bent on keeping Russia out and China down, although both countries will continue to sell considerable amounts of weapons.

This memo limits analysis to export market share as a reasonable proxy for international influence, product value, market power and future sales. It claims that the U.S. export market share is stagnant and even declining. It then theorizes why any decline is likely to flatten out or reverse due to feedback from the U.S. defence industrial system. Limits exist to how much market share the United States can recapture directly, since it is failing to make weapons which are in high demand for the coming decades.

U.S. market share is stagnant or declining

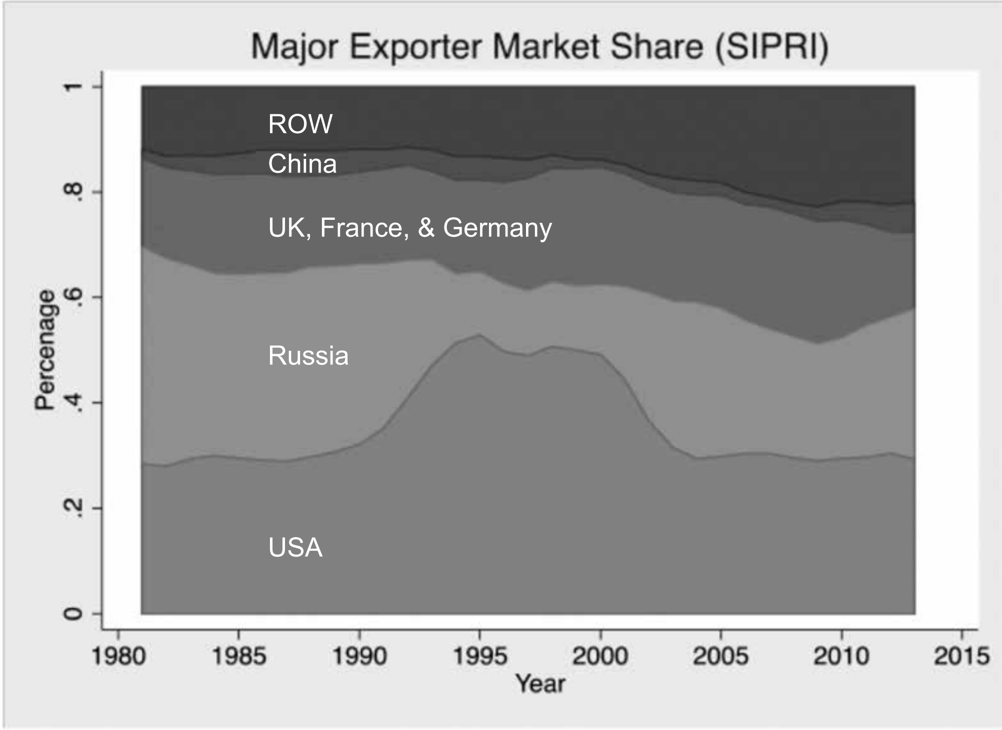
Figure 1 makes clear that the U.S. market share as a four-year moving average is pretty stagnant (data from the Stockholm International Peace Research Institute, or SIPRI), comparing the United States to other major exporters. Last year, the U.S. market share was at its historic low, but that low is only marginally below its late-Cold War share. Much of the movement is found among other exporters: Europe's "Big 3" appear in decline at the expense of China and, especially, the rest of the world (ROW).

What's keeping the United States on top?

Before analysing the forces behind its stagnation, it's worth reviewing American advantages.

Economies of Scale: The 2014 (mid-sequestration) U.S. procurement budget was over US$100 billion, about 15 per cent larger than the entire Russian military budget.

Figure 1
Market Shares for Major Exporters, 1980-2013 (SIPRI TIV)



Internal Competition: The United States still has multiple, robust, domestically-based prime contractors for any major product. No other country, except perhaps China, has this capacity.

Systems and Services Economy: While lagging behind the larger global economy, the defence industry appears to be shifting towards systems integration, software and after-sales services as the principal sources of value compared to bending metal. This remains a relative strength of the U.S. economy in general and its defence industry in particular.

War: An under-appreciated factor, American products are combat-tested to a degree matched by no competitor (excepting Israel), hardening and refining American C4ISR, unmanned platforms, precision weapons and logistics.

Allies/Clients: Of the 15 largest defence budgets besides the U.S., all but 4 are basically American allies.

"Stickiness": As evidenced by the (perhaps temporary) resurgence of Russia, even if all the elements above were not in place, there is likely to be a floor to U.S. decline. It's extremely hard to dismantle a military industrial complex.

Downward pressure on the "Uncompetitive" United States

Still, the market decline from the 1990s is real. Where is this pressure coming from?

Budget cuts: Perhaps the United States will lose some of its economies of scale. Lower budgets can also have a long-term effect in terms of lower R&D. However, decline in market share preceded U.S. budget retrenchment.

Augustine's Law: Unit costs in the United States continue to soar.

Declining allies' purchases: Total imports by "traditional" allies (Western Europe, Canada, Japan, Australia and New Zealand) have stagnated, whereas non-allies' imports have risen steeply (note that this includes countries like Saudi Arabia and the UAE). U.S. market share is dropping with all types of importers, and is particularly low with non-allies.

Regulation and export controls: Compared to other exporters, the United States attaches many more strings and is stingy with technology transfer. It has historically (if not consistently) refrained from exporting higher-end weapons before a viable competitor emerges.

"Uncompetitiveness": A feature, not a bug

What all these downward factors share is endogeneity: they are more a result of U.S. geopolitical and market power than a cause of its decline. The United States charges more, tolerates inefficiencies, attaches caveats and prevents technology transfer because it can. The massive defence budgets after 9/11 further distorted the market and did not incentivise exports.

But in an era of retrenchment, American market power remains sufficiently high, hence can recapture market share and still enjoy these outsized, if reduced, benefits (export regulations, rents for its defence firms, etc.). There is a reason why the F-35 is simultaneously the "Jet that Ate the Pentagon," (to use Winslow Wheeler's phrase), yet continues to win international fighter competitions.

Prices will drop and regulations will diminish. The impending relaxation of drone export regulations, the larger Obama Administration export reform efforts, and the Pentagon's contracting via its "ITAR-free" Defence Exportability Features Initiative all point in this direction. Allies will respond to U.S. retrenchment with (some) re-arming and by seeking to cement ties through weapons purchases.

Not selling what the market wants

There is, however, one downward pressure associated with U.S. international power that is probably impervious to this sort of feedback and will likely cap U.S. market share. The U.S. defence industry builds weapons to meet the needs of its primary customer, the Pentagon, which demands expensive, sophisticated tools of power projection. The market for such weapons is intrinsically limited; many states, particularly in Asia, are seeking to acquire anti-access or counter-intervention weapons that the United States neither purchases nor produces. This might be why Asia booms but U.S. market share stagnates.

Figures 2 and 3 examine the global market for missiles—the anti-access/area denial weapon par excellence and thus a growth field for many countries in Asia. The United States is selling more expensive, sophisticated weapons but the growth in the missile market is on the lower end with a dramatic spike in terms of missile numbers (Figure 3) rather than missile quality (Figure 2).

Figure 2
Amount (TIV) of Global and US Missile Exports (SIPRI)

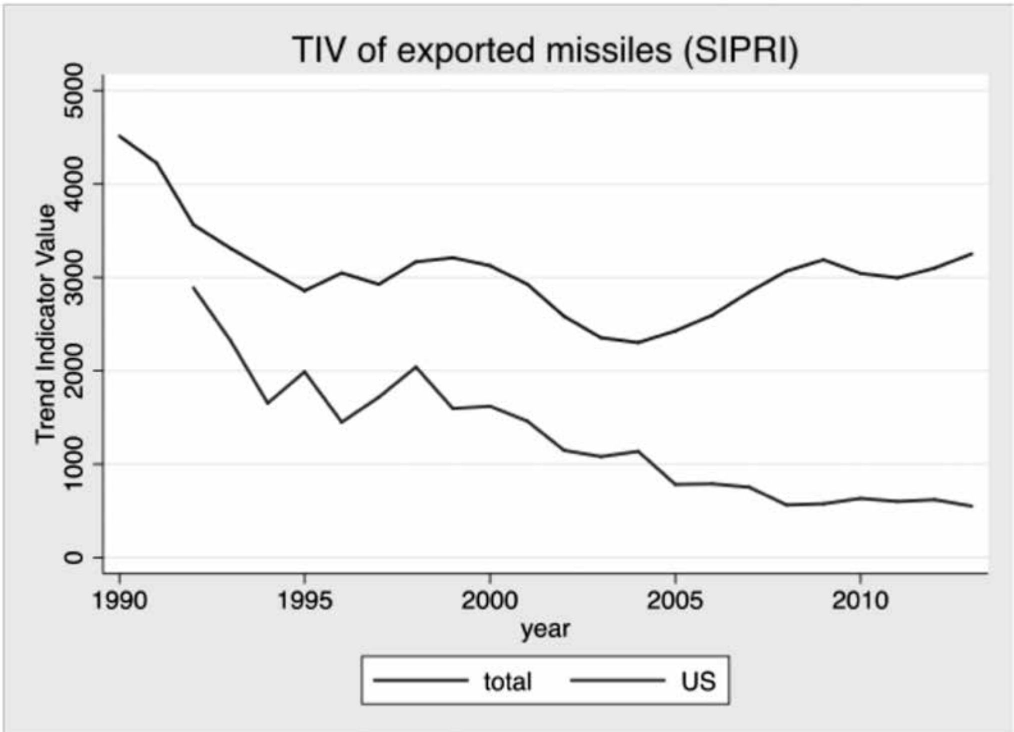
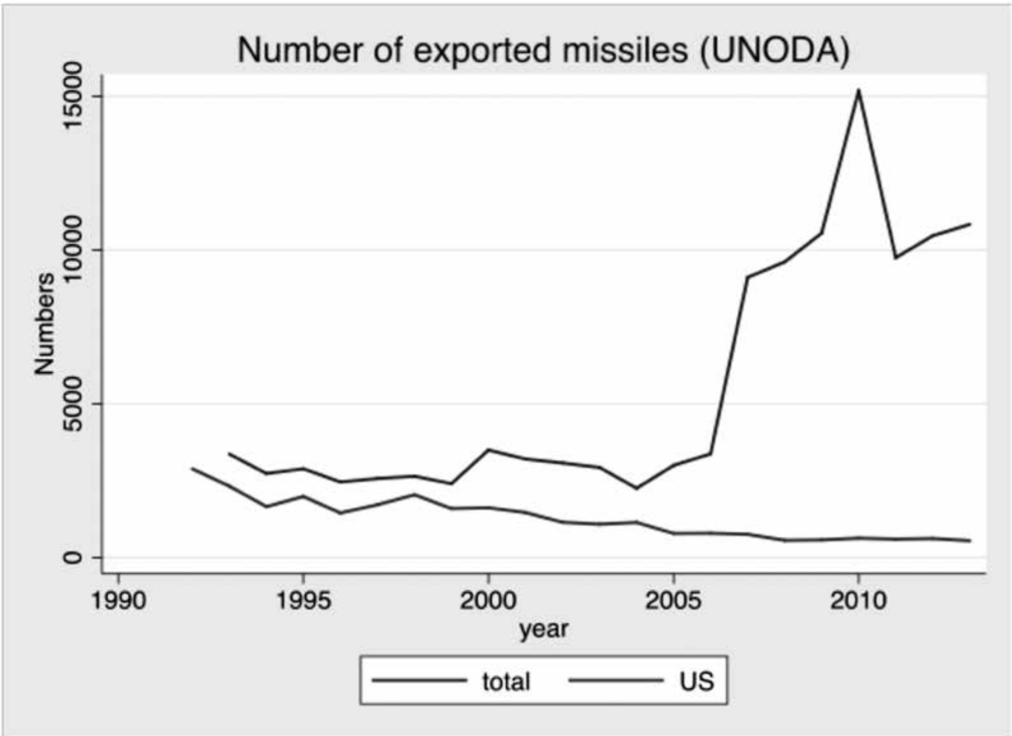


Figure 3
Numbers of Global and US Missile Exports (UN Disarmament Agency)



America adapts?

The United States shows evidence of adapting to a new reality to preserve its privileged position. The thumb on the scales that has Australia leaning towards Japan for its submarines has an American fingerprint. The ostensibly Swedish Gripen fighter contains so much U.S. technology that, from a regulatory standpoint, it might as well be exported from the United States. In one sense, India's 2004 purchase of Israel's Phalcon Airborne Warning and Control system represents a US$1.1 billion loss for the U.S. defence industry which is largely responsible for the technology transfer that helped build the thriving Israeli arms export sector. But the deal still required American approval, withheld in 2000 for a similar sale to China. Such an arms network can still be designed to keep China down, Russia out, and friendlier states in, and the American defence industry will make more money through these "non-American" sales than if the contracts went to Russian or Chinese products.

THE OUTLOOK FOR THE U.S. DEFENCE INDUSTRY IN 2030

Philip Finnegan
Teal Group

The U.S. defence industry is in a current period of budgetary austerity with considerable strength but limited flexibility to respond to a changing worldwide market. Corporate direction and government policies need to be modified to ensure that technological leadership and competitiveness do not erode in the future.

The current industrial situation

The state of the industry now is quite strong. By all financial measures, the defence industry has been doing well over the past decade. Defence revenue has soared. Operating profits have increased even faster as companies have engaged in aggressive cost-cutting.

In addition to their current financial strength, barriers to entry are high. The five largest U.S. defence companies today are the same as those two decades ago. Innovative technology companies may seek to penetrate the market at its margins (such as SpaceX's challenge in space launch to the United Launch Alliances' *de facto* monopoly on military launch services), but fundamentally there is little interest by innovative outside companies in trying to compete with the defence mega primes in what is perceived as a low-profit market with considerable paperwork and restrictions.

The continued leadership of the five mega-defence firms (Lockheed Martin, Boeing Co., Raytheon Co., General Dynamics Corp. and Northrop Grumman Corp.) is not in question. The U.S. government is unlikely to allow any mergers among the largest U.S. defence companies due to the level of concentration already in the industry. Medium-sized defence companies are unable to put together the aircraft, missiles, defence electronics and information technology capabilities that are combined in these giants. The limited mergers and acquisitions now going on are among medium-sized companies as larger companies divest technical services business that may cause conflict of interest issues for their larger systems integration and manufacturing units.

Nor will there be a challenge from European companies. European firms are generally retrenching in the United States. Airbus Group (formerly EADS) and Finmeccanica are looking at sales of some of their existing U.S. businesses. QinetiQ already sold much of its North America operation. BAE Systems sold the unmanned aerial vehicle (UAV) business it acquired only several years earlier. Some European companies, such as BAE Systems and Finmeccanica, have not gotten the transatlantic synergies they originally hoped would be created.

These trends suggest that the U.S. industry leaders now will continue to be the leaders by 2030. Change will be focused on consolidation in mid-tier and smaller companies rather than the mega-defence firms.

Future industry and government challenges

Despite its current strength, the industry faces serious challenges to its future technological strength and its international competitiveness. The challenges stem from changes within the industry itself and from U.S. government policies.

One of the major changes in the outlook of the U.S. defence industry comes internally from the shift in corporate culture towards an increasingly short-term focus. Now there is a serious effort by defence companies' management to turn much, if not all, of their available cash flow to stock purchases and dividend increases.

Cash returns to shareholders have soared over the past decade. For example, Northrop Grumman reduced its outstanding shares by a third in the period from 2008 to 2013. The company also plans to buy back another quarter of its shares by the end of 2015 at a cost of US$4 billion. To do this, it will use cash, free cash flow and may even issue debt. This may be somewhat more aggressive than other leading companies, but not terribly. Lockheed Martin Corp., Raytheon Co. and General Dynamics Corp. have all been reducing their share count though a decade of buybacks.

These stock buybacks and dividends, which a decade ago were a relatively insignificant use of cash, now exceed combined spending on mergers and acquisitions, capital spending and company-funded research and development. That takes money away from investing in the future of the companies in favour of immediate returns to shareholders.

Defence stocks have responded by outperforming the overall S&P 500 for the past decade. The focus on returning cash to shareholders is increasingly difficult to change as time goes on. Defence industry stocks now attract a shareholder base that relies on a high yield. Management must respond to the needs of the shareholder base.

Executive compensation is now more aligned with stock performance than in the past, giving chief executive officers incentives to continue aggressive buybacks and dividends at the expense of the capital spending and company-funded research and development spending needed to invest in the company's future. In addition to research and development spending cuts over the past decade, there has been a shift towards spending funds on projects with more immediate payoffs such as bid and proposal costs. This leaves progressively less for longer-term research needs.

In accordance with this shift in the corporate culture, the defence industry now places a high priority on cost-cutting to raise profit margins, which already have risen markedly in recent years. That puts further pressure on the limited capital spending and research and development.

Recruiting technical talent into the defence industry is becoming more difficult. Increasingly, commercial companies are offering opportunities in similar areas such as cyber, electronics and aeronautics. With greater prospects for growth and a more flexible work environment, it becomes difficult for the defence industry to attract the talent it needs. The extraction of cash from defence businesses and aggressive cost-cutting serve to aggravate the difficulties in attracting talent to the industry.

The low levels of research and development spending and difficulties in recruiting talent threaten to undermine the defence industry's ability to compete in very active, dynamic areas of industry, such as cyber, unmanned aerial vehicles and communications. Developments in those fields will come from commercial companies in an increasingly globalised market.

The problems are not only with industry priorities, but also with U.S. government policies. The government's failure to stick with long-term plans to reward risks taken by contractors is a well-known problem that is being aggravated by tight military budgets. The Unmanned Carrier-Launched Airborne Surveillance and Strike aircraft programme has attracted considerable research and development funding from leading defence contractors. Yet, it is now going to be cancelled or delayed indefinitely. The U.S. Navy is embroiled in a bitter internal fight with some involvement by the Congress in a continuing debate over how capable the system should be. The easiest way to solve the problem is to avoid any decision. Of course, a decision like this only reinforces the industry's interest in avoiding any risk in investing company-funded research and development money.

U.S. export restrictions embodied in the International Traffic in Arms Regulations (ITAR) are a serious impediment to U.S. industry's ability to make exports and cooperate with international industry. This has already fostered the growth of European satellite and unmanned aerial vehicle systems designed without U.S. components as ITAR-free systems in order to ease their export to the rest of the world. The goal is to avoid the complications and delays of dealing with the complexities and restrictions of U.S. export regulations.

The United States has weapons systems that were developed with only the U.S. military in mind. Generally military services consider their requirements without any consideration of whether systems can be exported. For example, when the Navy decided to incorporate a larger helicopter for its FireScout MQ-8C, it instantly made the system unexportable under the Missile Technology Control Regime. Before that shift in priorities, Northrop Grumman had an active worldwide marketing campaign for the MQ-8B, which was small enough that it would have been able to be exported.

By comparison, Elbit Systems designed its Hermes 900 with exports in mind, carefully making sure that its capabilities would not bar it from export under the Missile Technology Control Regime while also providing enough capability that the Israeli Defences Forces would purchase it.

Cost is a low consideration for U.S. weapons systems as the priority is placed on performance. The result is that many of these systems such as Global Hawk or the F-35 Joint Strike Fighter become affordable to only a very small number of countries, leaving the wider market open to lower cost alternatives.

Likely industry condition in 2030

Looking ahead to 2030, the United States is likely to have much the same industry structure as today. The leading prime contractors will continue to be the same companies. Among mid-size contractors there will be more consolidation by companies seeking to compete with the major primes in a particular sector and also in technical services, a key area in which much larger roll-up companies will emerge.

The danger is that there will be little depth to the industry as a whole. If major companies continue their current policy of returning considerable amounts of cash to shareholders at the expense of capital spending and research and development spending, then they will find it difficult to remain at the cutting edge of technology. This may be aggravated by difficulties attracting technical talent as the industry stagnates and alternative commercial opportunities grow.

The threat is that the industry with become increasingly hollow, facing problems keeping up with the technological advances being pioneered in commercial industry in sectors such as cyber and electronics. It will also face problems being competitive in world markets.

The government is at least showing signs of recognising a need for change. Better Buying Power initiatives recognise the need for fundamental change in procurement to ensure improved affordability. The Better Buying Power initiative unveiled in 2010 to help the Pentagon respond to budgetary pressure has the potential to benefit both industry and the Department of Defence. It focuses on achieving affordable programmes by controlling life cycle costs and improving competition. It also is working to improve incentives for productivity and for research and development, essential elements for changing the current behaviour of defence companies.

There has been some movement on President Obama's Export Control Reform initiative to streamline many defence exports. It remains to be seen the extent to which it succeeds. There has been some criticism that it has introduced a tremendous amount of complexity that potentially could leave companies open to violating the law and it also involves enhanced enforcement. The reform has been a modest step forward, but obviously more will need to be done in an increasingly global economy.

There is a need to build in exportability early in the arms development process. The Pentagon is working to try to consider this by making exportability a priority in the design of some weapons systems so anti-tamper and other measures can be added early to limit their cost. In its first design for exportability pilot programme, the Department of Defence has included an exportability design requirement for the U.S. Air Force Three Dimensional Expeditionary Long-Range Radar. Another exportability pilot programme is being developed for the Navy's Next-Generation Jammer.

Yet the extent to which industry and government can shift their current policies to ensure a healthy industry in the future remains uncertain. The fact that version 3.0 of "Better Buying Power" was unveiled in September 2014 after two previous versions of the initiative suggests that the Department of Defence is trying to respond to the need for reform and that change is remarkably difficult.

THE FUTURE OF THE EUROPEAN DEFENCE INDUSTRY

Martin Lundmark
Swedish Defence Research Agency

The defence industry is an industry that apparently at all times is in need of restructuring, consolidation and reform. However, experience tells us that there are bolstering and restraining impediments to such radical, structural change. Governments take the defence industry seriously for several reasons, e.g. national security, technology protection, technology development and employment—and prestige. I will in my paper discuss how a set of security and macroeconomic factors could develop, and how that would affect the structure and strength of the European defence industry.

There are four central change factors that will shape the future conditions and industrial landscape of the European defence industry:

- *Europeanisation*: The Europeanisation of the European defence market and defence industry suffers considerable setbacks, together with the EU as a community loses pace in its supranational development.
- *The U.S. security posture*: The U.S. becomes more isolationist; it has less global, military engagement and less defence technology interaction with Europe. China's strategic advances are its main concern.
- *Russia's security outlook:* Russia continues to pursue its strivings to have a stronger geopolitical influence, and continuous to push what it sees as its "national interest".
- *The development of China*: China continuous unbroken its security and geopolitical advances.

In relation to these four, certain other geopolitical changes will be touched upon. The overall developments regarding the European defence industry's conditions will be discussed below:

Europeanisation

The present (2014) massive surge for Europeanisation of the European defence market and the defence industry will in the coming 5-10 years, experience considerable setbacks. The dominating actors (the U.K., France, Italy and Germany) will in their vital defence technology investments and priorities opt out of EU-wide settlements and industrial development schemes. Germany will be more EU-friendly, but still show a sceptic reflex. Italy will be the less reliable partner due to its recurring financial crises and political instability. Therefore, France and the U.K. will be the axis of defence technology dominance (with aerospace as the exception from this cohesion). The EU will in several matters lose their command in the European development, especially due to the U.K.'s gradual refrainment from the EU.

The four dominant nations will gradually support and create “wealthy clusters” of defence industrial facilities. They will largely disregard of the Commission's regulation through the Defence and Security Procurement Directive regarding open procurement—they will have much wider scopes of what are “vital strategic interests”, thus not abiding to open procurement. Their aggregate spending on defence R&D and defence technology development will be even more dominant in Europe than today.

Sweden's defence industry will survive in a few segments. Either thanks to strong Swedish technology priorities (“vital strategic interests”)—Gripen fighters and related technologies, submarines and underwater technology, or due to the fact that Sweden will increase its R&D and development programmes in radar and missiles. Bofors will go out of business in 2017.

Several of the European nations with modest defence spending and defence industry (e.g. Austria, Portugal, Greece, Netherlands, Belgium, Denmark and Switzerland) will clearly diminish their footprint on the European defence-industrial landscape—their governments will show limited support to their domestic defence industry. Those nations' defence R&D will decrease and be focused on following and understanding technology development—without really being an active part in it. Their companies will either be acquired by larger companies, be closed down or fall to a less visible position on the defence technology value chain. In the newer, Central and East European EU members (e.g. Slovakia, Czech Republic, Hungary, Romania, ex-Yugoslavian nations—members or not of the EU) this change will be strong—only a few companies that manage to attract international demand in Asia, Africa and South America on lower technology sophistication will manage to survive in niches; driven by those customers settling on “good enough” technology. Poland has taken an intermediate position in the defence technology value chain, thanks to accords with the wealthy clusters.

War, threats and unrest

Defence spending in Europe will increase over the period firstly because of Russia's imperialistic doings, but also due to the enduring instability in the Middle East. The defence spending will first increase to a higher level and stabilise on that level around 2020.

The EU's ambition for a military force has failed. In case of a major conflict between Europe and Russia, the implicit agreement is that Europe would operate in a NATO force under a U.S. command, but with largely separate forces vis-à-vis the U.S., and with less inter-operability than today.

Religious and ethnic conflicts have not spread to Europe, but prevail in the Middle East and Central Asia. Greece' recurring economic crises has made it an outcast in the EU and NATO. NATO still exists, but with the U.S. showing decreased priority. Finland joins NATO in 2017. Sweden (now surrounded by NATO) joins in 2019.

The U.S. has become much more isolationist, and has less military and technology links with European counterparts. Norway is the European exception; they have strengthened their military links with the U.S., with joint bases in Northern Norway. The U.S.' military developments are primarily reactions to Russian and Chinese advances on the other side of the Pacific Ocean. The U.S. has strong military collaboration with Japan and Australia.

Russia will for the entire period until 2030 continue to strive for increasing security influence, despite a continuously shaky economy. Inspired by China, they will build islands in the Baltic Ocean and the Black Sea where they will create naval bases—thereby increasing regional tension. They will continuously show their muscle in those seas and towards bordering states. Libya, Kazakhstan, Belarus and Uzbekistan will be their strongest allies. Ukraine has become dominated by Russia. Russia's security influence will increase in the Baltic and Arctic Sea. Russia's actions have united the threat perception of the European nations in opposition to Russia.

China will continue to expand their security, military and defence technology influence. China will not directly affect European regional security, but due to their increasing presence and influence in some African states, China will create continuous conflicts with European nations' economic and security interests.

Armament spending is still strong in the Middle East and Southeast Asia, which in turn creates new arms export opportunities for European defence companies. In addition, should North Korea collapse sometime in the near future and is subsequently united with the south, China could likely further increase its influence in the Korean peninsula, at the obvious expense of the U.S.

The European defence-industrial landscape

The overall size and turnover of the European defence industry will decrease relative to the rest of the world. The dominating European nations will disallow most of the attempts from U.S. companies to acquire strategic defence companies—in line with their increasing focus on “vital strategic interests”. They will create “wealthy clusters” of the same fashion as MBDA (that consolidated more than 60 per cent of all European missile industry and demand into one company/conglomerate). Inside these clusters, there will be forts of technology protection, where smaller companies from other European nations will possess junior positions in the value chain.

Aerospace will be the exception. Dassault will suffer a dramatic crisis due to its failure on the export market—the French state will have to accept a consolidation of Eurofighter and Dassault. This new entity (“European Military Aerospace”, EMA) will develop the next European fighter. Saab will survive due to a sufficient export success and continued support from the Swedish state. Sweden will however not engage in a new fighter programme, and Sweden will therefore start from around 2020 to steer towards a drop in the value chain as a partner to EMA. The U.K. will however concentrate its resources in aerospace towards the U.S., thus exiting Eurofighter. European nations that chose F-35 will largely be geared towards the U.S. fighter technology development (since they have put their defence aerospace R&D and spending in JSF/F-35). Several European nations will also lower their ambitions in fighters—it has become too costly with the most advanced fighters. Gripen will for some be the alternative.

In military shipbuilding, there will be considerable consolidation. There will be two dominating companies, also owning production facilities in the less prominent European nations where low-cost production will take place. The land segment of armoured vehicles, artillery, hand-held weapons and ammunition will also experience considerable consolidation, with some of them being acquired from the U.S. The submarine segment will have three companies (from Sweden, Germany and France). MBDA will continue to dominate, with Saab surviving as an affiliated niche supplier, lower on the value chain.

Cyber, C3I and other “RMA” and electronics-based systems will be dominated by the “wealthy clusters”. A large share of the European defence R&D is directed to such technologies. There will be more European technology solutions in these domains, with less inclusion of U.S. components.

Technology development

Defence R&D in Europe has increased in the top five defence-industrial nations, and the defence technology, development and production collaboration has increased. Missile seeker technology has become a prioritized technology area, in order to decrease the dependence on the U.S. The U.S. is still spending four times more on defence R&D than the EU aggregate (around six times more in 2014). European defence companies have through offset had to allow considerable technology transfer to customers in Asia and South America. This has, together with U.S. isolationism, further distanced Europe from U.S. technology development.

CYBER/C3I will be the decisive component of military capability. It will also be the most vulnerable component. Militaries see considerable uncertainties regarding how sophisticated cyber, C3I and electronics technologies that abound in all military systems can withstand adversaries’ counter-measures. Some military systems are therefore designed as rugged, encapsulated strike systems with limited electronics, and a small number of alternate strike modes—the decision loop having limited alternative actions.

Globalisation

State ownership has clearly decreased in Europe overall, but states use contracts and golden shares to direct their defence companies. Defence companies have less business opportunities in the U.S., and depend more on European defence R&D and state support. Through export and offset, they have expanded their supply chains with some of their customers in Asia. China has become a more important part of the supply chain, and Chinese companies have minority shares in several European companies.

Brazil and India have largely not been successful in creating globally competitive defence industries. Korea has due to Chinese pressure decreased its defence technology ambitions.

To sum up, by the year 2030 there could be a major divergence between the U.S. and Europe. EU has largely failed in its Europeanisation of the defence market, and is overall not a strong security actor. The European defence industry has been concentrated to the dominant nations and become more dependent on the dominant nations' defence spending.

THE EUROPEAN DEFENCE INDUSTRY IN 2030 AND BEYOND: RUNNING TO STANDSTILL?

Aude Fleurant
Stockholm International Peace Research Institute

In the realm of the political economy of defence, forecasting is a notoriously tricky exercise. Because of the numerous geopolitical trends and unexpected crises, shifting domestic priorities in military powers or sudden changes in economic conditions prognostics are often proven wrong. Even so, forecasting remains a valuable and heuristic way of investigating thorny subjects, a label that can easily be applied to the European defence industry and its mid-term evolution. This working paper seeks to provide preliminary elements for a discussion of the European defence industry's future and its place and role in the global defence industrial landscape.

To a large extent, the academic and policy-advising discussion about the future of the European defence industry is shaped by the project of creating an integrated, "Europeanised" defence industry, somewhat along the lines of what was achieved with EADS (now Airbus Group) and MBDA in the first years of the 2000 decade. In turn, this goal, also advocated by several European states as well as Brussels institutions, tends to focus on obstacles that are presented as having repeatedly hindered the defence industry's integration process since the wave of aerospace consolidations. Therefore, it attracts attention on the major political divisions that underpin these hurdles and the consequent failures of efforts to streamline production capabilities. This tendency to concentrate on the problems of "Europeanised" defence integration tends to leave out the scope of analysis important choices made by both states and corporations in terms of strategies that may also shape and define the future of the industry.

The European defence industry's immediate commercial and political parameters have not substantially changed since the late 1990s.[35] The

35 For the purpose of the worskhop, the European Defence Industry is understood in its largest sense as all the military production (and R&D) capabilities present in Europe, excluding Russia.

European defence landscape remains a collection of national markets each characterized by specific requirements and processes. Except for some countries sharing a border with Russia, the threat environment in Europe is generally perceived as benign and most national defence budgets remain well below the 2 per cent of GDP effort required by NATO. Military spending is concentrated in five Western European countries, combining more or less half of the continent's resources devoted to national defence.[36] This concentration is even greater if you look at military R&D spending.

European Commission's efforts to harmonise and integrate the Europe defence equipment market, with initiatives such as intra-community arms transfers' streamlining and offsets prohibition, are too recent to have had visible impacts on member states. For most of them, even those involved in major overseas military operations, domestic demand for equipment has shown modest growth and except for a very limited number of actors,[37] it was hit by the impacts of the economic crisis on states' finances.[38] No new major cooperation programme capable of federating national capabilities was launched since the end of the Cold War and although several trans-European small mergers have occurred, the latest major industrial merger proposal between BAE and EADS was blocked.

In order to deal with these constraints and ensure their survival and sustainability, some of the continent's major military industrial players have turned to the global arms market and exports to compensate for sparse domestic orders. In this, they were and still are supported by their national governments. They have turned to new growth centres of the global arms market, embodied mostly by "emerging markets" such as Brazil, India and Russia. Most of these countries pursue goals of enhancing their technological and industrial capabilities—both civil and military—and are using offsets policies to reach these goals in a market that is largely in favour of the customer. Others, such as the U.K. and Italy, have decided to target the U.S. market, which is also hard to access and comes with stringent conditions.

This has led several of the biggest European defence companies to establish a long-term presence in foreign countries with which they wish to do business through acquisition of production capabilities, joint ventures and partnerships with local companies, or becoming part of one of the country's major company's supply chain and the opening of manufacturing and training facilities. None of these actions are unprecedented in the framework of major foreign sales, especially if offsets are involved, but their importance and significance are somewhat new. Dassault Rafale signing the Indian MMRCA contract is now a condition for the French government to be able to order its last tranche of fighter aircraft.[39]

For several European companies,[40] another chosen avenue of adaptation to a difficult home market environment is to maintain or grow the civil part of their activities. Looking at the sources of revenue for several major European companies in the past 10 years, one can see that portfolio diversification has remained a corporate objective even during modest growth period. The way the new Airbus Group (ex-EADS) has reorganised also strongly relays the impression of a distancing from defence related activities while at the same time, states harbouring these companies insist on keeping selected or exhaustive capabilities in their territory in order to secure autonomy of supply and support alliance commitments, for instance.

These selected trends, some of them contradictory, have put the industry in an uncomfortable position for some time. They make forecasting its development on a 15 year timeframe difficult, even more so in the current geopolitical context. To support the reflection and foresight exercise, I submit three scenarios:

- **A (re)strengthening of the European anchor:** The most original of scenarios, the formulation and, most importantly, the implementation of a European defence policy accompanied by an agreement to share resources and to harmonise needs and requirements would obviously significantly impact the supply side development strategies and trajectory. In the current state

36 Excluding domestice military forces such as French gendarmerie or Carabinieri

37 France, Poland.

38 France has chosen to protect its investments budgets in its five years defence spending plan, cuts are made essentially in manpower.

39 The last "tranche" of the French government Rafale order is dependent on the signature of the MMRCA contract by the Indian government according to the last defence spending five years plan.

40 Those are mostly aerospace/aviation companies such as Airbus and Saab, OEM and electronics companies such as SNECMA, Thales, Cobham or Selex, in sector into which it is easier to have a dual-use profile. Other major prime contractors, such as the French naval shipyard DCNS, are currently implementing diversification strategies.

of affairs, such a prospect seems unlikely to materialise as EU member countries are still arguing about what constitutes a “European economic operator” and disagree about where and how to conduct military operations, or about what types of weapons to sell to which countries and at what conditions. Nevertheless, the general continental integration process has been characterised by phases of conflicts and stalemate interspersed with agreements leading to sweeping policy changes. The level of attention being raised by defence and security issues recently may create the necessary conditions for a reopening of negotiations.

- **The in-between option for European defence—a variable geometry:** This refers to a phenomenon that has peppered the European defence panorama in the 2000s until now. A diversity of intra-European agreements have been put in place (i.e. between Nordic countries, Visegrad Group, Lancaster Treaty, pooling of ammunition supply arrangement through EDA, recent Nexter/KMW JV announcement, etc.), agreements of variable scope and scale that create an additional layer of European cooperation spaces between companies/companies, companies/states and states/states. It does not seem far fetched to think that the flexibility afforded by these arrangements will continue to be exploited when opportunities arise, which will add complexity to an already complex situation. Nevertheless, their main weaknesses, namely their limited scope both in terms of goals and resources, and their longevity, will limit their impact and will likely be insufficient to act as proxy to a more comprehensive continental approach.

- **Status-quo—an increasingly internationalised European industry:** If the current situation persists, which is a possibility, we will likely see an increase of internationalisation of the activities of several European companies. They will compete between themselves and others players coming from the “global south” as well as the United States—a situation that will put pressures on prices and may lead to more demanding offsets and therefore greater capabilities transfers (knowledge, production, etc.). This will further weaken the relation with the domestic market (except in the cases of state-owned companies), making claims of return on investments in the national economies more and more questionable. In the longer term, it could definitively undermine a “European power” project.

There are several other possible scenarios, but these three give a good starting point for a meaningful discussion that could lead to new ideas about the current trajectory of the global defence industry, its drivers and consequences.

THE CHINESE DEFENCE INDUSTRY IN 2030

Michael Raska
RSIS

Over the past two decades, numerous books and studies have been published on China's military modernisation concomitant with the development of Chinese defence science and technology (S&T) and the search for innovation in China's defence economy. In retrospect, the varying literature attempted to identify, track and assess the key drivers, enablers and constraints, capabilities, and programmes that will likely shape the future trajectories of China's military modernisation—its pace, character, direction, magnitude and impact on regional and global strategic environment. Notwithstanding contending assessments of the continuity and change in the Chinese S&T base, its strengths and weaknesses, the key questions have remained fundamentally constant: Can China innovate and become an advanced technological power? What is the nature of China's efforts to transform its defence science, technology, and industrial capabilities? What are the critical sources of this innovation? What are the approaches and strategies that China is pursuing? How will China absorb, assimilate and exploit its technological advancements for military purposes? And what are the key security ramifications for the region and the world?

With the gradual yet profound trajectory of China's rise as the greatest potential competitor to U.S. military predominance in the 21st century, Western strategists and policy-analysts have demonstrated even greater need to assess the likely domestic, external and technological drivers and aspirations shaping China's military modernisation. Indeed, the rising importance and scope of the debate has been tied to the substantive uncertainties in potential security challenges in the Asia Pacific region, and the perennial need to minimise miscalculations and prevent strategic surprises. In this context, however, any future-oriented "over-the-horizon" assessments of China's S&T and defence economy are bound to a range of caveats: from the dangers of linear extrapolation of China's innovation paths and patterns that are inherently dynamic—shaped by multiple variables and input factors that may produce a wide spectrum of potential trajectories; to challenges in overcoming individual biases and judgments (overestimation and underestimation) aggravated by a lack of hard evidence and thus vulnerabilities for error. That said, assessing China's long-term defence innovation trajectories must be viewed in a historical, relative and comparative context.

Seen from this perspective, the development of China's defence industry can be projected into four overlapping waves: (i) the Maoist Era (1949-1978); (ii) Deng's Demilitarisation Era (1980s-1990s); (iii) Reform Era (1998-2012); and the current (iv) Xi Jinping's Reform Era 2.0 (2012-present). In the early Maoist era, China's defence industrial strategy and technological development reflected dependence on Soviet assistance. Facing major Western threats, Moscow wanted Beijing to counter-balance the U.S. and provided China with arms plants, blueprints, knowledge transfers along with Soviet models of organisational structures and management culture. At that time, China's defence sector was at the centre of economy, controlling heavy industrial sectors, and was the principal engine driving China's technological and industrial innovation development. In this era, China's defence economy had two parallel technological and industrial tracks: conventional and strategic weapons development. Innovation, however, diffused primarily in the strategic sector with key programmes such as Liangdan, Yixing (2 Bombs, 1 Satellite) under the guidance of Marshal Nie Rongzhen. With the Sino-Soviet split in the late 1960s, coupled with China's domestic political upheavals of the Great Leap Forward (1958-62) and the Cultural Revolution (1966-72), China's conventional base atrophied and innovation virtually disappeared.

From the late 1970s, defence science and technology programmes were regarded important in promoting economic development but not a top priority in Deng Xiaoping's Four Modernisations. Deng argued that China no longer faced Cold War threats, and should switch from militarisation to economic development, liberalisation, and "opening up" reforms. In other words, China's defence industry should pursue concurrent development of dual-use technologies applicable to both civilian and military needs—principally under the Junmin Jiehe strategy: combining military and civilian activities, peacetime and wartime preparations prioritise military products and let the civilian sector support the military. One of the key programmes of that era became the National High Technology Programme (“863”) launched in March 1986. The programme had initially focused on developing seven strategic priority areas: laser technology, space, biotechnology, information technology, automation and manufacturing technology, energy, and advanced materials. In the mid-1990s, China expanded these areas in size, scope and importance. The 863 Programme is ongoing, funding projects such as the Tianhe-1A supercomputer.

By the late 1990s, the military output of defence industry fell to 15 per cent (compared to 90 per cent in 1979), and China’s defence industry was nearly broken. The defence sector was plagued with excessive bureaucratic size and overstaffing, production over-capacity, scattered location of enterprises, lack of cooperation between military and civilian production, and entrenched in conservative, risk-averse culture that resulted in inefficient production. Indeed, most Chinese systems were at least a generation or two behind comparable military equipment being produced at the time in the West or in Russia, and problems with quality and reliability abounded. In 1998, these factors led to major reforms in the defence industry, aimed to revitalise the qualitative output, processes and management of the industry. The reform era under Jiang Zemin and later followed by Hu Jintato introduced market-based mechanisms, accelerated industrial consolidation, and increased R&D resource allocation. At the 3rd Plenum of the 16th Party Congress in 2003, a decision was made to build new civilian technological and industrial base with embedded military capabilities (*Yujun Yumin*). This strategy paved the way for a convergence of civilian and military S&T hardware and processes with associated reforms, including allowing select private sector firms to engage in defence work.

Notwithstanding the range of internal drivers, changes in China’s external security perceptions have also accelerated the processes in reshaping Chinese defence economy since the late 1990s. While Taiwan has been traditionally the key driver to China’s military modernisation, another factor for defence S&T projects was the U.S. strike on the PRC Embassy in Belgrade in 1999. In its aftermath, the Central Military Commission held an emergency meeting and called for “accelerated development of Shashoujian (assassin mace) arms.” Since then, China’s military modernisation has shifted towards developing comprehensive asymmetric capabilities targeting U.S. vulnerabilities in the Asia Pacific. The PLA currently pursues a two-track vision of military modernisation: (i) upgrading existing equipment; while simultaneously (ii) introducing a new generation of select systems that would enable future transformation of the PLA capable of “diversified missions.” Its operational concepts are based on Anti-Access/Area Denial strategy, which China calls “counter-intervention”—interpreted by the U.S. and other regional powers as an attempt to restrict the access and freedom of action of their respective forces in areas of “core interest” to China.

With the widening operational requirements, the baseline strategy for China’s current defence S&T development is the “Indigenous Innovation” model—articulated in a supplementary document to the 2006 National Medium to Long-term Plan (MLP) for the Development of Science and Technology (2005-2020). The IDAR consists of introducing, digesting, assimilating, and re-innovating existing technologies (predominantly foreign arms and technology imports) in different ways, and is perceived as one of the most effective means available in closing China’s technological gaps. In the process, China attempts to translate its absorptive capacity to recognise, assimilate and utilise new and external knowledge into innovative capacity that may, in theory, lead to disruptive innovation. The cumulative effects of these developments are substantial, with China’s catalogues of air, land and naval platforms progressively being upgraded in terms of qualitative sophistication and operational effectiveness.

Indeed, the sheer pace, direction, character and output of China’s development of its defence S&T capabilities under Xi Jinping over the past two years has seen numerous accomplishments: from moon landing, space docking, supercomputers, to aviation prototypes such as J-20, J-16, helicopters and UAVs to the ongoing construction of domestic aircraft carriers and record number of commissioned ships such as Type 054A, 056 frigates and 052C destroyers. In the next 5-10 years, China is expected to transfer many experimental models from a R&D to a production stage, including a number of systems in emerging domains of “military rivalry”—outer space, underwater, cyber & near space. China’s political and military elites believe that a new wave of the global Revolution in Military Affairs is gathering pace, led principally by the U.S., and China must therefore accelerate the pace of its military development. In March 2014, China announced its US$131 billion defence budget, up by 12.2 per cent from the previous year, marking 17 consecutive years of near double-digit increases in defence spending.

The key question, however, is whether China's defence industry can sustain its relative progress both in terms of confronting its internal constraints while facing external competition? Notwithstanding the much improved technological capabilities, the nature of Chinese defence S&T is still based on coalition alliances, compartmentalised service structure and an overall legacy of Soviet times. This includes overlapping planning structures, widespread corruption, bureaucratic fragmentation, and most importantly, no real internal competition. Other barriers to innovation also include ensuring the structural strength, quality control, process standardisation, evident for example in the development of engines required for the next-generation aircraft. Extrapolating to 2030—can we envision China as a leading critical technological innovator of major weapons platforms and systems comparable in sophistication to global defence S&T powers? China's historical path dependence suggests this is unlikely. However, China will continue to seek niche technological developments that could potentially revolutionise the PLA's military operations by providing a credible asymmetric edge in regional flashpoints: i.e. anti-ship ballistic missiles (ASBMs), anti-satellite ballistic missiles (ASBMs), hypersonic cruise missiles, and systems converging cyber and space capabilities. Ultimately, as China becomes more technologically advanced, its military effectiveness will be increasingly shaped by its ability to align its strategic goals with technological advancements.

THE FUTURE OF THE RUSSIAN DEFENCE INDUSTRY

Maxim Shepovalenko
Centre for Analysis of Strategies and Technologies (CAST)

The evolving industry landscape

In the last quarter century, the Russian defence industry followed the world's mainstream—from optimisation to consolidation and over to globalisation. In the 1990s, the chain of supply was resurrected which broke up upon the demise of the Soviet Union. In the 2000s, the defence industry was consolidated into a score of vertically integrated holding companies. At the turn of the 2000s and 2010s, pilot projects were implemented featuring international collaboration efforts.

The recent transfer of authority over the Defence and Industrial Commission (VPK) from the Government to the President of the Russian Federation marked the end of the transformation period for the Russian defence industry, with a new cohesive governance system having been set up, superficially reminiscent of the Soviet-era, yet a qualitatively different one (see Fig. 1).

Whereas the upper layer of the pyramid is composed of government agencies entitled to design and coordinate the defence industrial policy, the middle one deals with policy implementation via both government and corporate bodies, with the lower one consisting of businesses, different in size and ownership, subject to this policy.

Currently, the Russian defence industry is developing on a mid-term planning basis, with a 20-year horizon for the defence industry as a whole (GPVs), and 10 to 15-year vision for industry-specific sectors (GPs), including diversification into commercial (non-military) market segments (FTsPs). The 20-year GPVs have a 5-year overlap and are detailed through the annual orders (GOZs). The current GPV-2020 has a budget of RUB 20.7 trillion (USD 600 billion) with 70 per cent of the sum earmarked for acquisition, 15 per cent for MRO and the balance for R&D. The services breakdown is as follows: Navy accounts for 26 per cent, Air Force for 21 per cent, Air and Ballistic Missile Defence for 17 per cent, Army for 14 per cent, Strategic Missile Force for 6 per cent and 14 per cent for the MoD-wide C4ISR.

None of the three previous GPVs was implemented.

Figure 1
Evolution of the Russian defence industry organisation

Organisational levels	Years		
	1980s	1990s	2000s
Government level:			
– policy designer	Defense Industry Department (*OOP*) of the Communist Party Central Committee (*TsK KPSS*)	Legal Department (*GPU*) of the Presidential Administration (*AP*)	Legal Department (*GPU*) of the Presidential Administration (*AP*)
– policy coordinator	Defence and Industrial Commission (*VPK*) under Council of Ministers (*SM SSSR*)	None	Defence and Industrial Commission (*VPK*) under Government (prior to 2014) / President (since 2014)
– policy implementers	Nine arms producingministries: *MOM*(nuclear), *MSM* (space systems and ballistic missiles), *MAP* (aircraft/helicopters), *MRP* (ballistic missile/air defence systems, early warning and space control systems, radars), *MSP* (shipbuilding), *MOP* (armour, artillery, small arms and optronics), *MKhP* (ammunition and explosives), *MEP* (military electronics), *METP*(power generators/sources, instrumentation) + ten double-use producing ministries	One ministry: *Minatom* (nuclear) + five subject-specific agencies: *Rosaviakosmos* (aerospace), *RAV* (armour, artillery,small arms and optronics), *Rossudostroyeniye* (shipbuilding), *RASU* (ballistic missile/air defence systems, early warning and space control systems, radar and communication systems, avionics, military electronics), *Rosboyepripasy* (ammunition and explosives)	One ministry: *Minpromtorg* (nation-wide industrial policy) + nine state-controlled/state-sponsored holding companies: *Rosatom* (nuclear), *URSC* (rocket and space systems, ballistic missiles), *UAC* (aircraft), *USC* (shipbuilding), *NPK UVZ* (armour and artillery), *Almaz Antey* (ballistic missile/air defence systems), *RTI Systems* (early warning and space control systems), *KRTV* (air-to-air and air-to-surface missiles), *GKRT* (helicopters, engines, MANPADS, ATGW, electronic warfare, small arms, ammunition and explosives, communications, avionics, electronics and optronics)
Corporate level	State-owned enterprises (*GP*) only	State-owned unitary enterprises (*FGUP/FKP*) and private businesses (public and private limited companies)	Public (*OAO*) and private (*OOO*) limited companies
Model of interaction between the levels	Ministerial administration based on state-planned economy	Mixed transitory	Market-based public and private partnership

Source: CAST

Obviously, the current GPV-2020 will not be fully implemented as well, with many activities being rescheduled for late milestone dates. The new GPV-2025, now under workout, will see a comparable budget with a different service breakdown, apparently, from Navy and Air Force to Army and, perhaps, Strategic Missile Force, and a more pronounced accent onto the R&D across the scale, i.e. fundamental, exploratory, applied and engineering. To concentrate on the breakthrough of R&D, an equivalent of the U.S. DARPA was set up in 2012—the Foundation for Advanced Research (FPI).

For the foreseeable future, investments would come from the Russian state, as the prime customer (40 per cent), and other customers, including foreign ones (20 to 25 per cent), with the balance (35 to 40 per cent) to be provided by the businesses themselves. By 2020, the holding companies would sell out all of their non-core businesses while completing IPOs for those public limited companies which would not require further support from the government.

As to the Russian defence spending, this has seen a steady growth; both in terms of absolute figures and as percentage of GDP throughout the last decade (see Fig. 2). And while it remains to be seen what would be the long-run effect of the current oil price turbulence in the international market, one can suggest that the two least affected categories of the federal budget appropriations will be the national defence and social security commitments.

Figure 2
Trend data on Russia's GDP, federal budget spending and defence appropriations
(RUB '000,000,000)

Year	GDP	Federal budget spending	National defence appropriations	as percentage of		World Bank's average annual exchange rate, RUB per USD 1.00
				GDP	Federal budget spending	
2001	8,943.6	1,321.9	247.7	2.8	18.7	29.17
2002	10,830.5	2,054.2	295.4	2.7	14.4	31.35
2003	13,243.2	2,358.6	355.7	2.7	15.1	30.69
2004	16,966.4	2,698.9	430.0	2.5	15.9	28.81
2005	21,610.0	3,512.2	581.1	2.7	16.5	28.28
2006	26,917.0	4,281.3	681.8	2.5	15.9	27.18
2007	33,348.0	5,983.0	831.9	2.5	13.9	25.58
2008	41,277.0	7,566.6	1,040.8	2.5	13.8	24.85
2009	38,786.0	9,660.1	1,188.2	3.1	12.3	31.74
2010	44,939.0	10,117.4	1,276.5	2.8	12.6	30.37
2011	54,369.0	10,930.8	1,516.8	2.8	13.9	29.38
2012	62,357.0	12,890.7	1,812.3	2.9	14.1	30.84
2013	66,755.3	13,342.9	2,103.6	3.2	15.8	31.85**
2014*	73,315.0	13,960.1	2,489.4	3.4	17.8	36.65**
2015*	79,660.0	15,361.5	3,026.9	3.8	19.7	
2015*	86,837.0	16,392.2	3,378.0	3.9	20.6	

** As per Federal Law No. 349-FZ dd. 2 December 2013 "On Federal Budget for 2014 and for planned period of 2015 to 2016".*
*** As per Central Bank of Russian Federation.*
Source: CAST

Globalisation vs Regionalisation

With a bipolar world having been replaced by a monopolar one in late 1991, and the latter evolving into the multipolar, it appears that the Russian defence industry consolidation process arrived at its final stage at a time when the globalisation trend is being replaced by that of regionalisation, specifically at the macro-regional level. This was preceded by similar developments in another key Russian industry, i.e. the energy sector. This said, the Ukrainian crisis and subsequent sanctions imposed by the West onto Russia might be regarded not as the prime cause but rather the catalyst of the ongoing process, latent until recently, yet more and more coming to the surface.

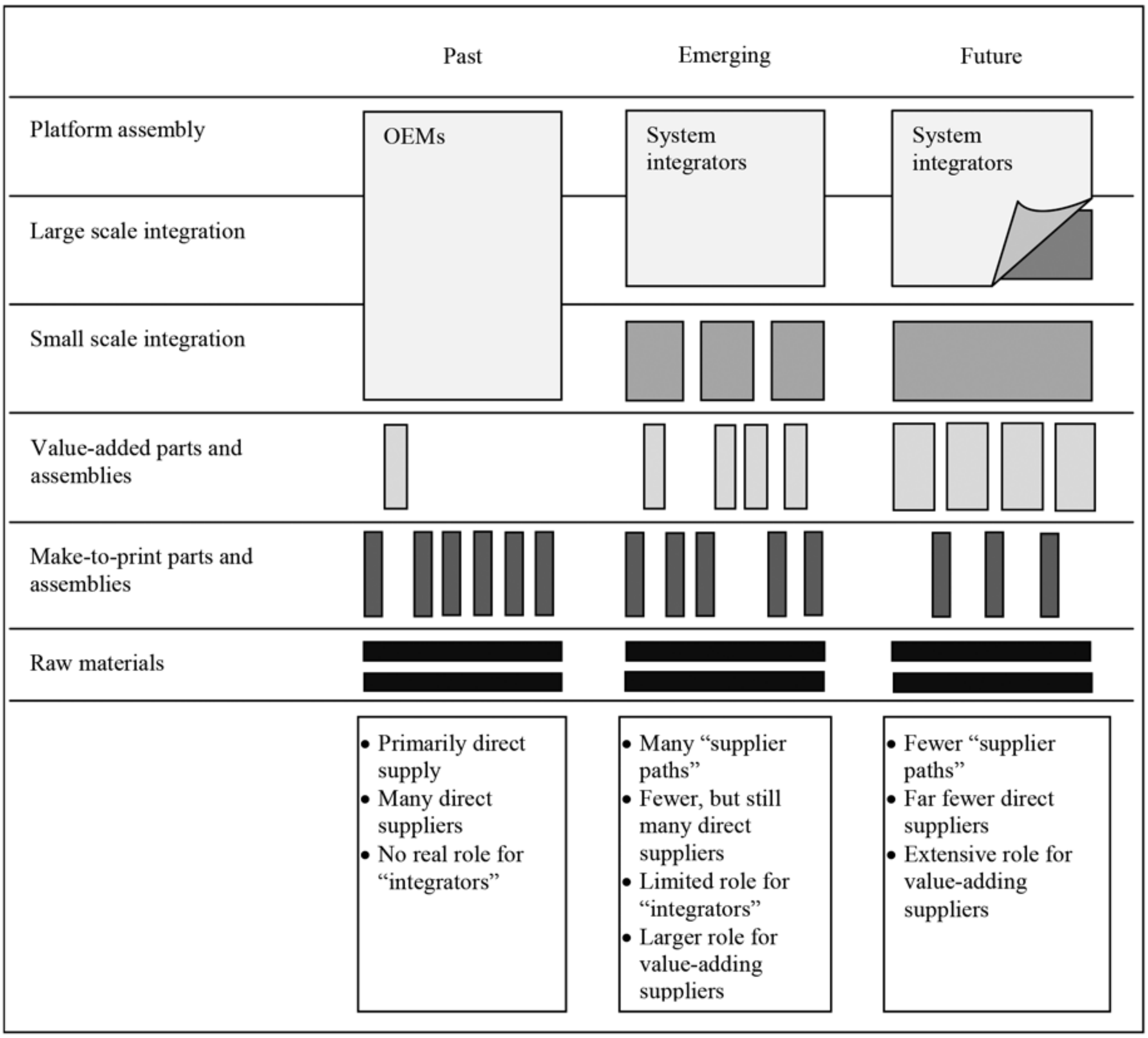
In the context of sanctions, Russia will be seeking trustworthy, predictable and sustainable partnership with countries that are not prone to U.S. political pressure and/or free from commitments arising from security cooperation therewith. Among these are, first and foremost, the BRICS nations, primarily China and India, and, potentially, South Africa and Brazil, along some other nations that demonstrate real, not declared sovereignty, like Turkey, Korea and Iran. The case of France is a real enigma, as is that of Italy, both of them being very dependent on domestic policy and electoral preferences.

As this takes place, the Russian defence industry at large intends to sustain its "system integrator" role in all key defence industry sectors which leaves room for potential cooperation with foreign partners in the "large/small (subsystem) integration" or "value-added/make-to-print parts and assemblies" niches (see Fig. 3). On the other hand, the Russian defence industry, in the latter capacity, successfully contributed to Chinese, Indian, South African and Korean projects, as well as some of the Boeing and Airbus projects. A separate issue is the co-development model (e.g. Russo-Indian Medium Tactical Airlifter project, Russo-Chinese long-haul wide-body airliner) which, apparently, will be considered on a case-by-case basis.

Practical aspects of cooperation

While it remains to be seen whether the crisis in relations between the West and Russia de-escalate or not, it is already clear what could be the potential areas for collaboration in arms design and manufacture (see Fig. 4). Of prime interest to Russia are military electronics, thermal imaging, avionics, engines (aircraft and ship), electric power supply and transmission systems, unmanned vehicles (air, land and underwater), light and ultra-

Figure 3
Evolution of the defence and aerospace supply chain



Source: SBAC / A.T. Kearney

Figure 4
Room for potential cooperation between Russian and foreign defence industries

Weapon systems	Russian materiel: on pair with Western equivalents or better	on pair with Western equivalents	not quite as good as Western equivalents	far behind Western equivalents
Fighter planes		X		
Military airlifters			X	
Helicopters		X		
Ballistic missile/air defence	X			
MBTs and other AFVs			X	
Artillery			X	
Small arms			X	
UAVs				X
Cruise missiles	X			
PGMs			X	
Submarines		X		
Large surface combatants				X
Small surface combatants			X	
C4I				X
EW			X	

Source: FFI / FOI / CAST

light helicopters, as well as retooling the defence and aerospace industry with the state-of- the-art machinery and equipment.

It is quite fascinating how the above strengths and weaknesses matrix overlays the current Russian Armed Forces priority programmes (see Fig. 5). Notably, the Russian Armed Forces, with little exception related to non-proliferation issues, could find a motivated partner for collaboration on almost every topical acquisition programme.

With due regard to technology development potential and political ties, at least four regional clusters of international arms collaboration, featuring the Russian defence industry, are perceptible, Northeast Asian (China, Korea); South and South-Western Asian (India, Iran); Middle Eastern (Turkey); South American (Brazil) and; hopefully, European (France, Italy), with apparently different labour division patterns applicable thereto.

When considering international collaboration in arms production, one should take into account that it is almost impossible to find in the international market an advanced weapon system of indigenous design that would not contain U.S.-designed or U.S.-manufactured components. Whereas one could speculate about ITAR-free solutions in terms of light arms, artillery systems, armour or ships (the platform proper), when it comes to air defence systems or combat aircraft or missiles or space systems the share of ITAR- free technologies steadily decreases with the increase in the level of sophistication. This makes the issue of using the COTS solutions, where appropriate, ever more topical for the Russian defence industry and its foreign counterparts.

At the end of the day...

By 2030, we will most probably see, on a global scale, two centres of gravity in defence science and industry, Transatlantic (evolving under the aegis of NAFTA and NATO) and Eurasian (evolving under the aegis of Eurasian Economic Union, Collective Security Treaty Organisation and Shanghai Cooperation Organisation). The backbone for the Transatlantic centre would be made of a U.S./EU ligament, whereas the Eurasian centre would see a Sino-Russian tandem, with the rest of the world nations travelling like electrons, as per Niels Bohr planetary model of the atom, along the discrete orbits at fixed distance from the nuclei. Each orbit and its distance from the gravity centre will reflect the depth of political, military, economic and financial integration of the respective partner nation with the core nations. As is the case of electrons, some nations, having acquired the critical mass, either politically or militarily or economically or science-wise, could pass from one orbit onto the other, emitting or absorbing a photon, which would stand for increasing or decreasing their respective added value within the international collaboration pattern. In some cases, the outermost partner nations (electrons) could be drawn over to the other core nation (atom).

On the national scale, the sanctions regime imposed onto Russia will likely persist for the long- term which would mean for Russia (i) need to strictly prioritise the acquisition programmes which make up the subject matter of the current (and eventually rescheduled) GPV-2020 and the yet-to-be-adopted GPV- 2025, (ii) wider use of COTS solution, where appropriate, and (iii) further optimisation of the national defence industrial base with the resolute disposal of the non-core assets.

Figure 5
Russian Armed Forces priority acquisition programmes within the international arms collaboration context

Weapon system under development	Weapon system to be replaced	Room for International collaboration	Likely collaboration partners
Strategic Rocket Force (RVSN)			
Sarmat advanced heavy ICMB (silo-based) / SS-X-30	SS-18 *Satan*	No	
Avangard advanced light ICMB (railroad-based)	SS-24 *Scalpel*	No	
Rubezh advanced light ICMB (silo-based) / SS-X-31	SS-19 *Stiletto*	No	
Army (SV)			
Families of advanced modular combat platforms: *Armata* (heavy tracked – MBT, IFV, ARV), *Kurganets-25* (medium tracked – IFV, APC, ARV), *Bumerang* (medium wheeled – IFV, APC)	 T-72/T-90 BMP-1/BMP-2/BMP-3 BTR-80/BTR-82	Yes	China, India, Iran, Turkey
Koalitsiya-SV advanced 152mm SP artillery system (tracked and wheeled)	2S19 *Msta-S* (SP), 2S3M *Akatsiya* (SP), 2A65 *Msta-B* (towed)	Yes	China, India, Iran
Taifun-K / *Taifun-U* families of MRAP vehicles (4×4, 6×6 and 8×8; 2-, 4- and 8-tonne capable)	None	Yes	Belarus
Family of advanced unmanned combat platforms	None	Yes	Belarus
Advanced combat gear loadout (Gen 3), incl. new automatic assault rifle	*Ratnik, Barmitsa*	Yes	

Figure 5 (cont'd)

PAK FA advanced multirole fighter (heavy, Gen 5)	Su-30M2/Su-30SM *Flanker C*	Yes	India
LMFS advanced multirole aircraft (light)	MiG-29SMT *Fulcrum C*	Yes	India, Iran
Shershen-EP advanced ground attack aircraft	Su-25SM *Frogfoot E*	Yes	India, Iran
PAK DA advanced long-range bomber	Tu-160 *Blackjack*, Tu-95MS *Bear H*	No	
PAK TA / Yermak advanced strategic airlifter (heavy)	An-124 *Condor*, An-22 *Cock*	Yes	China
Il-214 *STS* advanced tactical airlifter (medium)	An-12BK *Cub A*, An-72 *Coaler*	Yes	India
Il-112V advanced tactical airlifter (light)	An-26 *Curl*	Yes	Iran
PSZ advanced tanker aircraft	Il-78 *Midas*	Yes	China, India
A-100 *Premier* advanced AEW aircraft (semi-strategic and operational)	A-50U *Mainstay*	Yes	India, Iran
Tu-214R *Fraktsiya 4* advanced ECM/ESM aircraft	Il-20M *Coot A*, An-12BP *Cub C/D*	No	
Tu-214SR *Yastreb* advanced airborne CP/communications relay aircraft	Il-22M *Coot B*	No	
Tu-214K advanced aerial mapping/survey aircraft	An-30 *Clank*	No	
Il-112PS advanced SAR aircraft	Be-12PS *Mail*, An-12PS *Cub*	Yes	Iran
Yak-152 *Ptichka-VVS* advanced primary trainer (part of *UTK PNP*)	Yak-52	Yes	China, India, Brazil, Iran, Turkey
Advanced combat helicopter (fast and light, Gen 5)	Mi-28N *Havoc*, Ka-52 *Hocum B*, Mi-35M *Hind E*	Yes	China, India, Turkey
Advanced transport helicopter (heavy)	Mi-26 *Halo*	Yes	China, India, Turkey
Advanced utility helicopter (light)	Mi-2 *Hoplite*, Ansat	Yes	Iran, Turkey
Family of advanced UAVs (UCAV, HALE, MALE)	Tactical UAVs (mostly, mini and micro)	Yes	Belarus, Iran
Hypersonic air-launched cruise missiles	Kh-555 (AS-15 *Kent*), Kh-101 (AS-X)	Yes	China, India
Air and Ballistic Missile Defence (VKO)			
S-500 Triumfator-M LR SAM system (ABM-capable)	A-135 (SH-11/ABM-4 *Gorgon*, SH-08/ABM-3a *Gazelle*), S-400 (SA-21 *Growler*)	No	
S-350 Vityaz MR SAM system	S-300PS/PM (SA-10d/e *Grumble*), Buk M1-2 (SA-17 *Grizzly*)	Yes	India, Iran, Belarus
Family of advanced forward-based transportable radars (sea-, road- and rail-mobile)	None	Yes	Belarus
Angara advanced family of modular space launching vehicles (light, medium, heavy)	*Kosmos-3M* (SL-8), *Soyuz-U* (SL-4), *Proton* (SL-12)	Yes	India, Korea
Navy (VMF)			
Advanced ballistic missile nuclear submarine (Gen 5)	*Borey* class	No	
Advanced fleet nuclear submarine (Gen 5)	*Yasen* class	No	
Advanced multipurpose destroyer (conventional or nuclear-powered)	*Udaloy* class, *Sovremenny* class	Yes	India
Advanced offshore patrol vessel (littoral modular corvette)	*Grisha V* class, *Parchim II* class, *Nanuchka III* class, *Tarantul II* class, *Natya* class, *Gorya* class	Yes	India, Turkey, Korea, Iran
Advanced AIP submarine	*Kilo* class, *Improved Kilo* class	Yes	China, India, Iran, Korea
Advanced MPA aircraft	Tu-142MK/MZ *Bear F Mod 3*/*Mod 4*	Yes	China, India
BMMP advanced amphibious assault vehicle	BMP-3F, BMP-2	Yes	China, Iran, Korea, Turkey
Family of advanced UUVs	None	Yes	China, India, Korea, Turkey

Source: CAST

ISRAEL'S DEFENCE INDUSTRY IN 2030 AND BEYOND

Yoram Evron
University of Haifa

To a certain degree, the Israeli defence industry (IDI) is unique among defence industries. These are usually huge corporations operating in states with a strong industrial base, depending mostly on their local markets; the IDI operates in a state with a relatively small industrial sector and greatly depends on export. The IDI's advantages, which grant it a significant presence in the global arms market, are the close connection between its research and development (R&D) and the battlefield, Israel's relatively advanced science and technology capability, and the Israeli innovative culture. With these advantages, it can provide its customers in a relatively short time cost-effective, battle proven solutions. However, to maintain its high-volume export, the IDI has to compete with massive corporations supported by strong governments. To succeed, it has to expand its activity to new fields and territory, improve the coordination among the various companies in the sector, and simultaneously retain its innovative DNA. These are probably the main challenges that the IDI may face in the coming 15 years.

The structure and characteristics of the Israeli defence industry

The IDI consists of four big companies: three are government-owned: IAI, Rafael, and IMI; one—Elbit—is a public company, which has bought out many of Israel's foremost private defence industries. With annual revenues of US$2.7 billion (Elbit) to US$550 million (IMI), these arms manufacturing companies can be classified as medium-size in global terms. The three biggest companies (Elbit, IAI, Rafael) have annual revenues of over US$1.5 billion each, and feature in SIPRI's list of the world's top 100 arms-producing companies (2012 data).[41] These three

41 Stockholm International Peace Research Institute (SIPRI), http://www.sipri.org/research/armaments/production/Top100.

42 SIBAT, "Press Brief for 2013," www.haaretz.co.il/st/inter/Hheb/images/SIBET.ppt.

have numerous subsidiaries in Israel and abroad, both military and civilian. Besides these companies, 600 smaller ones are registered with Israel's Ministry of Defence (MOD). Their annual revenue is less than US$100 million each, and they comprise about 15 per cent of the IDI sector in revenue. In sum, the IDI's share of the global defence industry is about 0.5 per cent in terms of revenue.[42]

In innovation capability, the IDI develops and produces advanced but niche defence products. With the exception of the *Merkava* MBT it produces no major arms systems or platforms, and focuses on systems and subsystems in avionics, radar, electro-optics, UAVs, electronic warfare, cyber warfare, etc.

The IDI is unique in terms of its great reliance on foreign markets—about 75-80 per cent of its revenue. The reason is its inability to finance its huge R&D investments by local acquisition. So despite Israel's relatively small share in the global defence industry activity, it is one of the world's leading arms exporters (about US$ 7 billion annually). Its products sell well not just for their technological advancement but mainly because they are battle proven, cost-effective and supplied within a relatively short timetable. Israel is also willing to transfer technologies, to upgrade existing systems and to operate through local joint ventures that it sets up in customers' countries.[43]

The Israeli defence industry in 2030

Presumably, as long as Israel's strategic and political conditions don't change dramatically, and armed conflict remains an inseparable part of world politics, the IDI will maintain its position as a leading niche player in the global arms market. Given Israel's local conditions, we can also expect the IDI to keep relying on export. Under these assumptions, we can foresee certain developments, divisible into three categories: new technologies and fields of activity, IDI structure, and its activity in new markets.

1. New technologies and fields of activity: while the IDI will keep focusing on development and marketing of pure military technologies and systems, the decline of military budgets worldwide requires expansion of the share of other types of products and technologies. Thus, in addition to the IDI's continuous expansion and updating of its array of military products, it will develop new fields. For instance, all four leading companies regard cyber activity as a growth engine and aim to develop this field. They have established cyber divisions that develop new technologies and concepts that are both marketed as standalone products and integrated with existing products.[44] Similarly, keen attention is paid to HLS products and technologies, a growing number of which include cyber systems.[45] Lastly, more attention is being given—at least by Rafael and IAI—to civilian products with similar technologies to their military ones.

2. The structure of the IDI sector: In general, the IDI will become more consolidated. Three trends indicate this development. First, the four big companies will be reduced to three. IMI, which has not done well for years, is being privatised (completion of the process is due by 2020). According to a government decision, it will be divided into two: one company will take over most IMI activity and will be privatised. The other will take over the sensitive projects and become a government company.[46] We may expect the private company to find it difficult to remain large and independent, while the government company will merge with Rafael. The other big three will probably remain independent, and subject to their business performance and Israel's political situation, IAI and Rafael may be privatised but remain under strong governmental control. Secondly, in the last several years, the ties between the big three (Elbit, IAI, and Rafael) and small companies in the industry have strengthened. All the big three own, support and collaborate with start-up companies, as they see them as a powerhouse for developing new technologies and ideas. This trend is expected to expand.

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43 Kobi Kagan, Oren Setter, Yoad Shefi and Asher Tishler, "Defence Structure, Procurement and Industry: The Case of Israel," in Stephan Markowski, Peter Hall and Robert Wylie (eds.), *Defence Procurement and Industry Policy: A Small Country Perspective* (Oxon: Routledge, 2010), 228-254; Arie Egozi and Dennis-R Merklinghaus, "The Israeli Defence Industry," *Military Technology* (Oct. 2010), 109-125.

44 Reuters, Sep. 34, 2014, http://in.reuters.com/article/2014/09/23/israel-cybersecurity-companies- idINKCN0HI0YB20140923; *The Marker*, Sep. 14, 2014. In Hebrew.

45 For example, since 2011 Israel has held an annual HLS international conference to promote its exports in this field. See http://www.israelhls2014.com.

46 *Globes*, Apr. 23, 2014, http://www.globes.co.il/en/article-finance-ctee-approves-imi-privatization- 1000933314.

Finally, competition among the big three—one of the IDI's biggest problems—may perhaps be managed better. This issue has drawn the government's, especially the MOD's, attention; the latter has apparently assumed a more forceful position against the companies in this respect. In 2012, the MOD director-general threatened to withhold export license from companies that competed with each other. In addition, the heads of the largest DIs and MOD's director-general meet regularly, among other things to handle their competition abroad. Also, the CEOs of Elbit and IAI have been replaced recently, and the new ones apparently take a more collaborative approach.[47]

3. New markets: The IDI applies strong pressure on the MOD to allow it to operate in new markets. So far, it has been prevented from selling its products in many countries due to Israeli concern over technology leaks and agreements with the U.S. Worried about political limitations and declining military budgets in European and North American markets, the IDI exerts greater efforts in Asian and other markets. Last year it was said that Israel had sold defence systems to Pakistan and Egypt.[48] The IDI is also pressing the MOD to renegotiate understandings with the U.S. that limit its activity in certain countries.[49]

To conclude, by 2030, the Israeli defence industry can be expected to be more consolidated and focused on development of cutting-edge technologies, systems and solutions, while reducing production to a minimum. It will become more of a huge development, integration and marketing house than a traditional industry. As such, it will broaden its global network of partners, subsidiaries and sub-contractors; will be more active in markets other than West Europe and North America; and will be increasingly engaged in defence-related products that can hardly be associated with traditional military systems.

47 *The Marker*, Nov. 21, 2012. In Hebrew.

48 *Haaretz*, June 11, 2013. In Hebrew.

49 As part of this trend, in early 2014 the MOD increased from 39 to 100 the number of countries that the IDIs can sell to without applying for export licenses. *Haaretz*, March 19, 2014. In Hebrew.

NEW ARMS-SUPPLIER STATES

Kenneth Boutin
Deakin University

This paper examines the emergence of new arms suppliers and the consequences for the global defence-industrial landscape in the timeframe of 2030 and beyond. It argues that these issues cannot be considered in isolation from broader industrial trends. The ranks of arms exporting states will continue to expand, and we can expect to see two general paths of arms supplier development: defence industrialisation based on integration into trans-national industrial processes involving more established arms suppliers, and defence industrialisation through deliberate efforts to develop autonomous defence-industrial bases.

This has significant implications for the structure of the global arms industry and for efforts to manage the diffusion of advanced arms. Not only is it the case that advanced arms will be available from an expanding range of sources, but the integration of emerging arms industries into industrial processes centred around more established suppliers will help to sustain their development while increasing their importance to arms production and development in established arms suppliers. The defence-industrial landscape in 2030 and beyond will be characterised by generally less independent arms development and production on the part of established and emerging arms suppliers alike.

The emergence of new arms suppliers

The emergence of arms suppliers is understood here as involving the sustained development of a capacity to export arms that are produced or co-produced locally, or to contribute to arms produced in other states. This study is not concerned with states which intermittently transfer arms produced by "enclave" industries or by retransferring arms from third parties, as they have little long-term impact on the structure of the international arms transfer system.

The pattern of defence industrialisation is crucial to the arms supplier profile of a state. Recent decades have seen the emergence of an approach to defence industrialisation based on integration into trans-national industrial processes, often with official encouragement if not support. This is distinct from the more traditional approach involving a deliberate effort to develop a relatively autonomous defence-industrial base. We can expect these two general models, each of which offers particular benefits, to constitute the standard approach for emerging arms suppliers, with the pattern of defence industrialisation having significant implications for the international arms transfer system.

The emergence of arms suppliers through defence industrialisation based on integration into trans-national industrial processes is likely to constitute the most common model in the time frame of this study. This may be based on formal government-to-government arrangements or formal or informal inter-firm arrangements, including joint ventures and strategic partnerships. This trend first emerged in civil industry but is increasingly evident in defence-related research and development (R&D) and production.[50] The example provided by the successful defence-industrial development of a number of East Asian states, including Singapore and South Korea, encourages others to follow suit. This has the added advantages of compatibility with many states' developmental strategies, potentially contributing to efforts to promote development in key industrial sectors such as aerospace and electronics. This approach to defence industrialisation can be, but is not necessarily, state-led and is at least partially market-based. Embedding defence industrialisation in market processes means that while arms suppliers which develop in this manner will have far less independent production and R&D capabilities and political authorities must accept less comprehensive defence-industrial capabilities, this potentially is offset by the development of strong niche capabilities and by enhanced sustainability through easier access to the products of offshore sources of innovation and production. Political authorities in these states often approach arms exports as an important means of supporting local industry. This includes contributing to defence R&D and production programmes based in other states.

The alternative, more traditional model of state-dominated defence industrialisation will remain the exception. This can be expected in states where local industry is relatively isolated from trans-national industrial processes and where there are strong national security concerns coupled with concerns about the availability of arms from foreign suppliers. This approach centres around developing relatively independent national capabilities and often involves a focus on promoting "national champions", though these may draw on foreign technological and component inputs in a manner that is essentially parasitic. Iran and North Korea provide important examples of this approach at the present time, but this constitutes the ideal approach in India. This approach has less to recommend it in the sense that it requires more extensive state support and is more difficult to sustain, but it provides a much stronger basis for comprehensive national defence-industrial capabilities. Arms exports often are considered an indispensable means of supporting the defence industry.

New arms supplier states and the global arms industry

We can expect to see the continued emergence of new arms suppliers and their progressive development over time. Advanced arms that represent or are not far removed from the state of the art will be available from a wider range of sources. These states will supplement, rather than supplant, established arms suppliers. While the number of suppliers of advanced arms will increase, these will not necessarily be in a position to supply a comprehensive range of arms or to supply them independently. Arms production and development in these states will overlap with that of more established arms suppliers due to trans-national industrial integration, including in terms of arms-related R&D and production. Arms production and development in established arms supplier states will grow more dependent on the contribution of emerging defence-industrial states in the process, as they contribute components and technologies to established arms suppliers.

This has important implications for the international arms transfer system by rendering the system far less hierarchical than formerly, further undermining the analytic utility of approaches based on templates of "ladders of production" or "tiers" of suppliers. The effects of this can be expected to deepen over time, and advanced arms increasingly will be the product of firms from multiple states. Important regional differences likely will remain, but we can expect to see significant development of arms suppliers in areas not currently conspicuous in these terms as well as in East Asia.

50 See Stephen G. Brooks, *Producing Security: Multinational Corporations, Globalization, and the Changing Calculus of Conflict* (Princeton, NJ: Princeton University Press, 2005), 80-89.

There will remain a second category of arms supplier characterised by a capacity to provide a wide range of less-advanced and expensive arms, though they may be limited to supplying analogues or derivatives of foreign designs. These suppliers, which can be described as the "bottom feeders" of the international arms market, will meet the needs of states with limited resources and will serve as "suppliers of last resort" to states whose procurement options are limited by political issues and poor human rights records.

The transformation of the global defence-industrial landscape has important policy implications. The management of defence industrial activities in established and emerging arms supplier states alike will prove a far more difficult and complex exercise in an environment of deepening structural industrial integration. This similarly will be the case where controlling the diffusion of arms (including components and critical arms-related technologies) is concerned. Developing effective industrial surveillance and governance mechanisms for the range of industrial activities involved is a complex and difficult exercise, and limiting and preventing defence-industrial development in cases where this is considered important may prove impossible.

Issues for further consideration

The developmental trajectory of the evolving global arms industry raises a number of important issues for further consideration. This can be expected to generate greater efforts to manage defence-related industrial processes in the interest of security. It is important to consider the general form this will take. Will authorities be able to develop effective national industrial surveillance and governance mechanisms without jeopardising economic competitiveness? Will this drive increase inter-state collaboration or greater interest in developing arrangements such as the "approved communities" of defence suppliers being promoted by authorities in the United States at the present time?[51] Finally, does China represent the future of state-defence industry relations? As it develops and its economic reforms deepen, China is developing an approach involving liberalisation of state-owned enterprises and a close relationship with private sector arms firms. While the starting point for most states is very different from that of China, security concerns may lead them to a similar position.

51 See J.D. Kenneth Boutin, *American Technology Policy: Evolving Strategic Interests after the Cold War* (Washington, DC: Potomac Books, 2013), 106-20 for an indication of the complex requirements involved.

PROGRAMME

9 November 2014 (Sunday)

1900 – 2100	Welcome Dinner

10 November 2014 (Monday)

0830 – 0900	Registration
0900 – 0915	Welcome and Opening
0915 – 1200	Session 1: Global Issues
	Kathleen A. Walsh *Dual-use Technologies*
	Richard A. Bitzinger *Globalisation vs. Protectionism*
	Caitríona H. Heinl *Cyber*
	Paul M. Cole *Nuclear Weapons*
1045 – 1100	Tea/Coffee Break
1100 – 1200	Session 1 continues
1200 – 1330	Lunch
1330 – 1500	Session 2: USA and Europe
	Jonathan D. Caverley *The U.S. Defence Industry in 2030*
	Phil Finnegan *The U.S. Defence Industry in 2030 – Another View*
	Martin Lundmark *The Future of the European Defence Industry*
	Aude Fleurant *The Future of the European Defence Industry – Another View*
1500 – 1515	Tea/Coffee Break
1515 – 1645	Session 3: Asia and Emerging Supplier
	Michael Raska *China*
	Maxim Shepovalenko *Russia*
	Yoram Evron *Israel*
	Ken Boutin *New Arms-Supplier States*
1645 – 1700	Closing Remarks
1800 – 2030	Conference Dinner

PARTICIPANTS

(alphabetical sequence according to last name)

Richard A. Bitzinger
Senior Fellow and Programme Coordinator
Military Transformations Programme
Institute of Defence and Strategic Studies (IDSS)
S. Rajaratnam School of International Studies (RSIS)
Nanyang Technological University (NTU)

Kenneth Boutin
Senior Lecturer in International Relations
Deakin University

Jonathan D. Caverley
Research Associate
Political Science Department and Security Studies Programme
Massachusetts Institute of Technology

Paul M. Cole
Political Economist and Business Consultant

Yoram Evron
Assistant Professor
Department of Asian Studies
University of Haifa

Phil Finnegan
Director
Corporate Analysis
Teal Group

Aude Fleurant
Director
Arms and Military Expenditures Programme
Stockholm International Peace Research Institute

Caitríona H. Heinl
Research Fellow
Centre of Excellence for National Security (CENS)
S. Rajaratnam School of International Studies (RSIS)
Nanyang Technological University (NTU)

Martin Lundmark
Deputy Research Director
Swedish Defence Research Agency (FOI)

Michael Raska
Research Fellow
Military Transformations Programme
Institute of Defence and Strategic Studies (IDSS)
S. Rajaratnam School of International Studies (RSIS)
Nanyang Technological University (NTU)

Maxim Shepovalenko
Research Fellow
Centre for Analysis of Strategies and Technologies (CAST)

Kathleen A. Walsh
Associate Professor
National Security Affairs Department
U.S. Naval War College

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S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University

Nanyang Technological University
Block S4, Level B4, 50 Nanyang Avenue, Singapore 639798
Tel: +65 6790 6982 | Fax: +65 6794 0617 | www.rsis.edu.sg