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Editorial

Firstly, our sincere thanks to all the participants as well as our heartiest congratulations to the winners of the 2003 CDF Essay Competition! The prize presentation ceremony was held on 18 June 2003 at SAFTI MI where the Guest-of-Honour, Chief of Defence Force then-MG Ng Yat Chung, presented the prizes to the winners as well as tokens of appreciation to the judges.

The top three winning essays are published in this issue and we are sure that the minds of readers will be stimulated by their arguments and ideas. The First Prize essay, by CPT Stanley Chua, discusses the ever-important issue of training safety. He argues that despite employing risk assessment tools, trainers must still contend with psychological factors, such as flawed assumptions and irrationality, which can still impact on safety and that better awareness of these factors is the first step towards countering them.

CPT Choy Dawen's Second Prize essay takes a critical look at the concept of Effects-Based Operations (EBO) as well as its track record in order to assess its efficacy. His counter-intuitive claim that precision weapons may lead to greater emphasis on destruction at the expense of effects is a particularly insightful one. He concludes by offering some factors towards building the framework for EBO doctrine. LTC Joshua Ho's article on EBO, which also appears in this issue, would be a very useful starting point before one tackles CPT Choy's essay as it is a very comprehensive review and summary of the existing EBO literature.

The Third Prize essay, by LTC Roland Ng, hypothesises that modern military power is increasingly derived from information, access and speed. When network efforts are effectively applied, they can be a significant force multiplier for the military. However discovering the best strategy to apply network effects is a "fuzzy problem" at best and the author stresses that it must always be kept in mind whether the investments required will yield added value-for-money combat power.

You can view the titles, authors and synopses of the winning essays, as well as the list of judges, at the POINTER website (http://www.mindef.gov.sg/safti/pointer).

In this issue, we are also very privileged to have an article by Chief Defence Scientist Prof Lui Pao Chuen, co-authored with LTC Lai Chung Han, that traces the evolution of military affairs in MINDEF / SAF. With an intimate insider's point of view, it shares the historical context in which our defence build-up occurred and points the way to the future.

Eminent foreign practitioners and thinkers have also continued to share with us through POINTER's pages. LTG William Steele (ret.), formerly Commander US Army Pacific and President of the US Army Command and General Staff College shares his experiences about US Army Transformation in an interview with COL Lim Teck Yin, Commandant Singapore Command and Staff College. Dr James Boutilier, Special Advisor (Policy) at Canada's Maritime Forces Pacific Headquarters, shares his reflections on maritime security in the Indo-Pacific.

Finally, our "Letters" section has been renamed "Viewpoints" to better reflect POINTER's desire to give our readers a vehicle through which contests of ideas on professional issues can take place and to encourage you to share your ideas with us. We are pleased to present a very rich exchange on the concept of Integrated Knowledge-based Command & Control, better known as IKC2. BG(Ret) Sin Boon Wah, Deputy Chief Executive, Defence Science & Technology Agency presents some critical points on the one hand while a trio of writers, Dr Kenneth Kwok and LTC Roland Ng from the Future Systems Directorate and LTC Foo Khee Loon from the Joint Staff respond to BG(Ret) Sin's commentary.

We hope to see more high quality debate and invite our readers to write to us to share their thoughts and views.

Editors, POINTER

Sharing Experiences, Stories And Dreams: The Evolution Of Military Affairs In Singapore

by Prof Lui Pao Chuen & LTC Lai Chung Han

There is an open debate on the Revolution in Military Affairs or RMA – what it means, when it occurred or will occur, and how it will impact military operations. While RMA is more closely associated with the US military, especially in the wake of OperationDesert Storm and more recently Ops Iraqi Freedom and Ops Enduring Freedom, it was the Soviets who first coined the term " Military Technical Revolution " in the 1970s. They had thought that the next revolution would involve advances in micro-electronics, sensors, precision guidance, automated control systems and directed energy. The Soviets were not far off the mark.

Looking at how the SAF has developed since its inception in 1965, evolution is perhaps a more accurate description of the path we have taken. Our technology, organisation and doctrine have co-evolved progressively over the years. We are no longer the "poison shrimp" of the 1970s. Today, the SAF is a credible deterrent and is capable of securing a swift and decisive victory. The progress we have made closely mirrors Singapore 's rags-to-riches story. Here, we would like to share with readers our views of the key developments of the SAF over the last 36 years as well as our dreams of how the SAF can evolve in the next 20 years.

Fundamentals of Singapore's Defence

Let's begin with the fundamentals of Singapore's defence. This sets the scene because fundamentals do not change easily. Firstly, we are located at the Southern tip of the Malaysian Peninsula between the Malaccca Straits and the South China Sea . We are small in size. The little red dot in the satellite image of South East Asia is larger than the whole of Singapore (see Diagram 1). Land is scarce. Our land area was 580km 2 at independence in 1965. We have since expanded our physical space through land reclamation, increasing our land area by some 17%, to 680 km 2 in 2000.

Secondly, we have no natural resources. We import almost everything, including all our food. Half of the water we consume comes from Malaysia.

Thirdly, our economy is extremely dependent on free trade, particularly sea-borne trade. Today, our trade to Gross Domestic Product (GDP) dependency ratio is 3:1. Our Sea Lines of Communications must be open and free for us to be economically viable.

Fourthly, we need Foreign Direct Investment to sustain our economic growth. Peace and stability are pre-requisites for investors to invest in a country. Therefore, we need a strong military to deter aggression and provide national security in order to have peace and stability.

The resources of the entire nation are mobilised under our Total Defence Concept to deal with threats to our national security. All the five components of Total Defence – Military, Civil, Economic, Social and Psychological – are important and mutually reinforcing. You can think of them as the five fingers of a hand. However, Military Defence takes up the lion's share of our most precious resource, all the men in Singapore . At the age of 18, all men in Singapore are required to serve two years of compulsory full-time National Service (NS). On completion of their full-time NS, they are liable to be called-up for military training for up to 40 days a year till they are 45 to 50 years old. The Government of Singapore is prepared to spend up to 6% of our GDP on defence. A significant part of the land in the more remote areas of Singapore has also been allocated for operational bases, military camps and training areas. Clearly, there is a limit to how much national resources we can deploy for national security. Our present level of investment is about as much as our country can afford.

The Qualitative Edge of the SAF

The qualitative edge of the SAF is our people. Our population of four million comprises three million Singapore citizens, and one million permanent residents and foreigners. Our economy can draw on a population of four million people, but our national security is built on our three million citizens. Obviously, we do not have the people to build up a large professional SAF. To compensate for our lack of numbers, we have to leverage on each and every one of our people. We do this through education and training, and by challenging them with heavy responsibilities in the

SAF. Parallel to the development of our people, we have to develop our organisations, warfighting doctrines and to create additional leverage through technology and systems engineering. This formula for the development of our military capability is unlikely to change in the foreseeable future.

Revolution versus Evolution in Military Affairs

It is difficult for military forces, including the SAF, to make trend-breaking changes during peacetime. It is even more difficult for a military force with proud traditions, or for a young military force that has just won a war.

An example taken from recent history is how the formidable Israeli Air Force (IAF) was humbled on the first day of the Yom Kippur War in October 1973. This was six years after the amazing victory of the Israeli Defense Force in the Six-Day War. The Six-Day War was decided after the first three hours with the success of the surprise attack mounted by the IAF. Their fighter aircraft flew low-level to avoid detection by Egyptian air defence radars and achieved complete surprise. Nearly all the fighters of the Egyptian Air Force were destroyed at their airbases. Six years later, the Israelis were caught by surprise when the Egyptians started the war on the Jewish holy day of Yom Kippur. The Egyptian Army broke through the Israeli defence lines and surged across the Suez Canal . They deployed a formidable air defence to protect their Army from the IAF. As a result, about 10% of the attacking aircraft were shot down. The IAF had to change their tactics quickly. In fact, they were able to adapt their tactics and supported the ground forces in crossing the Suez into Egypt before the war was called to an end.

It was the pain of heavy losses and near-defeat that helped the IAF learn quickly and jettison their doctrine of low-level attack. Similarly, it took the losses suffered by the Royal Air Force during the first three days of Operation Desert Storm in 1991, some 18 years later, for Western Air Forces to reach the same conclusion that the doctrine of low-level attack had been made obsolete by low-level air defence weapons. For the SAF, we hope we will never have to learn such lessons that same painful way. We recognise that we have to change and to keep changing our doctrines, weapon systems and organisations. But how do we know for sure that new warfighting concepts and doctrines will be superior to what we already have in place? Looking at the private sector, corporations fight many small battles every day and have quarterly financial results to provide feedback on their strategies and tactics. But the SAF does not have such feedback or wish for many small battles to help shape its strategies and tactics.

Not surprisingly then, the conditions for a RMA are stringent and almost always involve some nasty shock to the system and status quo. Fortunately, RMA can sometimes occur under less dramatic circumstances. For instance, if there are daring dreamers and doers – the visionaries and missionaries – with time to think outside the confines of primary work; when the operational tempo is low and the organisation is willing to change; when Modelling and Simulation (M&S) is used extensively to experiment with the future.

In the last decade, Sweden is the only country in the world that has been able to radically restructure her military forces with a 70% cut in Army units, 50% cut in Navy units and 30% cut in Air Force units. In fact, the amalgamation of the three Service Staffs with the Joint Staff is even more radical than the drastic downsizing of the Services. In most countries, changes to military forces are more evolutionary than revolutionary, even when the new warfighting concepts being introduced are revolutionary in nature. Capital assets like tanks, fighters and ships are very expensive and will take a long time, some 30 or more years, to depreciate and be replaced. Only a small percentage of a military force is therefore renewable annually. The Swedes, as the first movers in the current RMA, will have taken about 10 years to go from conceptualising their new warfighting concept to fielding a demonstrator on Gotland Island in 2006.

Integrated Warfare and I4

Turning to the SAF, our evolutionary path can probably be described as moving towards greater integration. Today, the SAF ' s warfighting concept may be described as Integrated Warfare. We started on this path in the early 1980s and we have today integrated the Concept of Operations (CONOPS) of the Army, Navy, Airforce and Joint Staff. Should we ever go to war, it will be one war and not three.

Integrating CONOPS is the first "I" of "I4" – "Integration, Integration, Integration & Integration". Integration is more than Joint as an integrated force will have to be developed in a holistic manner with all the linkages and inter-connections identified at the onset, not as afterthoughts. This is the most difficult integration to achieve.

The second integration is between Operations and Intelligence. The blurring in the distinction between sensors that are traditionally used for operations as opposed to those used for intelligence has forced the integration of the two communities. This integration of sensing systems and counter-sensing systems will help to achieve surprise and

avoid being surprised, which will be decisive in winning wars of the future.

The third integration is the integration of weapon systems within each Service and across Services. Every weapon system will be able to tap the composite real-time situation picture, and in turn contribute information from its onboard sensors.

Finally, the fourth integration is Integrated Defence Development, which converts the resources of money, people, time and political goodwill into military capabilities in the most efficient manner. This will require centralising the acquisition process along with a corps of professional system engineers and programme managers.

Command, Control and Communication & Intelligence

An example of an Integrated Warfighting System is our Integrated Air Defence System (IADS). At the centre of this system, and of the SAF as a whole, is the SAF Command, Control and Communication & Intelligence System (SC3IS). When the idea of a single integrated C3I system was first conceived, it was truly a revolutionary concept. And it was clearly the approach to adopt as we had the opportunity to build a new system from ground up. But we would not have the comfort of following the footsteps of others. Even the Israeli Defense Force and the Swedish Armed Forces, which were the paragons for Joint Warfare, had separate systems for each of their three Services. Naturally, no contractor offered to build the SC3IS for us. However, as we were sure that an integrated C3I system would give us the instrument to weld our three Services into an integrated whole, we had no choice but to take the plunge to develop the SC3IS.

As we could plan, design and build the system from scratch, we could create one single system to serve the needs of the three Services and the Joint Staff. In other countries, each Service would build a C3I system to meet its specific needs. Many years later, they would attempt, with great difficulty and at great cost, to make the three C3 systems inter-operable. As planned, the SC3IS became a key instrument for the three Services to learn to work together. And over time, the operational concepts of the three Services evolved from fighting separately towards the current SAF concept of Integrated Warfare.

In the case of the Army, because it was being built from ground up, there was no legacy equipment that needed to be integrated into the SC3IS. However, the Airforce, had inherited the radars, computers and displays of the Air Defence Radar Unit (ADRU) at Bukit Gombak. Line and microwave telecommunications connected the ADRU to Tengah Airbase and Changi Airbase, and to the Bloodhound Surface-to-Air Missile (SAM) squadron at Seletar. What the RAF left behind was a very advanced semi-automatic operational system for the 1960s, but it soon became obsolete in the late 1970s and created immense challenges for integration into the SC3IS. Like the Army, the Navy had no legacy C3I system and therefore our system engineers had greater freedom for system development and optimisation.

Overall, the physical components of the SC3IS such as operation centres, sensing systems, communication systems, computer and display systems and information-security systems took less than 10 years to develop. However, the human components like the command and staff officers as well as the doctrines and procedures took much longer! Concept development started in 1975, but it was only in the late 1980s that the system became fully operational and validated in exercises.

The SC3IS is today a healthy living system with the capacity to learn and adopt new concepts of operations. The key to its growth is the quality of its operational and technical staff, the continuous upgrading of its people, hardware and software. Our integrated development strategy was to take many small steps that would work, rather than to aim for one big bang.

Integrated Air Defence

A similar story can be told regarding our integrated air defence system. The Bloodhound SAM provided long-range interception of medium and high level incoming targets at ranges beyond 100km. It was however not designed to shoot down fighter ground attack aircraft flying low-level to evade radar detection. The RAF tried to protect their airbases with obsolete 40mm Bofors anti-aircraft guns. There was also no low-level air defence for other vital targets, like the Sembawang Naval Base and ADRU. This was the gap in the air defences the RAF had hoped to fill with the Rapier low-level SAM, which was still under development at that time.

Planning for a new air defence system began soon after the British announced its troop withdrawal on 16 January 1968 . The top priority was the defence of our airbases from low-level attacks. The first air defence weapon system that we purchased to fill the low-level air defence gap was 12 fire units of the most modern anti-aircraft guns. The then Technical Department in the Ministry of the Interior and Defence recommended the purchase of 24 units of twin 35mm Oerlikon guns and 12 units of Super Fledermaus fire control equipment from Contraves , Switzerland . These were then the most modern and sophisticated anti-aircraft systems in the world and the purchase proved that Singapore could afford to buy the best equipment for the SAF even in the 1970s. The Technical Department also managed the acquisition of all the other vehicles, radios and supporting equipment required to the raise the 160 Battalion, the first air defence battalion of the SAF.

Later in 1975, the Minister of Defence set up a Special Projects Office to review the SAF ' s major operational capabilities, including Singapore ' s air defence system. The top-level air defence study identified Singapore ' s vulnerability to low-level attacks by fighter aircraft and shelling by artillery and rocket artillery. To protect Singapore , the solution had to be a combination of an early warning system, active defence system and passive defence system. As we could not detect low flying aircraft until they were less than 10km from our borders because of terrain and having an airborne early warning system was beyond our means then, a SAM-based air defence concept was adopted.

Besides the "hardware" , the "software" of the air defence system, namely the people, doctrine and procedures were just as important and had to be developed in parallel. As in the development of the SC3IS system, the greatest challenge was not in the technical aspects of integrating the hardware. It was the creation of a community of men and women who would make the air defence system work as soon as it was commissioned and more importantly, to be able to continuously learn and improve the system. The integrated air defence system is also a manifestation of our Integrated Warfare concept with the RSAF assuming complete responsibility for the defence against air threats, including protection of Army units in the field. In turn, the Army protects the RSAF's airbases from artillery attacks.

Our air defence concept was changed soon after the IADS was implemented in 1983. The Government decided to purchase the E-2C Airborne Early Warning system. With the ability to see fighter aircraft from 200nm, a fighter-based defence would be more effective than a SAM-based defence. Although the squadron off our E-2C Airborne Early Warning aircraft was extremely costly, it was a strategic early warning system. It was also our first serious investment in Information Superiority.

The E-2C buy prompted the development of a new generation of systems for the SC3IS. For a start, the SC3IS would need new computers in order to operate with the E-2Cs. Link 4 and Link 11 were acquired to enable inter-operability with the US Navy (USN). In particular, Link 11 was a critical piece in enabling inter-operability between naval ships, fighter aircraft, E-2Cs, naval bases, airbases and operations centres.

Adopting New Concepts of Operation

With the completion of each project, the SAF gained greater operational capability and developed competencies in new warfare areas. Just as valuable to us were the skills and experience that came with implementing these projects. Our engineers became more confident with each success and dared to embark on more ambitious projects. For example, it was the integration and consolidation of some 30 years of hard-earned experience in naval ship design, construction, operation and support that give us the confidence to push the state-of-the-art in the new ships that we built for our Navy. Trust was built up over time between the operational staff of the Navy and the technical staff in DSTA and in the defence industries. It is also this trust that allowed our Navy to introduce new CONOPS without waiting to follow in the footsteps of older Navies.

This was evident in the Navy ' s acquisition of the Maritime Patrol Aircraft (MPA), Advanced Patrol Vessels (PV), Mine-Counter-Measure-Vessels (MCMV), Landing Ship Tanks (LST), Missile Corvettes and submarines in the 1990s. In the same period, Tuas Naval Base was developed to improve the shore-based capability of the Navy. The development of Changi Naval Base to replace Brani Naval Base began in the late 1990s, representing another jump in the shore-based capability of our Navy. The next jump in operational cap-ability will come at the end of this decade with the introduction of new stealth frigates.

In fact, the Navy's development is a classic case of what we like to describe as the "Daring to Dream, Do and Deliver" Integrated Defence Development cycles. The strate-gic cycle begins with "Dream" and continues with the phases of, "Deliberate", "Decide", "Do", "Discover", "Deliver" and "Delight", and back to "Dream" again. The tactical cycle encourages doing, discovering and deliberating.

New Conceptions of War

Looking to the future, we need new ways of conceptualising war. We have studied many scenarios in which the two extremes are the conventional war between peer states and low intensity conflict between two states with different types of forces during Troubled Peace. 1 The conventional war is short, decisive and very capital intensive. On the other hand, the low intensity conflict is protracted and costly in terms of demands on manpower. Having to prepare for both scenarios will require both money and people. This in turn requires us to examine resource allocation and tradeoffs in our force development plans.

We could think about the military functions as an arrowhead made up of seven triangles (see Diagram 2). The tip of the arrowhead is STRIKE. A military force must be able to strike with precise and lethal force. However, in order to strike, the force has to survive attacks by the enemy, which necessitates protection. Together, the two triangles of STRIKE and PROTECT form a diamond and can be construed as two sides of the same coin. For both sides, there are open programmes that serve as a form of deterrence to potential adversaries, as well as black programmes that give us the secret-edge. The force must also be able to move to and in the area of operations and to sustain itself during operations. The triangles of MOVE and SUSTAIN are therefore at the same level as PROTECT. Supporting these four triangles is the foundation of “Information Superiority” . This foundation is made up of the three triangles of SENSE, C3I and INFO WAR.

Technology Revolution

In the arrowhead of future war, new technologies feature prominently in each triangle. For STRIKE, the leading technology will still lie in guided missiles. In PROTECT, it is Stealth, Electronic Warfare (EW), Anti-Missile Missile (AMM) and Cover, Concealment and Deception (CCD). MOVE depends on air, land and naval plat-forms, while SUSTAIN requires logistics, engineering and maintenance. The foundational layer of SENSE, C3I and INFO WAR draws on EO & TI, radar, sonar, communications, computers and software.

We would like to cite a common life example to show how technology has evolved in the last 30 years. Volvo has developed only two sports cars in the last 40 years. The P1800 is 38 years old and you can still see it on the roads today. The new C70 is the latest sports car from Volvo. A comparison between these two cars will show that most of the new features like digital fuel injection control, automatic transmission, ABS, airbag, Electronic Environment Control (EEC), remote control door locks are computer-controlled electronic devices. Vehicle Electronics (VETRONICS) now account for more than one third of the cost of a car. As in other sectors, such advances in electronics, computers and software are no longer driven by military needs but by commercial applications.

These “disruptive technologies” and the remarkable drop in their prices have made new operational capabilities more affordable and realisable. Technologies in communications, sensors and computers and the fusion of these technologies in various applications like Internet can be adapted at a very low cost for military applications to achieve Information Superiority. The exponential increase in performance of microchips and the fall in their prices have also made the production of missiles less costly. For instance, we read that Boeing can produce the new Tactical Tomahawk at US$700,000, a small fraction of the original cost.

The Challenge of Integration

Besides leveraging on technology, we need to integrate military operations with the new technologies. A major obstacle to integration is the natural tendency of organisations to optimise within their boundaries. Integrated Defence Development attempts to create openings between organisational boundaries, allowing great scope for globally optimised solutions. The integration of MINDEF, the SAF, DSTA, local defence Industries and our universities in their efforts to plan and develop new warfighting systems is critical. The other critical element is the integration of the operational staff and technical staff.

Over the years, we have opened windows and doors between the Operations and Intelligence functions. We are also opening windows and breaking walls between the three Services and the Joint Staff. The demolishing of walls is however like area cleaning or grass cutting - a never-ending task. We need to continue demolishing walls all the time otherwise they will close up again. After 20 years at integration, Joint Operations & Planning Directorate is still very much into the business of demolishing walls.

For the world’s leading armed forces, the integration of Integrated Knowledge-Based Command and Control and Precision Strike is key to compressing the warfighting cycle. We can characterise this as the “ LEADER ” cycle

comprising the operational tasks of Locating, Enquiring & Identifying, Attacking and Defeating enemy threats, Evaluating the results of the attack and Reporting the results (see Diagram 3).

Our view is that the side which can complete the LEADER Cycle faster will win the battle. The first two tasks of locating the enemy and identifying them are the prerequisites for the attack. The technologies of stealth and counter stealth, Electronic Intelligence (ELINT) and counter-ELINT, Electronic Counter Measures (ECM) and Electronic Counter-Counter Measures (ECCM) will enable the side that has mastery of the electromagnetic space to find the enemy first and to conceal its own forces. In the Internet world of today, speed has replaced mass as the competitive advantage in business. The speed to mass effects of guided weapons launched from separate locations has also displaced the massing of forces as the competitive advantage in warfare. The competitive advantage of military forces will be speed and precision.

Warfare 2020

Indeed, if we indulge in a little crystal ball gazing, the fundamentals of warfare in 2020 will remain largely unchanged. Surprise, Offence, Defence and Leadership will continue to be relevant. Missiles of various kinds will form the offensive "spear" of warfare, while CCD, Armour, ECM and AMM will provide the defensive "shield" . In 2020, there will be a proliferation of high performance sensors and sensor platforms, unmanned systems and low cost guided weapons. Even individual soldiers will be enhanced with computers. Wireless networking, the Internet and higher performance computing will become ubiquitous. M&S will also have pride of place in all our planning processes.

Turning to our area of operations in the archipelagos and littorals, we see that it extends from the seabed to space and from the sea to the beach to the land beyond and to underground spaces. What is not visible to the naked eye is the electromagnetic space and cyber space within which battles will be fought to gain Information Superiority and Dominant Battlespace Awareness. Warfare 2020 will be a new paradigm characterised by revolutionary changes in the way we think about battle spaces and how warfare will be integrated in all the battle spaces.

In thinking about warfighting systems for Warfare 2020, we need to take a lesson from the commercial world. The short product life cycle of commercial products like cellular phones demand a new product development paradigm, which minimizes product development time. The old paradigm of making physical prototypes and then subjecting them to product testing and market testing, i.e. that of " Test-Fix-Test " , has been replaced by the new paradigm of " Model-Test-Model " . As an example, Motorola ' s product development centre has engaged the Institute of High Performance Computing to develop virtual models of their new products to conduct all kinds of virtual testing before moving into production. The US military has also embraced experimentation, computer simulation and wargaming in battle labs.

Achieving Information Superiority

Information Superiority will be decisive in Warfare 2020. To illustrate how we are working towards achieving Information Superiority, we want to recount our current experience in exploring the need and requirements for a High Altitude Long Endurance Unmanned Aerial Vehicle (HALE UAV). It has been a journey along the "Model-Test-Model" road. In our view, a HALE UAV appears to be a feasible and attractive option for the tedious AEW mission and surveillance mission over Singapore . We have coined the name LALEE (Low Altitude Long Enduring Endurance) for this platform idea. LALEE is potentially an integrated airborne surveillance and communications system designed to provide continuous temporal cover-age over a very large area.

The Predator with Hellfires proved to be an effective idea in Iraq and Afghanistan . Before the wars, US Air Force (USAF) and USN were developing new CONOPS for the use of UAVs in combat. The first reported test of the Predator Unmanned Combat Aerial Vehicle (UCAV) saw all three fired missiles scoring direct hits. The USN also invested in naval UCAV (UCV-N) through the Pegasus demonstrator. Innovative countries like Israel and Sweden are also working on a range of UAVs.

In terms of micro-UAVs, they have really moved from the realm of dreams to reality. Current vehicle designs include the MicroSTAR from Lockheed Saunders, the Blowfly from UC Berkeley, and even the Sparrow from our own ST Dynamics. The MicroSTAR, for example, weighs 100g, has a range of 5km and a 30-min endurance. It is also capable of autonomous navigation and video imagery.

This fulfilment of the "Dream-Do-Deliver" cycle for UAVs is really only the tip of the iceberg. It is fuelled by the

dramatic fall in the cost of robotics, which will provide the solution to our larger manpower limitation. Of course, exploiting the air dimension with UAVs was our first priority given the steady drop in the pilot pool as well as our continued need for a robust air defence. Beyond UAVs, we should also develop unmanned ground vehicles and small robots for FIBUA and other hazardous missions. Similarly, we should do research on robots for underwater mine clearance. In general, missions with high-threat exposure, e.g. scouting, identification, clearance of obstacles, mines and tunnels, should be assigned to robotic systems. Nanyang Technological University (NTU) already has a programme for a robotic crab and an Unmanned Underwater Vehicle (UUV).

Integrated Knowledge-Based Command and Control

Integrated Knowledge-Based Command and Control (IKC2) is another rallying call in the endeavour to achieve Informational Superiority. It describes the SAF's ability to know and therefore shape the battlespace – our version of Network-Centric Warfare. The IKC2 monograph has been written on this subject and we would therefore not elaborate on it. Suffice to say that in our view, it is an important foundation for giving the SAF a superior capability that is not based on platform numbers or quality.

We feel that the immediate focus must be the evolution of the ideas and rolling out the networks. This can be achieved by emphasising the operational concept development and capability gains, and by building up the necessary information infrastructure. To do so, we believe that the strategy should consist of an architecture approach, ensuring a capability focus, learning and experimentation, and leveraging the 80/20 effect.

The notion of architecture is essentially a systemic approach or a " big picture " perspective of a system, where all the relevant parts of a system and the relationships between them are defined and articulated. Such an approach is particularly critical for complex systems, as it facilitates common understanding and a common language of the various aspects of a complex issue.

In addition, a good architecture will facilitate actions and decisions within each component, while maintaining big picture integrity. It will also limit the uncertainty and variability within the components themselves. Apart from building the components, there has to be a very conscious focus on rapidly translating these components into real capabilities. The priority and specific architecture components developed will be influenced by either capability or experimentation requirements.

Thirdly, we need to do more on learning and experimentation. Given that we do not know all the possible applications or implications of IKC2, there is a need for knowledge creation through learning and experimentation.

Finally, not all things are of the same importance in this initial learning phase. Focus therefore will be on the 20% that will give the 80% returns, particularly from the perspective of time. The sooner a capability is demonstrated the faster the learning will be. A bootstrap effect is the desired outcome.

Dreaming!

In all dimensions of warfare, technological advancements will catalyse a revolution in the way we organise and fight. In the air, we have UAVs of all types and functions. On land, we will have soldier-based systems to optimise all core, common and unique functions required by the individual soldier to perform his mission. The US Army has a Land Warrior programme that hints at the immense possibilities of enhancing the capability of each and every soldier. At sea, we will see new platforms to MOVE and SUSTAIN our forces. These include ideas originating from the US Naval War College – the SEA LANCE, Mobile Offshore Base (MOB) and submersible surface ships. In cyberspace, we will need cyber warriors.

We will use some naval stories, some from the USN, to discuss what it really means to "Dare to Dream".

A team of young USN and foreign Naval Lieutenants and Lieutenant Commanders, at the US Naval Post-graduate School (NPS) developed SEA LANCE (Seaborne Expeditionary Asset for Littoral Access Necessary in Contested Environments) as their integrating project for their Masters degree. They came up with a new ship design to meet the requirements for littoral warfare as spelt out in the " Street-Fighter " CONOPS. Using commercial ship building standards will help to bring the price of construction down to US$87 million. It is a daring project as there is no such ship in the world. Dreaming means daring to be the first.

In December 1999, the two-and-a-half year study sponsored by the Office of Naval Research concluded that it was

technically feasible to develop a Mobile Offshore Base (MOB) with today ' s technology. The platform will have a 6,000-ft long runway for C-17 class of aircraft operation and can hold 20,000 troops, 3,500 vehicles, 5,000 containers and 150 aircraft. A MOB is an alternative to having an airbase close to the area of operations. However, there are still many technical challenges that will need to be solved before MOB will become an operational system, but the study assessed that it is technically feasible to construct a MOB at a cost of US$5 - 7 billion. This project, however, did not proceed further as there were no sponsors. Though the MOB will be ideal to sustain an air-capable military presence in the littorals, the carrier community is not expected to clamour for it and sacrifice the flexibility they now have with carriers sailing at 30 knots around the world. The USAF is also not about to operate from a strip of floating concrete. Dreaming means daring to defy orthodoxy and organisational inertia.

The most "stealthy" surface ship will never be as stealthy as a submerged vessel like a submarine. The greatest military value of a submarine is psychological. If its location is not known, then surface ships must take actions to protect themselves against submarine attacks, thus reducing their operational efficiency. On the other hand, the slow speed of submarines and their limited weapon load make them less than effective once they are engaged in a battle. Surely a hybrid warship which can submerge to avoid detection and also travel at 30 - 40 knots on the surface will be superior to the conventional surface warship? In this case, there is no need for new technological break-throughs to design and build such a ship. However, the military value of such a semi-submersible ship can only be determined with difficulty. Submariners will find it of little value as it will not dive like a submarine and surface warfare officers will shun it. This concept will come into its own only when there is integration of the surface warfare and submarine warfare communities in the search for a more effective platform for the sea control mission. Dreaming means getting people from separate communities to converge their interests.

People Power

We have talked at some length about how the SAF has undergone an Evolution in Military Affairs. Technology and new warfighting systems have featured conspicuously thus far. What is missing? In a word, PEOPLE. Going back to the "arrow-head" analogy, PEOPLE form the shaft of the arrow. Ultimately, wars are prepared for, fought and won by people – the technologists and war-fighters. This is the qualitative edge we highlighted at the beginning. Quality people constitute the greatest competitive advantage. It is therefore critical that we recruit the brightest, groom and educate them well, not just as individuals, but also to become integrated as a team.

In our effort to groom and educate our people, we have launched various postgraduate courses, e.g. Defence Management & Systems Course and Defence Techno-logy & Systems Course. However, all these specialised post-graduate courses are usually not inter-disciplinary in nature.

There is also very little opportunity for the staff from the three different communities of warfighters, defence engineers and defence industry to network and create a stronger foundation for Integrated Defence Development. The Temasek Defence Systems Institute (TDSI) was therefore conceived as a platform, forged by a strategic alliance between National University of Singapore (NUS) and NPS, to educate and integrate the three communities in planning, designing, developing, creating, operating and sustaining integrated military forces of the 21 st Century. In addition, TDSI ' s vision is to produce graduates who will understand the dynamic complexities of a military force and be able to create maximum leverage by the integration of operations and technologies. As part of this vision, TDSI will launch in 2002 its flagship project, the Master of Engineering programme. The top two modules will be Guided Weapon Systems and Protection Systems – a corollary of the diamond of STRIKE and PROTECT in the "arrowhead".

Concluding Remarks

Let's try to complete the "arrow-head" analogy. We said that people are instrumental in the grand scheme of things. They form the shaft to steer and guide the arrowhead to the target – a swift and decisive victory in Warfare 2020. Technology itself will not win wars, but technological surprises help. That is why we need black programmes – some will call them Silver Bullets. But what propels the arrow? What is the bow in this "arrowhead" analogy? At the end of the day, we need a strong national will and commitment to provide for national security (see Diagram 4). Given our vulnerabilities, national will is absolutely critical for securing the national resources we need to defend Singapore in the present and in the future.

Endnotes

1 Interestingly, our discussion on this concept of Troubled Peace pre-dates the September 11 terrorist attacks.

Prof Lui Pao Chuen was appointed to the newly created post of Chief Defence Scientist in 1986 and continues to hold this appointment. Prof Lui has been intimately involved, since 1966, in the build-up of MINDEF/SAF from scratch and the subsequent evolution of military affairs in Singapore. He has held numerous important positions including Director, Logistics Division; Director, Special Projects Organisation; Senior Director, Defence Material Organisation as well as Director, Joint Operations and Planning Directorate. He also holds appointments outside of MINDEF/SAF including Adjunct Professor of Industrial and Systems Engineering at the National University of Singapore, Chairman of DSO National Laboratories and Director, Singapore Technologies Engineering Ltd.

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To Risk Or Not To Risk? Psychological Dimensions Of Risk Assessment And Their Impact On Training Safety

by CPT Stanley Chua Hon Kiat

The writing of this article coincided with the conclusion of investigations into the use of unauthorised training methods in combat survival training. Not for the first time, the paradox of training safety surfaced as the search for the optimum balance between safety and training realism continues to seem elusive. From systemic failings, operational lapses to individual non-compliance, reviews and inquiries over the years have identified a host of potential accident triggers. Yet, in spite of significant progress, training safety remains a tricky issue that continues to pose a challenge to commanders at all levels.

Fallacies in individual risk assessment are hardly known as the culprit for training accidents, let alone recognised as the fatal flaw. Yet, research has consistently shown that perceptions of risk are instrumental to potential accident involvement. 1 Confronted with a hazardous scenario, risk assessment is defined by subjective psychological responses that emanate from cognitive, social and emotive phenomena. These forces possess the capacity to distort, or otherwise, influence, risk assessment to the extent that the perceived risk in a situation is deemed to be acceptable. Given the disparities in the extent to which soldiers are susceptible to such forces, individuals differ considerably in their risk assessments, and the propensity for accidents is therefore unique across different people. This dictates that more attention must be paid to the psychological dimensions of risk assessment in grappling with the topic of safety in military training.

In this article, I will use the psychological aspects of risk assessment to explicate on the issue of why soldiers may choose to take risks. Too often, investigations that probe into causes of accidents have overlooked the why question from the psychological perspective and its related issue of volition – the fact that the individual has consciously opted to take the risk. In the discussion that follows, I will first challenge the assumption of human rationality in risk assessment and argue, to the contrary, that decisions about risks are commonly irrational. The manner in which psychological forces may lead to errors in judgement, to the extent that risk assessment is no longer performed rationally, will be demonstrated. Throughout the article, I will also outline the implications on training safety and preview some possible measures that can be adopted to overcome the fallacies in risk assessment.

The Mistaken Assumption Of Human Rationality In Risk Assessment

There is a need to debunk the myth that underlies most risk management approaches - the assumption that soldiers make rational decisions in relation to risk assessment. Indeed, psychological research has consistently shown that people do not always think in accordance with rational principles. 2 While rationality towards safety has been presumed on the basis that soldiers are keen to avoid getting injured or landing themselves in trouble, the reality is that many people take risks, because they deem that the risk is acceptable. Thus, decisions about risk often turn out far from what the rationality assumption would presume.

The term “risk” is normally regarded as a compound concept that describes both the probability of harm and its severity. However, this two-dimensional approach, while accepted in the scientific and engineering domains as the rational approach to risk assessment 3 , is an over-simplification of the risk assessment process. On one hand, it wrongly assumes that the probability and severity estimates of the risk in question will be accurately computed. On the other hand, it fails to recognise that in the minds of people, risk is appraised in multi-dimensional ways, such that probability and severity, while important, are not the sole considerations. Indeed, the fact that people often display behaviour with a high probability of accident occurrence and strong likelihood of serious consequences – reckless driving, for instance – demonstrates that risk assessment approaches premised solely on probability and severity considerations, are both inaccurate and insufficient.

In relation to military training, a dangerous corollary of the rationality assumption is that safety efforts are overwhelmingly focused on the prescriptive approach (i.e., telling soldiers what they should do), while little attention is given to the descriptive approach (i.e., understanding whether soldiers will do what they have been told to do). The former assumes that soldiers are rational, while the latter takes into account how irrational they can be. In the current risk assessment approach used by the SAF, the two-dimensional methodology is similarly adopted, in which it is advocated that hazard assessment should be computed based on the probability that an accident may occur and its expected severity.4 As argued above, this conceptualisation is incomplete. Instead, to derive a complete and accurate understanding of how training risks are assessed, consideration must be given to the multiple dimensions

of risk assessment and the irrational psychological forces that impact upon the assessment process.

The Psychological Determinants Of Risk Assessment

In contemplating whether “To risk or not to risk” , soldiers are confronted with a plethora of issues, each of which elicits a subjective perception as to whether the risk is acceptable. The decision to take a risk, then, is the result of collective perceptions on the following dimensions: 1) perceived probability of an accident occurrence; 2) perceived severity of an accident; 3) perceived ability to cope with a risky situation; 4) perceived necessity of risk-taking; and 5) perceived desirability of risk-taking. In each dimension, the individual’s perceptions will be influenced, and distorted, by a range of cognitive, social and emotive forces. In consequence, the risk assessment that ensues may no longer be effective as an instrument to enhance training safety.

At this juncture, it should be noted that the psychological forces that impact upon risk assessment reside at both the strategic and operational levels of decision-making. 5 Strategic decisions are formulated at the stage of planning when time is available for deliberation, and they include, for instance, decisions about resource allocations, approved methods of training and standard operating procedures. Operational decisions refer to those that are framed at the stage of execution, which usually entail snap decisions made under time constraints, such as whether or not to overtake a vehicle ahead, fly an aircraft into deteriorating weather or lead a platoon into dangerous terrain. As the outcomes of both strategic and operational decisions have a critical bearing on the potential of accident occurrence and training safety, both forms of decisions will be addressed in the discussion that follows.

• *Perceived Probability of an Accident Occurrence*

The first dimension of risk assessment is the perceived probability of an accident occurrence. Probability estimates are determined primarily by cognitive forces, and they are often computed based on mental strategies and rules-of-thumb, known as heuristics, which assist people to overcome their limited mental capacities in complex decision-making. 6 While heuristics work well and are especially useful when detailed analysis is either unwarranted or unfeasible, they can also be inaccurate, skewing estimates of probability outcomes and distorting risk assessment. This section will focus on the impact of the “availability” heuristic, which is the most commonly used heuristic in the derivation of probability judgements.

The availability heuristic describes how the ease with which an event can be recalled or imagined, affects the assessment of its probability. This heuristic is premised on the basis that an event that is easily recallable tends to occur more frequently and as such, is more likely to happen. However, the ease with which things come to mind is influenced by factors that are unrelated to its probability, which can happen for three reasons.

First, events that have occurred recently tend to be over-estimated, while those that took place a long time ago tend to be under-estimated. For instance, everyday encounters with soldiers suggest that each time an accident happens in a high-risk activity such as parachuting or underwater-diving, its recurrence is judged to be more likely. This is because the experience of seeing or hearing about an accident makes it more available to memory and imagination, thus seemingly more probable.

Second, the ease of recalling an event is a function of its publicity. Anecdotal evidence indicates that people under-estimate the likelihood of accidents arising from sports, because such injuries tend to be less sensationalised and publicised than those that arise due to other training activities.

People under-estimate the likelihood of accidents arising from sports because such injuries tend to be less sensationalised and publicised.

Finally, the probability of events that are personally encountered is often exaggerated, while those that occur outside of one ’ s immediate dealings tend to be under-estimated. For instance, in a study of people ’ s assessment of smoking risks, the tacit awareness of health problems that arise due to smoking is frequently disregarded in favour of rationalisation such as “ my grand-dad smokes three packets of cigarettes a day but he is still healthy at the age of 80 ” 7 , even though such examples hardly merit the evidential weight accorded. In this light, the reliance on the availability heuristic may lead to a distortion in judgements of probability.

From the factors highlighted above, three key consequences on training safety can be discerned.

First, decisions about an impending risk taken are poorly rationalised because events that occurred in the distant past are under-estimated. To this end, research on driving behaviour has shown that while people drive more slowly and carefully in the immediate aftermath of witnessing a road accident, they tend to be more willing to take risks after a long time has elapsed since they last witnessed an accident.8

Second, because the probability of events that receive less publicity tends to be under-estimated, decisions on resource-allocation may overlook hazardous scenarios that are likely, but not easily available to recall. Following from the above example on sports injuries, the relatively lesser attention paid to safety in sports activities, as opposed to other training activities, illustrates the possibly unwelcome effects of publicity.

Finally, in view that incidents occurring outside of one ' s immediate dealings tend to be under-rated, the objectives of information-sharing and open dissemination of lessons learnt, which are strategies that lie at the heart of the SAF's safety system, may be negated. On this account, by affecting probability judgements, the reliance on the availability heuristic can create significant repercussions on training safety.

Safety initiatives in the SAF must be pursued with these issues in mind. However, in relation to cognitive distortions, the channels of prevention are necessarily through education, instead of regulations or enforcement. Thus, the most immediate measure is to educate soldiers about the heuristics that they are prone to use when making risk assessments, so that they are able to understand their own scope for error and therefore recognise and challenge their underlying assumptions. 9 This is important because on the one hand, people often rely on such heuristics without conscious awareness, and on the other, soldiers tend to be "action-oriented" , preferring doing from thinking, which renders them particularly prone to using heuristics as a timesaver.

Beyond efforts to generate awareness, personnel may also be taught techniques for rational probability assessments. This will involve educating them to rely on statistical information, which, albeit abstract, is more accurate than availability judgements.10 To this end, at the organisational level, the compilation and dissemination of accident statistics, including causes and frequency of occurrences, will also be invaluable for risk assessment purposes. Given their potential impact on training safety, such measures should be instituted to minimise the further use of the availability heuristic in risk assessment.

• *Perceived Severity of an Accident*

The second dimension of risk assessment pertains to the perceived severity of an accident. Decisions that individuals believe will lead to catastrophic consequences on mortality, morbidity and property damage tend to be avoided. However, severity judgements may sometimes be inaccurate, not least due to ignorance about the potential ramifications of an action. For instance, recruits often fail to abide by the hydration regulations stipulated on the frequency and amount of water consumption, due to poor understanding of the severity of heat injuries. Notwithstanding the possibility that misperceptions can arise as a result of such ignorance, this section will focus on how judgements of severity may be distorted by cognitive and emotive forces elicited in response to dreaded, unfamiliar and latent risks respectively.

The perceived severity of an accident may either be exaggerated by the effects of dreaded and unfamiliar risks, or understated by the effects of latent risks. Risks that are dreaded are characterised by their apparent impact on mortality or morbidity. For instance, in an analysis of the public's perception of risks, nuclear power was seen as presenting the most severe risk of death, compared to motor accidents and cigarette smoking. Evidently, the perceived morbidity of nuclear accidents has resulted in the failure to recognise that both motor accidents and cigarette smoking, in reality, account for a far higher mortality rate. 11 In turn, risks that are unfamiliar refer to phenomena for which the hazardous consequences are poorly understood, such as biological and chemical hazards. Consistent with the findings for dreaded risks, there is considerable evidence in the literature that people tend to exaggerate the severity of unfamiliar risks.12

As over-estimations of dreaded and unfamiliar risks magnify the perceived severity of an accident, they dissuade risk-taking behaviour at the operational level. Nonetheless, at the strategic level, the consequences on training safety have been demonstrated by reviews that studied the secondary effects of erroneous risk perceptions. In terms of resource-allocation, for instance, the exaggeration of dreaded and unfamiliar risks was found to culminate in resources being committed to protect against the unlikely perils. In addition, the more a risk was dreaded, the more people wanted to see stricter regulations to achieve its reduction, even if they acknowledged the presence of other hazards that were more likely to occur.13

In a military training scenario, it is possible that resource-allocation may be similarly prioritised in favour of activities with severe morbidity consequences, such as live-firing and parachuting, to the resultant neglect of activities that appear less hazardous, such as routine field and physical training. Indeed, the higher occurrences of accidents that belong to the latter category of activities suggest the fallacy of this approach. Hence, even though the effects of dreaded and unfamiliar risks serve to discourage risk-taking behaviour at the operational level, they may nonetheless foster poor strategic decisions that impact detrimentally upon training safety.

On the other hand, the cognitive and emotive forces triggered by latent risks lead to under-estimations in severity judgements. Latent risks describe hazards with consequences that are not immediately harmful, such as radiation hazards. As the negative effects are not apparent at the point of risk-taking, people are less averse to its dangers. For example, in exchange for convenience and efficiency, soldiers sometimes subject themselves to known radiation risks by failing to use anti-radiation gear or adhere to safety distances, despite being aware of the long-term outcomes of radiation exposure. In this light, the psychological effects of latent risks may result in compromises to training safety by playing down the perceived severity of the encountered hazards.

In view of how misperceptions of severity emanate predominantly from unconscious cognitive and emotive forces, an awareness of their presence and influence is probably the best defence. Hence, at the operational level, educating personnel about their fallacies may again be the most effective way to alleviate the cognitive distortions. On the other hand, at the strategic level, enforcement strategies can be undertaken to complement the educational measures. In particular, independent third parties can be appointed to audit decisions on risk assessments, with the aim of detecting risk assessments that are made under the influence of distorted severity judgements. On the premise that independent parties do not hold any stakes in the activity being appraised, they will be less influenced by the effects of dreaded, unfamiliar and latent risks, and their assessments will therefore be less emotive and based on a more objective perspective.

Furthermore, unlike the primary assessor who is disposed to assimilate information from the remaining dimensions of risk assessment, a third party can appraise the dimension of perceived severity on its own merits to ascertain the validity of its rationalisation process. Hence, along with the measures aimed at generating awareness amongst personnel, having an additional layer of verification will safeguard against distortions in perceived severity and facilitate management of safety at the strategic level.

• *Perceived Ability to Cope with a Risky Situation*

While judgements about the probability and severity of an accident are based on the characteristics of the risky situation, the perceived ability of oneself to cope with the situation is concerned with an internal assessment of one's personal ability.14 This dimension is pertinent in view that soldiers sometimes take risks because they feel that they are able to avert any hazardous outcomes that may occur. Notwithstanding the fact that they may be genuinely capable of handling the situation safely, the danger arises when an individual's perceived self-ability has been subconsciously exaggerated. This section will therefore examine the manner in which misperceptions of risk may result from over-estimation of personal capacity on the part of novices and veterans respectively.

Studies have shown that human beings, particularly those who lack experience in an activity, are susceptible to the phenomenon of " control illusion " in the face of risks. For instance, while novice drivers sometimes take risks because they are incapable of detecting potential hazards15 , risks are also frequently taken despite an awareness of the impending danger. 16 In part, this is explained by the control illusion, which affords novices with an optimism bias that enhances their sense of being in control and leads them to discount the real risks that they face.17

In the SAF, the scepticism in which newly posted personnel sometimes regard on-job training or other familiarisation drills, for instance, suggests that some form of control illusion may be in place. In addition, the control illusion is reinforced each time an individual gets away with a risky action, which makes him learn that he is able to control events, even if the action is dangerous. 18 A familiar example is that each time a driver speeds, he acquires increased self-assurance and speeds more regularly, even though he is aware of the deadly consequences of speeding. On this account, novices may over-estimate their own abilities to cope with the situation and consequently adopt unsafe behaviours.

On the other hand, having extensive experience may also distort perceived self-ability, which results in the higher propensity of veterans to take risks. For instance, research in aviation psychology has shown that the presence of clouds and low visibility present a higher risk to amateur pilots than experienced ones, with the latter especially inclined to perform hazardous actions. 19 Similarly, studies in the military context have found that soldiers who believe that they have received thorough training feel more confident of their military skills, which counteracts their

sense of risk. 20

In addition, experience may also give rise to complacency, which may foster the belief that control measures are unnecessary. This is evident from the fact that from time to time, accidents occur as a result of veterans who disregard the need for safety measures, such as safety briefings and the use of checklists. Finally, the effects of experience may lead to desensitisation – a psychological phenomenon in which decisions become so routinised that minimal consideration is accorded to them. In time, this will be dangerous, as the mindless application of past decisions will be inappropriate for the new problems that arise following the inevitable evolution in the situational characteristics. 21 Taken together, the ill-effects of experience may then distort an individual ' s perceived ability to cope with the situation, which consequently promotes risk-taking behaviours that are deleterious to training safety.

The strategies formulated to improve training safety must therefore bear in mind that risk-taking decisions may emanate from an over-rated self-ability to cope with the risky situation. On the one hand, this necessitates measures on educating soldiers to estimate their coping and response abilities more accurately, by recognising the potential fallacies associated with control illusion and experience. On the other hand, to complement the effects of educational measures, complacency and de-sensitisation can be minimised by directing enforcement measures, such as supervisory mechanisms or surprise checks and inspections, towards the identification of risk assessment that may have been distorted by misperceptions of self-ability. Finally, to overcome the effects of control illusion, individuals should be primed to the common scenarios under which feelings of invulnerability will arise, before the commencement of an activity. For instance, prior to vehicular movement, drivers ought to be reminded that actions such as speeding, tail-gating, and lane-changing or overtaking under heavy traffic conditions, are all manifestations of the control illusion to varying extents. The institution of these measures will serve to reduce accidents that arise as a result of distortions to perceived self-ability.

• *Perceived Necessity of Risk-Taking*

The discussion that transpired thus far has examined the psychological dimensions of risk assessment based on the implicit assumption that risk is unnecessary and should be reduced. To be precise, though, risk-taking may be desirable, and even necessary, at times. This is especially true in the context of military training, in which the objective is to prepare and train soldiers in risky environments that sufficiently replicate the dangerous scenarios of war. 22

Hence, one of the greatest quandaries for soldiers when deciding whether or not to take a risk, is the need to strike a balance between realistic training and the safety imperative. In addition, individuals may also be torn between the need to conform to military values such as fighting spirit and endurance, as opposed to values related to safety. These issues, which underlie the perceived necessity of risk-taking, will now be examined in turn.

Military training and operations will always entail the presence of risks. Individuals are therefore confronted by the tension that on one hand, training must be safe, yet on the other, personnel must be exposed to risks in order to equip them with vital operational skills. As a result, from the perspective of achieving the training objectives, commanders may opt for a risky decision to be taken, for otherwise, the point of the exercise will be lost. 23 At the same time, the conviction that risk-taking is necessary will be further strengthened during peacetime missions, such as during a peacekeeping operation. In such cases, soldiers may be faced with situations in which mission accomplishment will be com-promised if the safety consideration is allowed to prevail.

Indeed, from the experiences of SAF officers in peacekeeping operations, the exposure to operational risks is accepted as an integral part of peace-keeping missions. 24 Against this background, risk-taking may be deemed to be necessary, as risk-aversion will either leave soldiers unprepared for the demands of war and operations, or result in compromises to the mission at hand.

The tension between training realism and safety is further reinforced by the existing organisational culture and values. Research into high-risk occupations has demonstrated that organisational culture can convince personnel to perform risky activities far beyond what they would normally do. 25 This is because the values, beliefs, symbols, norms, myths, rules and practices of an organisation establish perceived responsibilities, and exert subtle but pervasive influences on thinking and behaviour.

To this end, the propagation, and internalisation by soldiers, of organisational initiatives such as will-to-fight, core values such as fighting spirit, as well as the traditional military ethos related to courage, endurance, “never-say-die” and a “can-do” mentality, may worsen the dilemma on whether to persist with training. Particularly for vocations and

units that place immense emphasis on these attributes, their personnel may perceive further reasons for risk-taking both in peace-time as well as in operational environments.

While some degree of risk-taking is fundamental to military training, the adverse impact to training safety arises when individuals are unclear about what constitute acceptable risks. In terms of training realism, soldiers may be unable to appreciate the point at which the training risks involved are no longer acceptable in a peacetime context. For instance, the documented cases of instructors going overboard, and the incidences of ill treatment during training, are manifestations of how the passion for realistic training can translate into unacceptable methods being used.

On the other hand, in the endeavour to accomplish a mission, soldiers may be unable to appreciate the confines to which risks are more tolerable in an operational context. In the extreme cases, they may even end up ascribing to the over-zealous approach described by the " missionitis " syndrome – the tendency to accomplish the mission at all costs. In this light, the perceived necessity of risk-taking may distort the risk assessment at hand and consequently inflict serious repercussions on training safety.

In consideration that risk-taking must continue to be a necessary feature of training and operations, measures will have to be put in place to ensure that the emphasis is not carried beyond reasonable levels. As part of the educational measures, soldiers may be coached on how to sensibly discern the impact of risk-aversion on the achievement of training objectives and mission accomplishment. This requires an explication of the different sets of considerations that will pertain during operations as opposed to training, as well as the boundaries for risk-taking behaviour during operations. In turn, these efforts should be supported by legislative measures that stipulate clear guidelines and criteria for calling a halt to training or the withdrawal of a mission.

At the same time, in order to fore-stall situations in which the pursuit of training realism may lead to unacceptable safety compromises, particular attention should be paid to activities that are intrinsically prone to over-zealousness by soldiers. These include the various forms of endurance training that soldiers have to undergo, as well as two-sided exercises that pit opposing forces against each another.

Finally, potential benefits can be gleaned from moderating the spirit of " gunghoism " , especially if it is blindly pursued, though this must be achieved without diluting the operational mentality of soldiers. Thus, while risk-taking will continue to be necessary in some circumstances, the above measures will assist to ensure that it does not lead to undue compromises to training safety.

• *Perceived Desirability of Risk-Taking*

The fifth, and final, dimension of risk assessment is the perceived desirability of risk-taking. There may be risks that are socially desirable from an individual ' s point of view due to " rewards " that stand to be gained from risk-taking. The perceived rewards emanate from the trade-off between safety considerations and competing priorities, to the extent that the former is accorded secondary importance. This section will therefore focus on the perceived desirability of risk-taking and its implications on training safety.

Psychological research that ex-amines driving behaviour has produced extensive evidence that safety is only one of the many considerations that confront an individual when making a risk decision. 26 While the extent to which people are willing to compromise on safety differs, the decision to take a risk will inevitably feature social considerations, namely, the impact on self-esteem, convenience and efficiency. First, in relation to self-esteem, if risk-taking is perceived positively as a sign of courage, ability or strength, and risk-aversion is seen as a sign of fear or weakness, the anticipated trade-off to self-esteem can convince a soldier that the risk ought to be taken. The common tendency for new drivers to take risks while driving, for instance, is widely explained by their fear of losing esteem. 27

Second, the decision to take a risk may be encouraged if the risky approach serves to minimise the effort required to complete the task at hand. The frequency of vehicular incidents that have occurred due to the failure to provide a ground guide when reversing a vehicle, as required by safety regulations, illustrates this phenomenon aptly.

Finally, in terms of efficiency, the risky approach will be especially attractive if it reduces the time taken to complete the mission. For instance, research in the commercial aviation domain found that pilots took more risks when they hoped to return home earlier for the Christmas holidays. 28 In the everyday context, there are similarly many instances when individuals have chosen to drive more quickly and dangerously when they seek a faster arrival at

their destination. In this light, by offering a range of rewards, the perceived desirability of risk-taking may provide the impetus to engage in risk-taking behaviour.

In addition to the encouragement of risky behaviour, the perceived desirability of risk-taking also exerts indirect consequences on training safety. The effects of the attendant social forces suggest that the implementation of safety measures that require considerable time and effort – the very reasons why risk-taking is desirable – is likely to be futile. For instance, water sources that are set up at inaccessible locations during training are unlikely to be effective in preventing heat injuries, since soldiers may not be willing to summon the extra effort to replenish their water supply.

In contrast, measures that are built into systems and equipment, which then require no time and effort on the part of the human, will be more effective as a means to reduce training risks. A prime illustration is the installation of the Speed Warning Device (SWD) on vehicles, which is possibly the key reason why there are generally few accidents attributed to speeding. In the same vein, safety measures perceived to result in the loss of self-esteem are unlikely to be followed. This suggests that for units that draw pride in a " never-say-die " culture, the implementation of safety measures that require soldiers to opt out of training will not be well heeded due to the loss of esteem on the part of the individual who complies.

To this end, there is evidence that soldiers are willing to take risks in order to avoid what may be regarded as "unsoldierly" behavior in the eyes of their peers. 29

Thus, to derive a complete under-standing of training safety, it must be recognised that the forces of perceived desirability possess the capacity to negate the effectiveness of safety measures.

The fact that the perceived desirability of risk-taking may translate into actual risk-taking behaviour indicates that the regulations in force may not be sufficient, or enforcement of these regulations may be ineffective. As a pre-requisite, regulations must be stated clearly to provide an unambiguous reference to what constitutes acceptable or unacceptable risks. In turn, given that people take risks when the anticipated benefits are perceived to outweigh the costs involved 30 , the enforcement aspect can be strengthened either by increasing the potential costs associated with risk-taking, or by increasing the expected benefits for risk-aversion.

Specifically, this can be achieved by introducing disincentives for risk-taking (e.g. meting out of disciplinary punishment) and introducing incentives for risk-aversion (e.g. rewarding the preservation of an accident-free record). In addition, in view that the punitive measures will have negligible effects on behaviour if the possibility of detecting violations is remote 31 , concurrent measures in the areas of policing and supervision will have to be strengthened.

Finally, "high-risk" personnel who frequently take risks as a result of the social rewards may be identified for extra attention, by keeping a personal accident record for every soldier and maintaining it throughout his career. Such measures will go a long way in ensuring that the social forces involved in the perceived desirability of risk-taking will be prevented from exerting any serious consequences on training safety.

Conclusion

In the last 10 years, a total of 37 SAF personnel have lost their lives while undergoing training. 32 While one can only speculate on the extent to which their deaths are due to fallacies in risk assessment, it is hoped that the present ideas offer fresh insights and perspectives that will help to prevent future mishaps during training. In this article, I have argued that risk assessment is a complex process, requiring judgements not only on the dimensions of probability and severity, but also on the ability of oneself to cope with the situation, as well as the necessity, and desirability, of risk-taking. In turn, these judgements are beset by the transient utilities of a range of psychological forces, which act in conscious and unconscious ways to determine the outcomes of each dimension. In the final step of risk assessment, these outcomes are then assimilated into a decision that will dictate whether "to risk or not to risk".

It is often said that the greatest value of risk assessment lies not in the results that it derives, but the process that forces soldiers to think deeply about the sources of risk. Perhaps, in light of this article, the time has come for the SAF to start thinking about the psychological dimensions of risk assessment as a novel and potent source of risk.

Endnotes

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Effects-Based Operations: Obstacles And Opportunities

by CPT Choy Dawen

At first sight, Effects-Based Operations (EBO) is such an obvious concept that it seems a strange candidate for the latest fad in military thinking, coming after previous popular notions as military innovation, precision strike and information technology. After all, who can argue against crafting military operations to achieve specific, precise objectives? Clearly, no one advocates mindless destruction and attrition; and any military officer schooled in command and staff colleges within the past few decades could not have failed to learn from Clausewitz that war must ultimately serve higher political objectives. EBO thus seems a rather fancy acronym for what most people would simply call rational behaviour, of acting in the most efficient way to achieve one's interests and objectives.

Yet the current popularity of EBO amongst military thinkers might be a sign of growing dissatisfaction with current operations planning methods, which have become so regimented and mechanistic that it borders on the tedious. Courses of action are translated into dry numbers and tested through detailed OA (operations analysis) simulations; target sets are methodically listed in vast Excel spreadsheets and tackled line-by-line; while 72-hour air-tasking cycles are run with clockwork precision day after day, week after week. War, at least as seen from a command headquarters, has literally become a numbers game. While this transformation of war into a semi-exact science has allowed the military to conduct large-scale operations more effectively than ever before - indeed, you cannot run a million-man army without detailed planning and meticulous logistics - it has also taken away much of the room for strategising and artistic expression by talented generals. Gone are the days of the daring Blitzkrieg raid across the Ardennes , or the risky amphibious landing at Inchon that turned the tide of the Korean War. Instead, the most "artful" element of the 1991 Gulf War was a wide western hook; 12 years later, during Operation Iraqi Freedom (OIF), the US did not even bother with any fanciful strategy and opted for a direct blitz towards Baghdad. 1

EBO's biggest attraction, therefore, is that it reminds planners not to get too caught up with equations and spread-sheets, but instead to take a step back and reconsider the strategy-to-task linkages of what they are doing, as well as to dig deeper to find important weaknesses that can be exploited. Rather than attack an adversary's navy, which might have little bearing in a short war, perhaps it would be more effective to immediately go after the political leaders. Rather than hit every power station in the adversary's network, which might take tens of sorties, perhaps disabling a few key distribution nodes would suffice to bring down the grid. Leverage is thus the central idea of EBO - that more can be accomplished with less effort. 2 It is an idea especially attractive to small militaries such as the SAF, which do not have the kind of resource luxury that allows the US to fight and win wars of destruction/attrition.

Yet, intellectually compelling as EBO sounds, in practice there are crucial difficulties integrating its principles into operations planning. This article - while acknowledging the opportunities offered by EBO - attempts to survey the less-often discussed obstacles that militaries should be wary of. Because EBO has been employed in wars even in the past, I will start by examining historical antecedents to see whether EBO proved to be effective; and if not, the reasons for failure. A more theoretical discussion will then follow, where we will see that our currently poor understanding of complex systems will hamper accurate cause-and-effect analysis so crucial to EBO. I will also identify the trade-offs that EBO makes with respect to Destruction-Based Operations (DBO), primarily in the areas of risk (EBO effects are more contingent and susceptible to errors in intelligence or assessment) and planning effort (current planning staff is simply in-sufficient to cope with the higher workload required by EBO). Finally, I will discuss whether precision weapons might in fact threaten the viability of EBO (because they make destruction so easy), before summarising the reasons why militaries have therefore in recent times gravitated towards DBO models.

Despite this gloomy assessment, however, I believe that significant benefits can still be extracted from judicious application of EBO principles, especially at the operational and tactical levels where the vagaries of cause-and-effect assessment are less prominent. This article will then conclude by offering some suggestions for exploratory steps in EBO that militaries can take.

A Historical Survey

EBO is not an entirely new concept. Early airpower theorists, such as Guilio Douhet, Hugh Trenchard, and Billy Mitchell, were already advocating strategic bombing concepts prior to WWII that resemble modern EBO thinking. Many of them believed, for example, that civilian morale was so fragile that punishing bombardments of cities would coerce the adversary's population into capitulating. It was this belief which drove the British to firebomb the cities of Germany during WWII, thinking that quicker victory could be achieved. 3

However, there is much evidence to suggest that strategic bombing never really worked. Interviews conducted after

WWII indicate that the bombing campaigns against cities strengthened, rather than weakened, the will and morale of civilian populations. 4 Similarly, Allied planners at first thought that weakening the German industrial base would dramatically undermine the German war effort, thus the Combined Bomber Offensive plan (March 1943) emphasised striking aircraft and submarine production yards, ball-bearing factories, and petroleum production facilities. But, in fact, the German economy actually grew for several years, in spite of the attacks, by dispersing factory lines and shifting patterns of production away towards scarce items. 5 These poor results suggest that we do not really know what outcomes will arise from the actions we take.

In more modern times, the most positive demonstration of EBO was the 1999 Kosovo conflict, which many believe was won through thoughtful effects-based strikes aimed at forcing Milosevic to capitulate. 6 The cohesion of NATO members, the strikes on dual-use infrastructure which were devastating to the Serbian economy, and the threat of future invasion/unconstrained bombing were all cited as factors leading to Milosevic's surrender. However, some post-conflict interviews also suggest that Milosevic may have given up simply because he had already achieved most of his ethnic-cleansing objectives. 7 So did EBO work, or was NATO just lucky? The Kosovo conflict thus demonstrates one of the key problems with employing EBO in war - that often, one cannot discern the necessary and sufficient causes of an outcome, even with the benefit of hindsight. This is especially the case when dealing with the psychological factors behind the leaders' decisions.

As for OIF, the conflict which brought EBO theories to prominence, there is also little evidence at present that EBO was employed or worked. The strategy of decapitation (striking communications links or command nodes), which received much attention during the war, did not seem effective as US forces ultimately still had to destroy all the Republican Guard divisions guarding Baghdad and physically occupy the city itself before the war came to an end - even though it is almost certain that Saddam Hussein was on the run since the start of hostilities and could hardly command and control his troops. In addition, the massive scale of destruction - with some 15,000 precision weapons dropped and over 13,000 strike sorties flown 8 , against a Third World army weakened by 12 years of economic sanctions - also seems at odds with EBO principles of leverage and economy of effort. When a more comprehensive analysis of OIF is conducted in the future, it may still turn out that some EBO principles were applied, but the evidence available at present shows a level of destruction that reinforces attrition-based warfare more than EBO.

Implementing EBO: The Challenges

What explains the dismal record of EBO in the previous historical examples? What are some of the challenges that military planners must overcome in order to introduce effects-based thinking into their operations?

Understanding Complexity

The first challenge at hand is that we have a generally poor understanding of complex systems - which contain large numbers of interacting elements - such as global weather patterns, human crowd dynamics, and highway traffic. In such systems, complexity arises either because the interactions themselves are not straightforward, and/or that the interactions are so numerous that simple cause-and-effect analysis becomes quite impossible. Thus, an adversary's leadership structure is a complex system, because even the individual behaviour of each person is difficult to predict, let alone when collective decisions are to be made. Similarly, the adversary's military is also a complex system due to the many interacting elements involved (people, organisations, platforms and infrastructure). Unfortunately, since the behaviour and interaction of elements are so interwoven, several difficulties arise when we attempt to understand and manipulate complex systems.

One such difficulty lies in predicting the outcomes of an action on the system. In complex systems, it is difficult to draw accurate cause-and-effect linkages because higher-order disruptions and adaptive behaviour can often complicate analysis by enhancing, or ameliorating, the direct effect. If the power grid is destroyed, will population morale be affected? Perhaps there might even be no effect at all, which is very plausible, especially in Third World countries where power systems might be so notoriously unreliable that people have already learnt how to adapt. From the historical survey above, it should be clear that our knowledge today of military/political cause-and-effect linkages is nascent at best, and it will likely take many more years of research and analysis before we can confidently predict the outcome(s) of our actions. After all, it took meteorologists decades of research to even make moderately accurate forecasts of weather today.

To make matters worse, the second difficulty of dealing with complex systems is that you cannot simplify them for analysis. It sounds intuitive that even a complex system should have some elements or interactions which are more important than others. The notion of centres-of-gravity, for example, is based on this assumption - that there is a small set of critical nodes which if destroyed would cripple the system. However, our experience hitherto with

complex systems in other fields is that they cannot be simplified, but instead must be analysed holistically using brute-force methods such as agent-based modelling or Monte Carlo simulations. 9 Any attempt to simplify the system would result in a less-than-perfect description that generates wrong predictions or fails to account for important effects. 10

What Does This All Mean For The Application Of EBO Principles To Military Operations?

First, we need to recognise that many "theories" of cause-and-effect today are dubious at best. There is little evidence, for example, that decapitation causes much paralysis in enemy forces. Alternate links (courier, face-to-face meetings) can be set up in real-time, while authority can be pre-delegated to lower-echelon commanders if top leaders are killed or unreachable. 11 Similarly, we do not know any consistently reliable means of causing enemy capitulation (other than decisive defeat of military forces); previously popular theories such as attacking civilian populace, disabling enemy industry or killing political leaders have all been shown not to work. Sadly, EBO proponents often speak as if we already have a good grasp of cause-and-effect linkages in military/political systems, rather than acknowledge the reality of our poor understanding.

In addition, we may need to fundamentally change our methods of analysis to deal with the unique nature of complex systems. Because complex systems resist simplification, methods such as agent-based modelling may have to replace existing concepts and tools based on simplicity - classical notions such as critical nodes and centres-of-gravity 12 will have to be thrown out. Indeed, throughout the history of strategic bombing, airpower theorists have been looking for centres-of-gravity, be they ball-bearing factories, population centres, fuel/lubricant supplies or military/political leaders, and have never succeeded. 13

Their failure strongly suggests that we might have been working with a misguided concept in the first place. 14

No Free Lunch

But even if we do achieve a better understanding of complex systems in the future, there will still be some fundamental trade-offs that militaries have to make when adopting EBO over traditional attrition-based warfare.

The first trade-off is the inherent risk and uncertainty concomitant with an effects-based strategy. As EBO aims to achieve leverage, it is almost by definition that some targets will be spared in the belief that cascading effects would either render them inoperative or irrelevant. An oft-quoted example occurred during the opening night of the 1991 Gulf War, when strike planners figured that hitting just a few underground bunkers in the Iraqi air defence sector operations centres would be sufficient to force operators to vacate the facilities and cease operations. 15 But what if the analysis was wrong? What if the buildings struck were non-critical, and the operations centre remained operational? EBO therefore demands, as payment for potentially significant benefits, risk-taking from planners and commanders - an attribute that the normally risk-adverse military 16 would find hard to cultivate overnight.

The risk-taking is exacerbated because the effects of one's actions, especially higher-order effects, take some time to manifest. Do you then proceed with the second phase of operations, assuming the first has succeeded and achieved its desired effects? Or should you wait for more reliable assessment and confirmation, but risk losing the momentum and giving time for the adversary to adapt? It took guts, that opening night in 1991, to send large waves of strike packages after the initial opening blow, on the assumption that the EBO-strike on the air defence operations centre was effective. 17

Another necessary, although often glossed over, trade-off is the massive demand on intelligence and planning capabilities to substitute for economy of physical effort. Attacking a complex system through EBO requires laborious analysis of cause-and-effect linkages, supported by timely and accurate intelligence - all of which will fluctuate often during the course of war, thus requiring frequent updates to assessments and plans. In contrast, a destruction-based agenda is simpler to execute because it works by sheer extinction of elements within the complex system, without needing to care very much about the multitude of interactions. It may take longer, but it does not require as much mental work.

We should not underestimate the much higher workload imposed on intelligence assets and operations planners. For example, prior to a recent air force command post exercise, I was part of the core planning staff which spent two months devising an effects-based operations plan. However, once the exercise commenced, we simply could not cope with the frequency and volume of changes - not only to enemy disposition, intent and actions, but also to own forces' capabilities and higher command's intentions. In the end, although some elements of effects-based thinking

were retained, we had to revert to a largely destruction-based agenda because we simply did not have the bandwidth to continually change our ops plans to reflect new information and new contexts. We must thus recognise that any savings in physical destruction come at the expense of increased mental effort; there is no free lunch. 18

Advent Of Precision Weaponry

The final challenge to EBO comes from an unexpected quarter. At first glance, precision weapons seem to be a key enabler of effects-based operations by providing the ability to hit critical system nodes accurately and rapidly. For example, during WWII it would take thousands of bombs just to destroy a single factory - which makes it hard to tell whether the inability to disrupt Germany 's industrial base was due to faulty EBO thinking, or simply because the bombing was so ineffective. Similarly, during the early phases of the Vietnam War, when precision munitions were not available, the US Air Force was forbidden to attack the power-generating plant at Lang Chi Reservoir due to its proximity to a major dam. By 1972, however, when laser-guided bombs became available, the plant was destroyed leaving the dam untouched. 19 Without the ability to destroy targets accurately and expeditiously, clever target selection via effects-based thinking would come to naught.

But because precision weapons also allow militaries to prosecute destruction-based campaigns more quickly and more effectively than ever before, the case for EBO (whose primary benefit is leverage) becomes much weaker. In what must be the most classic demonstration of the effectiveness of precision munitions, during the Vietnam War more than 800 sorties employing dumb bombs were expended to strike the Thanh Hao bridge without much success. A few years later, in 1972, just four F-4Es were needed to destroy the bridge using first-generation laser-guided bombs. 20 And precision technology continues to improve - three decades later, a single F-15E employing Joint Direct Attack Munitions managed to hit five separate targets within a single pass. 21 When such dramatic increases in strike capability are achievable, EBO suddenly looks a lot less attractive than before. Why spend so much time prioritising a target list when you can simply attack everything on the list within a few days? Why risk the sector operations centre remaining functional by sparing some bunkers, when you can now simply destroy every one of them?

As an individual factor, precision weapons alone would not weigh very much against EBO. After all, even with better strike capabilities, there is always a case for strike prioritisation to achieve maximum leverage. However, when combined with the first two challenges - poor cause-and-effects understanding, and the trade-offs inherent in EBO - it is no longer so clear that a simple-minded destruction-based strategy is that much worse off.

Destruction-Based Operations: Still A Strong Contender

Given the above challenges to EBO, we can now better understand why DBO models are still very much in use today, despite continual attempts to introduce effects-based thinking into operational planning. Indeed, DBO has strong intellectual merits as well as practical advantages in implementation.

The theoretical foundation of DBO rests on the fact that one simply cannot avoid destruction of military forces in war. The onset of hostilities invariably means that other non-violent forms of conflict resolution - be they diplomacy, economic sanctions, or third-party mediation - have already been exhausted, or that political leaders believe military action would be most effective in achieving their objectives. In that case, one cannot escape the logical conclusion that to decisively end a war, it will be necessary to remove the adversary's military means. Thus, during Operation Desert Storm, it was necessary not only to expel Iraqi forces from Kuwaiti territory, but also to inflict grievous damage on the Iraqi military such that it could no longer pose a significant threat to its neighbours after the conflict. Otherwise, if the adversary's military apparatus remains intact, there is no guarantee that war would not restart. 22

Practically, DBO also avoids many of the challenges mentioned previously. It side-steps our poor understanding of complex systems through brute-force elimination of elements and interactions within that system - also a valid avenue of attack! A destruction-based strategy is also inherently less risky since there is no reason to spare targets; everything is marked for destruction sequentially and methodically. Furthermore, since the basic DBO strategy is the destruction of enemy forces wherever they are, planning effort is kept to mostly asset/weapon selection and manoeuvre planning, much of which can be done in advance during peacetime or periods of tension without grave danger of dramatic changes during war (unlike EBO strategies, which can change fundamentally at short notice). 23 Lastly, with precision weapons promising to make assured destruction a quick affair, the advantages of leverage and speed offered by EBO are severely eroded.

DBO is even practical for small air forces, which normally do not have many strike assets to play with. Although EBO

seems attractive because it offers them a high-leverage alternative to the attrition style of warfare practised by large nations such as the US, with precision munitions even small air forces today possess significant striking capability. 24 A hundred strike aircraft flying three sorties a day can potentially destroy up to 600 targets daily if each carried two 2,000 pound precision-guided munitions (sufficient to destroy most targets with a single hit). This level of destructive capability is enough to service even thousands of targets within a mere few weeks.

Hopefully, this section has shed light on why DBO should not be too easily dismissed, as it also has compelling intellectual and practical merits to offer. Because DBO has been the model of operations for a long time, we have become very good at destroying things. Even if EBO can deliver its benefits as promised, DBO is likely to remain dominant in the short to medium term, and even continue to remain viable for specific scenarios in the long-term.

Towards An EBO Framework

As always, it is much easier to criticise than to construct. Research into practical EBO models of operations is still in its infancy, and most articles on EBO can still only offer theories, definitions and prospects at the moment. As such, this article will not attempt to derive a complete framework for applying EBO to military operations, but instead offer some lessons learnt from the sections above to guide the future creation of an EBO doctrine.

• Demand high leverage from EBO. Considering the risks and efforts involved, and the relative ease of sheer destruction using precision weapons, the payoff from EBO must therefore be large. Unless high leverage is required and expected, it might be easier and simpler to stick with DBO such as when the enemy target list is very small to begin with, such as when the US invaded Grenada.

• *Focus on Operational and Tactical effects first.*

At present, applying EBO for strategic effects is problematic because our understanding of our own and the enemy's strategic complex systems is so poor. However, at the operational and tactical levels, EBO principles are much easier to apply. For example, when attacking an airfield, different levels of crippling can be achieved by hitting different components, ranging from closing runways to disrupt operations for a few hours, to eliminating ammunition dumps to cause turnaround problems for a few days. Similarly, operational objectives can be streamlined using EBO - such as by recognising that sea control may not be as important during a short war, which then frees up assets to perform other missions.

• *Destruction is also an effect.*

Although some EBO proponents sometimes try to emphasise differences by stressing non-violent actions or avoidance of strikes, we should recognise that destruction is also a valid effect that can be employed under EBO. Information warfare and diplomacy can be well complemented by judicious strikes on valuable enemy assets, as part of a total EBO strategy.

Conclusion

Throughout this article, we have seen a rather negative assessment of EBO's prospects. Does this mean we should give up thinking about effects-based operations and go back to attrition-based warfare?

Perhaps not. While the practical obstacles against implementing EBO remain formidable, the potential payoffs from EBO are so attractive that we should continue to devote resources towards studying complex systems, understand the risks involved with EBO strategies, and put in place the appropriate staff structures needed to perform higher-level operations planning.

Furthermore, although many EBO articles seem to paint a tension between attrition versus effects, as if we somehow had to choose one over the other, the hope of this article is to demonstrate that destruction has a logical foundation too. Indeed it seems more appropriate to consider EBO as simply an expansion of, not an alternative to, DBO, with different degrees of enemy destruction chosen depending on the context and the objectives desired. By adopting such an integrative approach to effects-based operations, we can capitalise on the destructive potential offered by modern precision-munitions, while cultivating the intellectual foundations necessary to exploit EBO once the concept matures.

Endnotes

1 There is some truth in the argument that this problem of methodical, predictable warfare is largely an American one, which has leveraged its technological superiority and overwhelming resource advantage to wage a style of warfare that emphasises sheer quantity and quality of firepower, rather than adopting daring, yet risky, strategies. Still, with the growing sophistication of ops analysis tools and the promise of reduced uncertainty that they bring, militaries worldwide have generally embraced more "scientific" methods of war planning, so much so that planning processes now leave much less room for strategy and guile.

2 Simple as it sounds, this defining principle is extremely important as it can be a good test of how effective your articulation of EBO is. No matter what definition of EBO you use, if it fails the test of leverage it is not worthwhile pursuing since you end up having to destroy just about everything anyway.

3 Robert Pape, Bombing to Win (Cornell: Cornell University Press, 1996), pp260-262.

4 Robert Pape, Bombing to Win, p272.

5 Alfred C. Mierzejewski, The Collapse of the German War economy, 1944-1945: Allied Air Power and the German National Railway (University of North Carolina Press, 1988), pp1-20, as quoted in Kevin B. Glenn, "The Challenge of Assessing Effects-based Operations in Air Warfare", Air & Space Power Chronicles (24 Apr 2002). See also Robert Pape, Bombing to Win, pp272-278.

6 Stephen T. Hosmer, Why Milosevic Decided to Settle When He Did (Rand Publications, 2001) and US Department of Defense, Report to Congress: Kosovo/Operation Allied Force After-Action Report (7 Feb 2000).

7 Frederic L Borch, "Targeting after Kosovo: Has the law changed for Strike Planners", Naval War College Review, Vol. 56, Issue 2 (Spring 2003), p64.

8 "Coalition Forces have fired 15,000 Guided Munitions during Iraqi Freedom", Defense Daily, Vol. 218 Issue 9 (11 Apr 2003), p1.

9 The world's fastest super-computer, currently NEC's Earth Simulator, was designed for climatic research.

10 For example, we commonly use a single measure, temperature, to measure the amount of energy/heat in a container of water. Although it is a very beautiful simplification that easily allows you to tell hotness/coldness, or the state of matter, it cannot account for the common phenomenon of evaporation. To explain evaporation, you have to perform the complex task of analysing each molecule of water individually, and then realise that they have a wide range of energies which allows some of the faster-moving molecules to break free of the liquid and escape as gas. It is not a trivial undertaking.

11 Robert Pape, Bombing to Win, p323.

12 Paul K. Davis, Effects-based Operations: A Grand Challenge for the Analytical Community (Rand Publications, 2001), pp12-13.

13 Even in physics, other than for textbook learning and simple applications, the centre of gravity does not convey sufficient information for more complicated uses, such as designing the suspension system of a car; for that purpose, knowing the actual weight distribution is necessary.

14 It is important to realise that the difficulties mentioned in this section are deeply fundamental to complex systems, not a problem of insufficient information. People often complain that EBO is difficult to implement because they lack sufficient intelligence about enemy capabilities, intents and actions (how can we find critical nodes in the power system if we don't have good technical knowledge about its design?). However, even with perfect information, we may still not be able to find critical nodes - especially if they don't exist in a complex system! Recently, the Naval War College and Gartner Inc. conducted a " Digital Pearl Harbour " exercise to evaluate the vulnerability of US computer networks by asking specialists to try and attack the system. Despite having the expertise of insiders, many of whom had designed the computer systems in the first place, they were unable to cause a catastrophic shutdown of the network. Clearly, we need to get away from blaming "poor intelligence", and instead undertake concrete actions towards better understanding of complex systems.

15 Allen W Batschelet, "Effects-based Operations for Joint Warfighters", Field Artillery, Issue 3 (May/Jun 2003), p7.

16 Militaries are notorious for layer upon layer of contingency plans, for backups to backups to backups. While sometimes derided, such risk-aversion and rigorous contingency planning is actually a laudable characteristic, which caters to the ever-present uncertainty of military operations.

17 The risk-taking element is more pronounced at the operational and tactical levels, where the contrast between attrition and EBO is more stark. At the strategic level, both DBO and EBO suffer from considerable uncertainty about whether actions (destruction or otherwise) would result in the desired outcome. However, arguably, DBO may still be less risky since destruction of enemy forces at least guarantees they cannot recover and retaliate.

18 Of course, such a trade-off might be worthwhile if you lack physical resources but are well trained and clever. Terrorists, for example, exploit such asymmetries all the time, utilising EBO ideas to conduct high-leverage terror operations against much better equipped and funded adversaries. A fairly cheap, yet precise, strike like the World Trade Centre attack was able to throw the world's largest superpower into disarray for a while, which demonstrates how much potential leverage EBO can give if properly executed.

19 Kenneth P. Werrell, "Did USAF technology fail in Vietnam ? Three Case Studies", Airpower Journal, Vol. 12 Issue 1 (Spring 1998), p87.

20 Merrill A. McPeak, "Precision Strike: The Impact on the Battlespace", Military Technology, Vol. 23 Issue 5 (May 1999), p20.

21 "F-15E Successfully Launches Five Boeing GBU-31 JDAMs on Single Sortie", Boeing Co. News Release (14 May 2002).

22 Paul K. Davis, Effects-based Operations, p12.

23 The best example of EBO strategies being subject to fundamental change at short notice was the opening decapitation strike of Operation Iraqi Freedom. It seems apparent that a more massive "shock-and-awe" opening blow was initially planned, but superseded by the unexpected opportunity to kill Saddam Hussein with an early surgical strike.

24 Shaun Clarke, Strategy, Air Strike and Small Nations, Royal Australian Air Force: Air Power Studies Centre (1999).

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Force Multiplication Through Network And Networking: A Frame For Discourse

by LTC Roland Ng Kian Huat

Austerlitz , 1805: The Information Battle

"A general never knows anything with certainty, never sees his enemy clearly and never knows positively where he is... It is by the eyes of the mind, by reasoning over the whole, by a species of inspiration that the general sees, knows and judges..."

The Military Maxims of Napoleon, Compiled by General Burnod, 1827

On 2 December 1805 , 66,000 Frenchmen faced the joint Russo-Austrian forces of 90,000 near the village of Austerlitz . The countryside was dominated by a gently sloping hill, the Pratzen Heights , which Napoleon's army initially controlled as its central position. But Napoleon ordered his men to abandon the Heights, and watched the enemy forces occupy it as he put a thin line of soldiers on his right flank. In an age when battles were determined principally by mass, it was natural for the allied generals to believe that Napoleon was aware of his difficult position, and therefore afraid to face confrontation before the major combat or commit a sizeable force to his flank at the expense of weakening his central position.

As the day broke with an impenetrable fog, the top of the Pratzen Heights floated like an island above the sea of mist. From his command post on the Heights, Tsar Alexander I of Russia , eager for battle, ordered the allies off the high ground towards the far end of Napoleon's weak right flank. He was determined to roll up the whole French army from there. But Napoleon had a few surprises for his enemy.

The allies hammering away at Napoleon's right flank soon discovered that it was not exactly "weak". In fact, two French divisions had covered 70 miles in two days from Vienna to reinforce this wing. Napoleon had put reinforcements where they were least expected, and faster than anyone thought possible. Instead of collapsing, Napoleon's right flank drew the allies further and further west until they had advanced beyond recall from the Pratzen Heights.

Meanwhile, as the sunrise burned through the mist, two French divisions - 17,000 men - appeared at the bottom of the valley below the Heights. The combined Russian and Austrian armies had followed the French emperor's script to the letter: Napoleon had wanted the enemy to attack his "weak" right so that he could attack a weakened allied centre at Pratzen Heights . Napoleon ordered a direct frontal assault. By 9:30 am , the French controlled the Pratzen Heights , demolishing the centre of the allied position. Napoleon swept across the battlefield and attacked the allies from behind. By 5:00 pm , Austerlitz was silent.

The French losses were 2,000 killed and 7,000 wounded compared to the allies' losses of 15,000 killed and wounded and a total of 11,000 taken prisoner. The Russians withdrew from Austria and the Austrians signed the Treaty of Pressburg, conceding substantial territories to the French. 1

What lessons can we draw from this? Stretching it to the extreme, we can argue that the Battle of Austerlitz was decided not by guns, muskets, or cavalry but by information and knowledge. It seemed that the same themes that guide the military transformation efforts in the Information Age were present almost 200 years ago. We are looking to state-of-the-art digital technology today to answer the same basic questions that commanders in the Napoleonic Wars needed to resolve:

• *Where am I? Where are my friends? Where is the enemy? 2*

• *What is actually happening? 3*

• *What (if anything) can or should I do about it?" 3*

Suppose, for a moment, if we overlay today's information and network technology on this battle, what might have

happened to the allies? Specifically, what might have happened if a myriad of airborne ground surveillance system, satellite imagery, and unmanned aerial vehicles had tracked and warned the allies about the arrival and disposition of Napoleon's reinforcements from Vienna ? What if Tsar Alexander I had been able to see the entire situation within Austerlitz on the morning of 2 December 1805 , including Napoleon's hidden trap in the haze, with continuous, real-time, all-weather coverage situational awareness technology from a multi-spectral sensing web? What if Global Positioning System (GPS) coupled with portable Geographical Info Systems (GIS) had warned the allies attacking Napoleon's right flank that they were being lured further and further away from their central position?

Finally, what if Tsar Alexander I, somehow through all the bits and bytes, managed to make sense of Napoleon's intention and plan, and digitally burst a clear order to his Iridium Satellite phones and Blue Force Tracker (BFT) 4 equipped forces on Napoleon's right flank to swing back and converge with those on the Pratzen Heights? It is not inconceivable that Napoleon's "trap" at the bottom of the Heights would have been annihilated at a stroke, and the battle might well have ended soon after, with a completely different historical outcome. But what if Napoleon had the same information and network technology at his disposal? More importantly, given Napoleon's fame for battlefield innovation, would he have organised his forces and fight in a way that is fundamentally different from what we know today?

The network is not a new discovery. In fact, warfare as an organised application of violence to achieve a desired end-state is only possible with effective networking of battle-space entities. Information has been at the core of military operations through the ages. This has not changed. Yet, war is also a product of its age. In the past, the generals have had little choice but to acquiesce to the fundamental "fog of war" and "friction of war" in the classic Clausewitzian theory. But at the dawn of the Information Age, there is a new and exciting possibility for the military leaders: information advantage can be translated into a decisive warfighting edge by new ways and means of networking the force and sharing information. Concomitantly, those endeavouring in this field also recognise the myriad of challenges and issues to resolve.

This article hopes to provide a frame for discourse on one important aspect - the phenomenon of network multiplication effects for the military 5 , and the possible strategy we can adopt to best harness them.

Nature And Characteristics Of Network

There are countless interpretations for terms on this subject, many by respected military thinkers and scholars. Some generally accepted ideas, as elucidated below, will be used in this article.

Working Definition Of Network

In its most simple form, a network can be considered as a collection of nodes, likely to be physically dispersed but linked in some ways such that content 6 can flow between these connections and enable the nodes to interact. The value of network is in the potential benefits that can be reaped to derive both systems and localised competitive advantages by linking together - or networking - nodes. 7

Players In Military Network

In the military context, we can see nodes as battlespace entities, which can exist in three primary functional modes: sensing (sensor nodes), sense-making and deciding (command and control (C2) nodes), and acting (actor nodes). 8 More specifically, actor nodes are entities whose primary role is in creating "value" in the form of "combat power" in the battlespace. They will carry out the primary combat functions of fighting and supporting the forces. On the other hand, the primary combat function of the sensor nodes is information acquisition while that of the C2 nodes is as the name implies. 9

The three kinds of entities can be located throughout the battlespace either in fixed locations or are becoming increasingly quite mobile. Some entities may, in fact, have complex functionality, concurrently performing the roles of sensing and acting. Conversely, there is also a wide spectrum of nodes, in terms of size (physical and organisational), technological sophistication and capability, performing the same function. For example, a node can be an infantry soldier, an aircraft, a tank or a ship.

Theoretical Boundaries of Network Effects

Metcalfe's Law 10 is often quoted as the premise for which network can create multiplication effects. It states there can be ΩN(N-1) possible links in a network with N nodes. 11 If each link has the same optimal "value", that is, if each link performs and supports the same optimal form of work (e.g. content sharing and collaboration 12), then the value of the network can be inferred as proportional to N(N-1). For large N, this will increasingly scale with N 2 . A point to note is that the nodes themselves also have intrinsic content values. However, if N is large, then N 2 will increasingly be the dominating element in the equation.

In a way, Metcalfe's Law sets an upper-bound to the value realisable from a fully meshed network of N nodes where each link provides an equal and positive optimal value to the system. On the other hand, in a system where none of the nodes are linked, the collective value is likely to be a function of the summed values of all the nodes. If each node has the same value, the collective value of the nodes will likely scale with N.

In reality, networks are seldom fully meshed, or comprise entirely stand-alone nodes. Between the two possible boundaries, there exists a vastly diverse range of possible network types and designs, ranging from distributed or decentralised networks, such as grid computing or biological swarms, to more centralised networks, such as the traditional hub and spokes military networks.

Applying the above theoretical framework in a military context, the value of a network can be considered as a function that varies with the number of nodes, the degree of connectivity 13 , and lastly, a factor of concepts that define the prevailing style and characteristics of warfare. The last factor will drive developments in technology, strategy and doctrine, organisational structure and processes, education and training, cultural and social practices, and other less quantifiable parameters. For convenience of this discussion, it shall be coined as x.

The outcomes as a result of permutations and interplay between the various factors can be represented graphically (See Figure 1). The hypothesis is that increasing the number of nodes or the degree of connectivity 14 with the same x will increase the value of the network, even though this will usually come at an increasing infrastructure and maintenance cost. However, the game changer is really the x factor. It can change the shape of the value curve, in particular, the gradient, thereby creating new possibilities for the network as a multiplier.

Deviation Of Network Effects From Metcalfe's Law In the Military Context

Strictly speaking, Metcalfe's Law is a representation of the power of inter-connections in the Ethernet and Internet. The logic goes this way: as the number of users reached critical mass with the introduction of the browser and the World Wide Web, the use of Internet became more widespread. This in turn, has induced individuals and companies to conduct activities, such as adding content, creating virtual communities and setting up electronic storefronts and trading hubs, which increase the value of the network for each connected user. This attracts yet more users, thereby creating a virtuous cycle. 15 The theory has worked in a free market where everyone is acting in his own best interest and has the freedom to do so.

Military organisations, on the other hand, are hierarchical in nature. The idea of command and control essentially is to guide the actions of subordinate battlespace entities in ways that will contribute coherently and collectively to assigned missions. When applying Metcalfe's Law in this context, it is therefore reasonable to posit that there may be deviations from the characteristics of network effects as exhibited in the Internet.

What are the likely deviations? Let's return to the fundamental questions, as highlighted in the first section, which commanders throughout history of warfare have had to address:

• *Where am I? Where are my friends? Where is the enemy?*

• *What is actually happening?*

• *What (if anything) can or should I do about it?*

The first set of questions resides in the physical and information domains, and the required answers are generally factual in nature. Today, advances in navigation technology have enabled high degree of geo-location accuracy for

own and friendly forces, as well as enemy positions detectable by intelligence, surveillance and recon-naissance (ISR) systems. Termination of Selective Availability by the US in 1 May 2000 has enabled users around the world to experience basic GPS accuracy of 10 - 20 metres or better, and 1 - 3 metres for those with access to Differential GPS. 16 In urban areas, low cost, low power Ultra-Wide Band (UWB) technology has the potential to provide 0.5 to 3 feet geo-location accuracy typically up to 250 - 300 feet in commercial buildings, and less than 0.5 feet accuracy with a line-of-sight range greater than 2 km outdoors. 17 The challenge now is how to fuse all this information into a coherent Common Situation Picture, and provide last mile information services to the end-users. The associated variations in network value, however, should still be reasonably analysed within the bounds of Metcalfe's Law.

The second and third questions, on the other hand, involve processes of sense-making and decision-making that will take place in the cognitive, emotive and social dimensions. Their resolution is as dependent on the commander's unique personal background and experiences as on the distinctive organisational and cultural system in which he is a part of. How will all these factors impact on our network value curve?

It is possible to posit that, for the same connectivity (assuming same value for each link) and x factor, while the value of network will increase as the number of connected battlespace entities increases, it seems to reach a point where it will plateau off or even dip as more battlespace entities are added to the system. Put simply, beyond certain critical point, just adding more connected nodes does not guarantee an increase in the value of network. Why? On one hand, beyond that critical point, if the existing connectivity is lower than that designed for his swelling forces, the commander will find it increasingly difficult to know what is happening on the ground and exercise effective command and control 18 over them. Using an economics term, the commander is said to have suffered "negative externalities". 19 An obvious remedy will be to increase the network capacity and connectivity.

However, if the existing connectivity is high, the commander will face another problem. Quantitative increases may not necessarily translate to more high-quality information on the network. In fact, the converse may be more likely when posting of information on the network becomes easier. As Herbert Simon has noted, "What information consumes is rather obvious. It consumes the attention of its recipients. Hence, a wealth of information creates a poverty of attention." 20 At the extreme, information consumption has the potential to dominate all other tasks for the commander's attention, unless a limit to consumption is introduced. Equally worrying, if the haystack just keeps growing, it will be harder for the commander to find the needle he should sense-make to get Napoleon's "species of inspiration".

In this case, the commander can choose to "delegate" to his subordinate commanders and let them customise information for their particular needs. Proponents of Network-Centric Warfare (NCW) talk about "Power to the Edge" – greater information transparency translated into greater empowerment for unit commanders and their charges. But this implies an imperative to ensure good alignment of the collective pattern recognition skills. Otherwise, distributed military analysis may generate fundamentally different interpretations of events. More analysis may then inherently mean more disagreements and discoordination. The challenge today is actually more pertinent than in the past because, ostensibly, more commanders now have greater immediate access to an ever-expanding information marketplace. 21

The above arguments simply recapitulate the classic centralization/decentralisation dilemma that haunts organisational design. More notably, without the right conditions and balance, a "content-rich" system can equally increase the uncertainties and hence "fog of war" and "friction of war" as in the case of "content-poor" systems. When this occurs, it is possible that the value of network will start to level off or even dip. The x factor will play a critical role defining this point (See Figure 2).

From Information Advantage To Multiplication Of Combat Power – A Thought Experiment In Thermodynamics

The discussion so far has focused on the characteristics of network value. How is this related to the idea of combat potential and power? 22 Earlier, we postulated that the value of network and networking resides in their potential multiplying effects to combat power through enhanced information and knowledge position. This potential can be realised through improving the number of nodes, connectivity and/or x factor of the military system. It must be emphasised that this is premised on the combat systems having the necessary capabilities, including manoeuvrability, firepower, protection and sustainability, to exploit the new opportunities made available by the network effects. One possible way to interpret the interplay between the various factors is through a thought experiment that relates them to processes in thermodynamics.

Thermodynamics, an essential science to understand processes in mechanical and bio-molecular systems, is the study of the patterns of energy change, in which heat and work 23 are two common forms. In an internal combustion

system, fuel/air charge is ignited to produce heat that expands gases. The expanding gases can then be channelled to perform work, such as driving pistons in cylinders of an engine. We can imagine combat potential as heat produced by the octane-oxygen combustion, battlespace entities as gas molecules that serve as carriers of energy, and combat power as work done in the form of kinetic motions of the gas molecules driving the pistons. What then about the network? In this case, “communications” occur through inter-molecular interactions when the gas molecules collide.

According to the first Law of Thermodynamics, “The energy of the Universe is constant.” The only thing that can happen to the energy is its transfer from the system to the surroundings or vice versa. The “system” is the part of the universe that we are interested in analysing or studying while the “surroundings” is, as its name implies, everything else. 24 Since everything is relative, let’s define the system in this thought experiment as the collective whole of gas molecules while the heat from octane-oxygen combustion, the pistons’ motions, and everything else will constitute the surroundings. Using the convention defined earlier, the military equivalent will be one comprising all the battlespace entities.

The French scientist, Sadi Carnot, realised that it was not possible to convert heat energy into useful work with 100% efficiency. Rudolf Julius Emanuel Clausius, one of the founders of the science of thermodynamics, later introduced the concept of entropy. It is a term that describes disorder, and in this case, the lost energy that is unavailable to do work. 25 In an analogous way, degradations, especially due to “fog of war” and “friction of war”, imply that combat potential can never be translated fully into combat power.

What happens when there are more gas molecules in the system, assuming all other conditions and factors remain the same? 26 Firstly, the heat generated by the octane-oxygen combustion will remain the same i.e. the energy start state of the surroundings will not change.

Secondly, more gas molecules in a specific volume means greater start state pressure. Mathematically, work done is defined asa product of pressure and change in volume. Coupled together, this means more work can be done, in the form of more powerful stroke, when the gas molecules gain energy from heat and push the pistons to expand the volume within the cylinders.

Thirdly, more collisions between molecules (those of the system and those of the surroundings) will actually take place when there are more gas molecules in the system. As heat is derived from the random collisions between molecules, the internal heat energy of the system will increase. This does not contribute to the work done and can be considered as wastage. Applying these observations in a military system, introducing more battlespace entities with all other aspects remaining the same will probably enable more combat power to be delivered even though the corresponding wastage will be higher. However, the combat potential is likely to remain the same.

Next, the network aspect. Earlier, the concept of entropy was mentioned. It occurs because energy transfer through inter-molecular interactions takes place not only in the system but also with its surrounding in order to reach a state of equilibrium. Without going into the details, it is suffice to say that this is actually a manifestation of the second Law of Thermodynamics 27 for the molecules in a system to reduce entropy. In the military context, by enhancing the network and networking aspects, we are essentially buying “information/content” to reduce entropy instead of more or better battlespace entities (equipment, platforms or even embedded combat systems). This, in turn, can give us more combat power even though the potential of the system still remains the same. However, a point of diminishing returns will eventually be reached. It will then become harder and harder to get more combat power from the same system, just like the increasing difficulty in squeezing more work out of the engine as the gas molecules system and its surroundings approach equilibrium.

Finally, to get folds increase in work done, instead of just focusing on the system, there will be a need to change the properties of both the system and its surroundings. In the internal combustion system, this can be attained through changing the design of the engine, such as making the cylinders bigger or by adding more cylinders; cramming more fuel/air charge into a cylinder of a given size, or using higher-octane fuel. Similarly, in a military system, dramatic improvements in combat potential and power are likely to be achieved only with fundamental changes to the x factor.

In summary, plotting combat power as a function of network value, Figures 3 and 4 illustrate the three ways in which it can be improved: (1) increasing number of connected battlespace entities with the same x factor 28 ; (2) improving the connectivity with the same x factor; (3) transforming x 1 to x 2 . The improvements from (1) will generally be “adaptive walks” 29 that are linear and evolutionary in nature. However, to get real transformation effects, we need

to think seriously how to “jump” the value curve through (2) and (3).

But in the process, we need to be mindful that there is no guarantee that simply hooking things up across the battlespace with faster and better means will increase combat power. In fact, if prevailing technology, strategy and doctrine, organisational structure and processes, education and training, cultural and social practices, and other key aspects of the military system are not compatible to take full advantage of the network effects, it is possible that the unintended con-sequences may be the degradation of military performance.

Reflecting On The Past And Present

So far, we have examined the network effects and implications on combat power in a theoretical frame. Can the conjectures withstand the test of reality? History may provide us with some insights.

Modern military organisation can probably trace its roots to the Napoleonic Wars. Between 1793 and 1815, the fielded armies had expanded significantly in size from tens to hundreds of thousands following the declaration of the levee en masse by the French and the subsequent adoption of the principle by other countries. 30 On the other hand, the means of communications had not evolved much from those available to the commanders in the pre-industrial-age – mounted couriers travelling at about 20mph or optical telegraphs based on fire or smoke signal – even though other Industrial Age advancements had brought radical change to the nature and conduct of warfare.

As a result, the means and ways available to a commander to gather quality information, make sense of it and provide timely directions to his forces increasingly lagged behind the growing complexity, size, and tempo of modern, industrial-age warfare. For instance, while we earlier noted Napoleon’s brilliant success at Austerlitz with 75,000 French troops, he lost control of half his force of 150,000 men at Jena and had no control of his 180,000-man force at Leipzig. 31

Obviously, there were many important factors at play that shaped the outcome of these battles. But leading military thinkers such as John Boyd believed that Napoleon’s continued reliance on a highly centralised command and control system even as his battlespace entities increased appreciably was one key factor that led to his eventual downfall. 32 Could Napoleon have done something more creative? For example, to overcome the limitation of his system, Napoleon had used his aides-de-camp as a “directed telescope” to gather information independently of his general staff and commanders. 33 This somewhat imp-roved the connectivity aspect. But on the whole, it became increasingly difficult for his existing network and networking means to support his ways of commanding and controlling his expanding size of battlespace entities.

A fundamental solution would be to change critical aspects of the x factor. The technological breakthrough came first. Eliot Cohen believed that the telegraph, together with the railroad and rifle, were the most critical technological innovations that brought revolutionary changes to the conduct of warfare in the mid 1800s, in particular, the American Civil War. 34 The railroad increased the mobility of larger armies, sustained them, and in some cases even enabled them to make operation moves by rail, as at the First Bull Run. 35 But telegraph made the coordination of movements and operations for large armies a continent apart a reality. In 1864 alone, the Union military system handled some 1.8 million messages, a phenomenal volume of traffic for the time. 36 The effects of more technological breakthroughs, such as telephone and radio, culminated during the period 1914 - 45, when the main belligerents, waging “total war”, called up between them over a hundred million men and orchestrated them in battles that stretched from Leningrad to El Alamein, and from the North Atlantic to the South Pacific.

The improvement in connectivity was, however, a double-edged sword. Commanders networked by new communication means to their subordinate units responded to these technological advances by increasing control on those under them. They now had a faster means to demand more information from subordinate commanders while they themselves had to respond to increasingly more information requests from their superiors. The unprecedented amount and quality of information available to the senior commanders in greater responsivity gave some the illusion that they knew as much as the ground commanders, and increased the temptation to interfere with lower-level decisions. As Major General J.F.C. Fuller explained from his WWI experience, this temptation frequently became too great to ignore:

“The General became more and more bound to his office, and, consequently divorced from his men. He relied for contact not upon the personal factor, but upon the mechanical telegraph and telephone. They could establish contact, but they could accomplish this only by dragging subordinate commanders out of the firing line that they may be at the beck and call of their superiors. In the World War, nothing was more dreadful to witness than a chain of

men starting with a commander and ending with an army commander sitting in telephone boxes, improvised or actual, talking, talking, in place of leading, leading, leading." 37

Since the end of WWII, advances in technology have provided the military with new and better means to see, command and control, and act. In particular, progress in the connectivity aspect has been phenomenal. For example, the number of radio sets rose from one for every 38.6 soldiers during WWII to one for every 4.5 soldiers in Vietnam. 38 This is an increase of almost 900%. Today, the US Army Land Warrior System program plans to provide communications and networking capabilities to dismounted soldiers that will provide them with own and friendly positions, as well as voice, data and imagery linkages between soldiers and other battlefield systems. 39 In the Operation Iraqi Freedom After Action Report, the US 3 rd Infantry Division (Mechanized) recommended that Blue Force Tracking (BFT) should be fielded to every vehicle in the division. 40 In synergy with other technological breakthroughs, especially in firepower and mobility, the land area that potentially can be dominated by a particular force in a conventional war has increased significantly. For example, during the Saipan invasion a division covered about 40 km 2 , during Vietnam 350 km 2 and during Desert Storm 4000 km 2 . 41 This trend of increasing dispersion and distribution is likely to continue as the military integrated advances in information technology into its systems.

In summary, military organisations in the last 200 years have adopted different approaches to tap the power of network that could provide them with greater combat effectiveness, and some were more successful than others. We would be deluding ourselves if we think that there is a "perfect" strategy that will prevail in all scenarios. Rather, the examples illustrated that the strategy we adopt must take into consideration our current position on the value curve, and devise the best combination of "adaptive walk" on the same path, and medium and long "jumps" onto the next curves.

Contemplating The Direction Into The Future

So what is our current position on the combat power value curve? History again can be a useful guide. Some scholars have asserted that the modern style of land warfare for large-scale high intensity conflict was born during the Great War in 1916 - 1918. 42 Before that, the prevailing style of warfare was characterised by Napoleonic contact battle of physical encounter with masses of infantry and cavalry manoeuvring, and supported by generally short-range, direct fire from openly-deployed guns. The doctrinal emphasis was on flank attack, envelopment and annihilation. However, the brutal shock from battlefield failures as epitomised by the Schlieffen Plan and the German offensive of 1914 necessitated a conceptual shift away from this linear two-dimensional style of warfare.

Through a series of landmark battles 43 in 1916 - 1918, the belligerents learned to integrate technological advances in indirect fire artillery, tanks, air power, and communications with new organisations, structures, processes and training to fight a three-dimensional, indirect fire modern style of warfare as we know today. The doctrinal emphasis was on exploiting all three dimensions to break through from the front while simultaneously devastating the full depth of the enemy rear. The psychological shock, in the form of paralysing breakthrough, became the objective while accurate indirect fire and survivable shock forces employed at the operational level were its key.

Even though severe constraints still limited the effectiveness of the new model, many features of the modern style of warfare had proven their relevancy and feasibility in the battles of 1916 - 1918. These included coordinated, massive employment of armour, artillery and air power, tank and anti-tank duel, air-to-air combat, strategic bombing, aerial reconnaissance and imagery, close air support, air defence, electronic battlefield communications and new logistics support systems. The ramifications were so deep that some have even argued that subsequent technological advances in the 20 th century, including information and communications technologies, were merely technical fixes instead of conceptual revolutions from the model laid down in 1916 -1918. 44

If we accept the above arguments, it means change in x factor is not anywhere in sight, and the best strategy is probably a mixture of "adaptive walks" with occasional medium "jumps". However, leading proponents of Network-Centric Warfare (NCW) believe that we are actually at a point of inflexion where the Information Revolution is going to spur new concepts of warfighting fundamentally different from the past. The hypothesis is thatunlike theIndustrial Age where power came from mass, power in the Information Age will come from information 45 (organic and sharedcontent), access (to information 2 and information 2 services) and speed (of command and execution). 46

At the same time, in the last decade of the 20 th Century, some significant changes in the global and regional security environment took many by surprise. The most fundamental change was the end of the Cold War and the collapse of the Soviet Union . In its aftermath, small scale regional rivalries and conflicts, previously suppressed by the division of countries into ideologically defined geopolitical blocs, have flared up around the world. A decade later,

the attacks of September 11 starkly pointed out the rise of Transnational Terrorist Threats (T3). Low-intensity conflicts (LIC) and Operations Other Than War (OOTW) become a key mission component for the military instead of occasional special operations. If these drivers and trends are indeed the precursor of something revolutionary yet to take its full shape, then a bolder strategy that comprises more medium and long "jumps" will be necessary to fully exploit the opportunities available, as well as avert the risks of being caught by surprise. In times of resource scarcity, there will also be a need to create the capacity to make the long "jumps" by scaling down investment in other approaches.

Eventually, the strategy to adopt is really a matter of judgement. But the first thing we need to do is to keep moving. In evolution, stasis means death. Moreover, new peaks can never be found if we are not constantly exploring. Herein lies the value of experimentation. It will allow us to test and evaluate a variety of new concepts, and avoid premature decisions and unintended "lock-in" in times characterised by uncertainty.

Conclusion

In conclusion, the subject of network effects for the military and the possible strategy we can adopt to best harness them is in the realm of "fuzzy problem" and cannot be addressed linearly. As we journey forward, we ought to consciously and continuously ask, "What added combat effectiveness does that additional investment in network buy?" To this end, it is hoped that this article will provide a useful frame to discuss the some of the issues and challenges pertinent to this subject.

Endnotes

1 Adapted from "The Ulm-Austerlitz Campaign, 1805",http://www.pbs.org/empires/napoleon/flash/n_ war/campaign/page_7.html.

2 Robert R. Leonhard, The Principles of War for the Information Age (Presidio Press, 1998), p36.

3 Frank M. Snyder, Command and Control: The Literature and Commentaries (Washington, D.C.: National Defense University, 1993), p15.

4 The Blue Force Tracker is a new US digital tracking system employed in OIF that allows individual soldiers to map their positions, keep track of both friendly forces and the enemy, share information and communicate by e-mail (CNN, 19 March 2003).

5 The original frame was developed with CPT Jacqueline Lee, FSD, as part of an experimentation work. Any error or misrepresentation in the current form are, however, the author's.

6 The research "Data, Information, Knowledge, and Wisdom" on the OTEC website provides a good summary.

7 David S. Alberts, John J. Garstka and Frederick P. Stein, Network Centric Warfare: Developing and Leveraging Information Superiority (CCRP 2nd Edition), p93.

8 Ibid, p116.

9 Ibid, pp57–59.

10 Robert M. Metcalfe, Packet Communication, Ph.D. Thesis, Harvard University , Project MAC TR-114, (Dec 1973).

11 This is because each of the N nodes can interconnect with each of the other (N-1) nodes. The division by two is necessary because each interconnection is double-counted. "Metcalfe's Law"by Haim Mendelson, Encyclopaedia of Computer Science.

12 Collaboration can be in terms of creation of new content, or synchronisation of actions or employment of the shared content directly in actions (e.g. Co-operative Engagement).

13 For simplicity, connectivity is simply used in this discussion to denote the proportion of inter-connected links in a

network of N nodes that potentially can have _N(N-1) links, assuming each link has the same characteristics (although this is unlikely to be the case in real networks).

14 Increasing the number of nodes will increase the value of the network provided the overall connectivity of the system is maintained. Otherwise, an increase of stand-alone nodes in the system simply means a lowering of overall connectivity of the system, which in turns means lowering the value curve. Solely increasing the connectivity of the system will also result in an increase in the number of connected nodes even though the total number of nodes in the system remains fixed.

15 “Metcalfe’s Law”by Haim Mendelson.

16 “Frequently Asked Questions About SA Termination”, The U.S. Interagency GPS Executive Board, http://www.igeb.gov/sa/faq.shtml.

17 Dr. Robert J. Fontana, “Experimental Results from an Ultra Wideband Precision Geo-location System”, http://www. multispectral.com.

18 David S. Alberts and Richard E. Hayes in “Power to the Edge: Command...Control...in the Information Age” (CCRP Jun 2003, pp 20-31) spoke about six different approaches adopted by the military in the 20 th century (from most to least centralized): Cyclic, Interventionist, Problem-Solving, Problem-Bounding, Selective Control and Control Free. “Command and control” is used in a neutral sense here and does not connote any endorsement of more centralisation or de-centralisation.

19 An externality is a cost or benefit that falls on people who are not directly involved in an activity. In our case, even if the commander maintains the proper functioning of his immediate connections, the negative effects experienced further down the line will have an adverse impact on his functions. See Enrico Coiera, “Information Economics and the Internet”, V7N3 (May 2000), Table 3.

20 K. Kelly, New Rules for the New Economy (London: Fourth Estate, 1998).

21 “Perfect Information and Perverse Incentives: Costs and Consequences of Transformation and Transparency” by Michael Schrage, MIT Security Studies Program (SSP) Working Paper (May 2003), p8.

22 Combat power can be perceived as “the realized capability of a force at any instant of time to achieve results in combat in furtherance of a particular mission against a specific enemy force in a specific combat environment”. It can be in the form of both traditional (lethal) and non-traditional (non-lethal) means. This is differentiated from Combat Potential, which can be interpreted as “the latent capacity of a force to achieve useful results in combat with its existing organization, training, equipment, support, motivation, and leadership”. See Edmund L. DuBois, Wayne P. Hughes, Jr., Lawrence J. Low, “A Concise Theory of Combat”, Institute for Joint Warfare Analysis, Naval Post-graduate School , p xvii.

23 Heat is the exchange of thermal energy from a hot body to a cold body. Work involves the net directed movement of matter from one location to another. “Energy is Conserved: The First Law of Thermodynamics”, Department of Chemical Engineering, University of California , Berkeley , http://www.cchem.berkeley.edu/~chem130a/sauer/outline/firstlaw.html.

24 Guillermo Moyna, “Brief Review of Thermodynamics”, http://tonga.usip.edu/gmoyna/biochem341/ lecture2.html.

25 “Entropy”, Brooklyn College , City University of New York, http://www.brooklyn.cuny.edu/bc/ahp /BE/Depts/BE.Entropy.html.

26 Other than oxygen, air is constituted of other kinds of molecules. Theoretically, it is possible to control the octane-oxygen ratio even as more of other kinds of molecules are introduced into the mixture.

27 The second law is concerned with entropy (S), which is a measure of disorder. The second law says that the entropy of the universe increases. An increase in disorder (overall) is therefore spontaneous. Guillermo Moyna, “Brief Review of Thermodynamics”.

28 Strictly speaking, except in networks already have 100% connectivity, increasing the number of nodes will increase both the number of connected and standalone battlespace entities in the system. In this case, the increase in combat is attributable to both greater quantity of players and better network.

29 A term to describe the process of incremental upward steps in evolution. It is an efficient and less risky method compared to evolutionary "jumps", as there is a causal relationship between effort and reward - every step forward is usually a step upward.

30 Martin van Creveld, "Some Reflections on the Future of War", Naval War College Review (Autumn 2000).

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32 John R. Boyd, "Patterns of Conflict" notes in A Discourse on Winning and Losing, a selection of unpublished notes and visual aids complied from 1976–1992, pp38-39.

33 Martin van Creveld, Command in War (Cambridge, Mass.: Harvard University Press, 1985), p10.

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39 "Army to Upgrade Land Warrior System With Blue-Force Tracker", National Defence Magazine (Feb 2004).

40 "Third Infantry Division (Mechanized) After Action Report - OIF", http://www.strategypage.com/articles/3IDAAR/chap1.asp.

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42 Brigadier Jonathan Bailey, "First World War and the birth of modern warfare" and Williamson Murray and MacGregor Knox, "Thinking about revolutions in warfare" in The Dynamics of Military Revolution 1300 - 2050, compilation of studies evolved from The Marine Corps University Foundation's HistoricalParameters of Revolutions in Military Affairs (April 1996).

43 These battles included the Brusilov Offensive of 1916, the British Army's battles on the Somme that same year, the Cambrai attack of 1917, the German offensives of 1918, and the British offensives that followed. Brigadier Jonathan Bailey, "First World War and the birth of modern warfare", pp132-153.

44 Ibid.

45 Note that "information" under NCW conventional may include notion of "data" and "knowledge" i.e. the full spectrum of "content".

46 VADM Arthur K. Cebrowski, USN (Ret), Director, Force Transformation in IEEE Spectrum (Jul 2002).

LTC Roland Ng Kian Huat is a Weapons Systems Officer (ADA) by training and is currently an Assistant Director at the Future Systems Directorate. Previously he held the appointments of Branch Head at MINDEF and HQ ADSD as well as Squadron Platoon Commander. He graduated with a Masters of Engineering from University College, London .

THE POINTER CONVERSATION With LTG William M. Steele, US Army (ret.)

Lieutenant General (LTG) William M. Steele, US Army (ret.) has had 35 years of distinguished service in the US Army during which he witnessed warfare transform from the traditional to the modern, spanning the full spectrum of operations. He has a wealth of experience dealing with joint operations in low intensity conflicts and military operations other than war as well as conventional hot war itself. Over the span of his career, he commanded the elite 82 nd Airborne Division from 1993 to 1995 and the US Army in the Pacific from 1996 to 1998. He served as the Deputy Commander of the US Army TRADOC before retiring in 2000.

He began the transformation process in US Army Command and General Staff College (CGSC) and headed the Army Training & Leader Development Panel Officers' study in 1998 and 1999. The study yielded 92 recommendations of which 90 have or will be implemented.

LTG Steele is now Vice President, Future Applications for Cubic Defense Applications Group.

LTG Steele visited the Singapore Command and Staff College (SCSC) in early 2004 and, in an interview with Commandant SCSC, COL Lim Teck Yin, on 15 January 2004 , shared his insights on US Army Transformation.

I would like to start the interview with the question of what's the distinction between "change" and "transformation" in the context of the US Army.

Change is continuous. It is a constant during our lifetime. During your career, change is continuous whether you are in the Army, Navy or the Airforce.

People deal with change in a routine way, especially within hierarchical organizations. It's usually evolutionary or incremental and takes place over long periods of time with minor adjustments that individually go unnoticed...taken collectively the result is evolutionary or incremental change within organizations.

Transformation, on the other hand, is much broader in scope and intent. It deals with change in organizational cultures and human behavior. Organizations involved in transformational change question everything about the organization. Nothing is sacrosanct; everything is questioned!

Do you see human behavior as the greatest obstacle to transformation?

Human beings and their behavior are the greatest inhibitors of change. Ask a group of 100 military officers if they fear change. Perhaps 3% will admit to their fear. The other 97% fear change but are not willing to acknowledge their fear...it is against their nature.

Significant change runs counter to everyone's nature. People are comfortable within their environment because they know what to expect. Change produces unknowns. In transformation, those unknowns affect the very nature of the organization and its environment. Their consequences are not known so they are resisted. The natural human response is to resist transformation.

People are comfortable with long-term incremental changes. They often go unnoticed and are easier to understand. Transformational change, on the other hand, shakes the very foundation of an organization's existence. Everyone is unaware of the effects of change and usually question their relevance in the new organization. Transformational change is so powerful it changes the purpose of an organization.

The US Army is involved in such a transformation. With the end of the Cold War and the ongoing global war on terrorism, the threat and operational environment changed and became unpredictable, uncertain and ambiguous. It is just the opposite of the Cold War environment's predictability. When the US Army asked itself: "Are we prepared for that kind of environment? That kind of a threat?" The answer was No! We were a smaller Cold War force not prepared for the unpredictability, uncertainty and ambiguity of today's strategic environment. We needed to change our organization; to adapt ourselves to a new operating environment or risk finding the Army irrelevant.

Could you trace some of the key events that led to the realization of the need to transform? Were there painful lessons that made it more and more evident that a larger transformation needed to take place or was it not so evident to the US Army that this was necessary?

The US Army met the end of the Cold War, the fall of the Berlin Wall in 1989 and the dissolution of the Soviet Union in 1992 by becoming a smaller Cold War force. We failed to realize how the new strategic environment would change our armed forces and Army. For 50 years, our reason for existence was to face down the Soviet Union and the threat of global communism. From the US Army perspective, that was service to the nation and the essence of our Cold War existence.

Our armed forces and Army were built for Cold War confrontations. If we had gone into conflict, we had armed forces that could compete successfully on the battlefield against Soviet formations. We had evolved over 40 years of Cold War competition to a position of dominance; learning lessons along the way when we faced the Soviets or global contingencies. In 1989, the US Army stood at its apex. Then the Soviets decided they were no longer going to compete! Three years later, the Soviet Union collapsed and the global scene changed dramatically.

Our force did not change immediately. In fact, we became focused on maintaining our identity as a smaller equally capable Army. That approach proved fortunate when Saddam Hussein invaded Kuwait in 1991. Fortunately our Cold War force, along with coalition partners, was available to force Saddam Hussein out of Kuwait . A Cold War force employing Cold War doctrine against Iraqi forces of Soviet design and doctrine... a competition for which we prepared throughout the Cold War. Soon after Desert Storm, we applied those same Cold War tactics in Somalia and in Haiti using light forces. We used Cold War heavy forces to cross the Sava River into Bosnia and stabilize the former Yugoslavia . These forces were effective because they rapidly adapted force structure and doctrine to a new environment; incrementally changing to meet immediate challenges. We used the same approach in the Kosovo campaign in 1999. Incremental change over the long term! We were comfortable with that approach because it did not threaten our existence.

Throughout the 1990s, different US Army leadership strata viewed our role, organizational structure, doctrine and operational tactics, techniques and procedures differently. Senior leaders felt simply maintaining our dominance over our peer competitors was adequate to meet the nation's needs. My generation inherited that approach. Ten years later, when we became the Army's senior leaders, we saw a need to trans-form the Army to meet a new strategic environment and global threat.

Our generation was led by General Eric Shinseki. In 1999, he became the Chief of Staff, US Army (CSA). He had just completed an operational tour as the commander of the multi-national force in Bosnia and had the courage to step forward and lead the most dramatic change to our Army since the years preceding WWII. The task was to change the US Army to make sure it was relevant today, and well into the 21 st century. Transformational change was required to ensure dominance in land operations for the first half of the 21 st century. Our Army needed to experiment to develop new ideas, concepts, technology, doctrine, structures, material, training and leader development programs. Transformation was required but, convincing the rest of the Army and our elected and appointed government officials was a significant challenge.

Beneath General Shinseki and the senior Army general officers were differing opinions. They varied in the general officer corps and among field grade and company grade officers. Non-commissioned officers and enlisted soldiers had their own opinions as well. Most could not understand why the dominant global land force needed to make such dramatic changes. These different views created obstacles to change and transformation.

You've explained earlier on how experience and culture are inhibitors to transformation. Were there any of these systemic organizational structures in place that were natural inhibitors to transformation?

The main inhibitor was human behavior. But, organizational structures and tradition became inhibitors as well.

Let me give you a few examples. Like most armies, our Army is composed, some would say divided, by branches. We group them into combat, combat support and combat service support branches. When the Army began transformational change, most branches felt threatened because the impact on the branch was unknown. The branch chiefs and many of their officers resisted changes that were disadvantageous and only supported changes that were to their advantage. Branches are charged with protecting the integrity, traditions and customs of the branch so any change with unknown impact was resisted. The branches had evolved over the years into semi-independent fiefdoms with identities many felt were more important than that of the Army. They were so protective and parochial they failed

to see the larger view... “what was good for the nation was good for the Army.” As opposed to “what was good for the branch was good for the Army.” In reality, when we tried to make significant changes, branches were initially an inhibitor.

The Army’s professional bureaucracy also posed special problems. Over time, bureaucracies can forget their reason for existence and focus on protecting themselves. Bureaucratic success becomes survival. Changes with unknown effects shake their foundation and cause overt and covert bureaucratic resistance. Civilian industry and contractors can also be resistant to transformational change; especially when their core business investments are threatened. Such was the case at the beginning of the US Army transformation.

Could you recount for us what followed from September 11, what were the discussions within the US Army that led to the strategic and organizational leaders recognizing collectively that it was high time that the US Army got on to its trans-formation?

The US Army transformation strategy evolved over two years. When General Eric Shinseki became CSA in the summer of 1999, an Army vision emerged based upon an extensive internal assessment of the force. Officers, non-commissioned officers and soldiers throughout the force were asked what changes were needed in the Army. Compilation of their answers provided a good starting point for transformation. The disparity of their recommended solutions also indicated that change would be difficult. When the September 11 attack occurred, we were two years into transformation with minor successes and continuously facing resistance by the professional institution, bureaucracy and natural human behavior.

One of the most significant sources of resistance was from the general officer corps. We had asked these officers to make significant changes and they had not bought into the solutions or even the need to change. Transformation conflicted with their personal perception of their responsibilities, duties and professional experiences. I mentioned the branch chiefs. They were a great example. In most cases, they were not enamored of this idea of change - we asked them to step forward as a branch chief and admit to the Army and branch members that their branch had to change. If it was in the best interest of the Army and the nation for the branch to take a step back, the branch could lose its modernization priority for new equipment, get smaller, acquire fewer resources, be merged with another branch or eliminated.

It was very difficult to get them to understand that perspective. In their defense, they were chartered to represent the branch and ensure its success. That normally meant acquiring more resources and branch prominence so stepping back was not something they warmed to initially. While some officers understood immediately, most did not. About 90 days before September 11, the CSA started an Army Strategic Leader Course for general officers. The purpose of that course was to educate active duty general officers to think strategically and accept the need for Army transformation. The officers were assembled in courses of 20 to 25 for a one-week course in strategic leadership to help them understand that transformational change was needed to keep the Army relevant to the needs of the nation. At the conclusion of the course, their charge from the CSA was to make transformational change happen. Before September 11, two courses were conducted. I was a senior mentor for the general officers in both of those courses. When they were completed, we still had not convinced those general officers that the Army needed to change.

Then came the September 11 attack. There was a strategic leadership course scheduled the next week. The CSA decided to hold that course but changed the attendance list to include all serving active-duty division commanders and some aspiring corps commanders. The first thing they received was a thorough classified operational briefing that identified the enemy, their location as best as we could determine and a discussion of the difficulties their Cold War Army was encountering to close with and destroy the terrorists. Attitudes began to change.

It soon became apparent to every general officer in that course that our Cold War Army, with Abrams, Bradleys, Apache helicopters and heavy artillery systems, was not what the Army needed to invade global terrorist sanctuaries. The general officer corps began to realize that change was required...“Yes, we have to change to be relevant in the future because the future is going to be spent fighting terrorists.” We felt we made a great deal of progress in that one course because of the September 11 crisis. In every course that followed, the general officers arrived with the attitude they had to change the Army. The attack helped us deal with the acceptance of transformational change in the US Army.

There are really three ways you can handle transformational change within an organization. You can let it happen over time and incremental change will occur over a career. It can happen without much guidance or management; in some cases you don’t realize until you leave the organization and look back. That’s most typical. Another way is leadership change. Recognizing a need to change, the leadership leads change. We have to change the organization to remain relevant and competitive. It’s usually not a popular method because it consciously involves changes to

responsibility, accountability, jobs, roles and relations among people within the organization. Leadership change is the most difficult kind of transformational change. It requires buy-in from all members of the organization when personal consequences are unknown... that's contrary to human nature. The third type of transformational change is during a crisis. In a crisis, cultural changes can be made very quickly.

Prior to September 11, 2001 , the CSA was attempting leadership trans-formational change, the most difficult method, with limited success. After the attack, the Army quickly shifted to crisis-generated transformational change with great success. It is still on-going. General Shinseki's successor, the present CSA, General Pete Schoomaker, continues to advocate transformational change in the US Army. General Shinseki's time-table for change was considered by many as overly ambitious. General Schoomaker has accelerated that time-table to keep the Army at the forefront of transformation within the Department of Defense. Final structure, doctrine, materiel, training and leader development programs are still evolving. In fact, they will never become final...because change is continuous. The September 11, 2001 attack helped our nation, elected representatives and appointed leaders in the executive Branch of government understand the uncertainty and ambiguity of the future and support these changes.

You mentioned earlier that it was fortunate in a sense that there was a Cold War Army that was ready to take on Saddam Hussein in 1991/92. Could you comment on how transformation initiatives have impacted on readiness levels in the US Army?

From 1999 to September 11, our transformation was one of leadership transformation. The leaders were trying to convince the Army and lead it through change. As I mentioned [earlier] that's the most difficult kind of transformational change. Prior to and during that time, the US Army retained most of its forces to respond to global contingencies.

The Army could afford to take one or two brigades off the global deployment schedule and take 18 - 24 months to build them into new organizations and formations. During that time the brigades would stand-down; merge with new equipment, doctrine, behaviors and capabilities. So the plan was to stand down two brigades simultaneously from an active force of approximately 40 combat brigades. The remainder of the force was capable of responding to contingencies without undue risk. All combat units were to be manned at 100% of authorization which was the first readiness initiative of trans-formation.

We had been manning our combat brigades at 90%; some of them much less. The rest of the Army, the institutional Army, had to pay the bill to make sure that the combat units were manned at 100% of authorized strength. That was the plan before September 11. After September 11, the original plan continued. Some units were taken off-line to transform. That's still going on and now includes the combat brigades of the US Army National Guard. Since September 11, 2001 , we're also taking transformational ideas and material and spiraling them into units rather than waiting until 2010 to field a transformed organization. The US Army is seeking the available cutting-edge capability today and providing it to today's force. Does it have a readiness impact? More turbulence is created but the immediate readiness and combat payoff is well worth the accelerated pace. The readiness positives far outweigh the negatives. It has given additional warfighting capability to units that were not forecasted to change for several years. This approach is required because all US Army combat brigades are involved today in the War on Terror...waiting for modernization is not an option.

As the Study Director of the Army Training and Leader Development Panel that was part of the Army Transformation Campaign Plan, could you elaborate on the key study findings?

As I recall, the four most significant findings were the importance of the leadership and organizational competencies of self-awareness and adaptability, the culture of professionalism, officer training and education and lifelong learning.

The most significant thing we told the CSA is that all Army leaders, whether non-commissioned officers or officers, have to have two mega-competencies: self-awareness and adaptability. These two work together; you can't separate one from the other. We wanted all leaders to look within themselves to assess their own talents and skills; to assess those skills against the environment that they found themselves in; to identify which ones were strengths and which ones were weaknesses; to start their own self development to sustain strengths and improve their weaknesses. That's self-awareness. We also determined that leaders had to make their organizations self-aware.

The second part of that competency is to be able to anticipate changes in the environment. To be able to look into the future, a year, a month, and five years and anticipate changes. Then to assess your individual skills, strengths and weaknesses against what will be required in that future environment...to adapt. Improving those areas of weakness required in the future so you can operate successfully. So our number one finding was the idea of a symbiotic

relationship between the meta-competencies of self-awareness and adaptability applied to leadership and organizations.

The second finding was about Army culture. We told the CSA and our senior leaders that we had no one in the US Army monitoring the Army's culture. No one was in charge or conscious of organizational culture. Over time culture had migrated with each decision that had an impact on the institution. Two directions for cultural change were always available. One was to migrate towards the profession of arms, the profession of being a soldier. The other was to migrate away from the profession towards the bureaucracy of a hierarchical institution. The former was desired; the latter unconsciously followed. We discovered most of our cultural migration had been towards bureaucracy and away from the profession.

Most of our Army leaders, young officers especially, saw themselves serving in a bureaucracy rather than a profession. That was a significant shock to the panel members. When we sorted through all the information, the young officers told us our professional beliefs were out of balance with our bureaucratic practices. We believed one thing but actions countered or inhibited our beliefs. They gave us several examples. Many others were identified, recommendations made and adjustments implemented. Ultimately the senior leaders learned they must be the protectors of the profession. They have to be conscious about the impact of their decisions on the profession today and in the future.

Thirdly, we looked into officer education and found officer education had become, in some branch schools, not relevant to the environment. The training had become classroom-based with not enough effort on warrior spirit, warrior ethos and the application of tactical and technical knowledge in a combat environment. We were spending too much time in the classroom talking about theory and not enough time in the field learning about fighting.

We also found we had developed infantry, armor, artillery officers, etc. but none of them identified themselves as US Army officers. They defined themselves as officers of their branch. We wanted to change culturally so officers identified themselves first as US Army officers and secondly as branch officers... all without destroying the pride and tradition of the branches. We recommended an initial entry course for all lieutenants as a rite of passage...a common experience all officers could share. The course develops self-confidence and teaches leadership skills, field craft, fitness, weapons handling and combat techniques. We recommended our officer advanced courses become combined arms focused and preparation for company command rather than merely advanced branch skills.

We looked at our intermediate course, the equivalent of your Command and Staff Course, at our Command and General Staff College (CGSC). It is the senior tactical course in the US Army. We realized we were training too many people there who were not warriors. We recommended we give a higher tactical education to our warriors and provide a different education to the non-warriors in our profession. They became known as changes to our Intermediate Level Education or ILE. They are in the process of being implemented. ILE resulted in a common core course for everyone and then an advanced warfighting course for our warriors. The common core course is exportable and will be taught at many different locations. Everyone will have an opportunity to attend a common core course for about 90 days. The warriors then attend CGSC at Fort Leavenworth for about seven months of advanced warfighting operations. It will give them a graduate degree in tactics and how to fight. Non-warriors will also attend additional schooling to prepare them to serve the remainder of their career in their selected career field. That's the officer education piece in a nutshell.

The panel looked at US Army collective training and found we had not put adequate resources into training aids, devices, simulations and simulators to support operational units and readiness training. We recommended budget adjustments to correct the problem. We found unfunded requirements in our combat training centers for equipment and facilities re-capitalization and modernization. Those have since been corrected.

Finally, we told the CSA the officer corps needed to commit to lifelong learning. The Army needed to support that commitment. It wouldn't be enough for the officers to commit to lifelong learning without the Army providing the means. It is a partnership. The Army recognizes that partnership and is providing the required resources.

I think it would be interesting for our readers if you could elaborate on what you consider are the elements that make up the profession as opposed to a bureaucracy.

My understanding on the issue of the profession benefited greatly from the works of Colonel (Dr) Don Schneider, US Army (ret .) He's a professor of Behavioral Science on the US Military Academy faculty. Don has led significant study on the Army as a profession. I agree with his conclusions that the profession is really made up of four elements.

The first, and probably the most important, is the need to have a documented body of professional knowledge that identifies unique expertise - why the profession exists. In the case of the US Army, it would be knowledge about how you fight, how you train, how you maintain readiness, how you assess the force, how you care for the force, how you sustain the force, etc. All of that in writing becomes the US Army professional body of knowledge. It is not fixed in time; is constantly changing and evolving as the operating environment changes. The profession is always learning and documenting its knowledge. Everybody contributes new ideas and concepts that make up the professional body of knowledge...the schoolhouses, operational units, the department staff, etc. Everyone is involved.

Secondly, a profession has to have legitimacy. Legitimacy is something awarded to you; the profession cannot simply declare itself legitimate. It has to be awarded to you by the people who recognize the profession. For the armed forces, that's the civilian population, the elected and appointed officials within the government and the law of the land. Legitimacy also has a great bearing on professional values and behaviors. Without legitimacy you cannot have a profession!

The third and fourth are about competition. There is external and internal competition. You can't be a profession unless you're forced to compete for the jurisdiction of your ideas within your profession. Internally, it's a competition on developing new professional ideas and knowledge. Who does what and how it's done? Who's creating and constantly developing and updating this new body of knowledge? It is a dialogue between different competing ideas - seeking an outcome that is the best for the profession.

External competition is other armed forces. They compete against one another. In the adversarial relationship, who is the dominant force? Or even in coalitions and alliances, who has the best capability? This competition is a healthy thing - it fosters new ideas, new ways of doing things and improving the profession.

You mentioned earlier on in the study of leader development on the two competencies – self-awareness and adaptability. Could you highlight the main differences of the leadership development between now and the past?

The Cold War environment was very predictable and well-defined. We became very process-oriented. If you talked to anyone about warfighting in the US Army before the 1990s, they would talk great lengths about synchronization and capabilities. Synchronization and capabilities are nothing more than processes to figure out how you get combat power into the battle. It was process; science as opposed to an art form. Science worked especially against a predictable threat. It also provides structure for inexperienced leaders and their staffs.

When the Soviet Union dissolved, the threat and environment became less predictable, very uncertain and ambiguous. We were not sure the scientific process would work against asymmetric foes. Now, rather than teaching leaders what to think and what to do, which we did in the Cold War, we teach them how to think and how to solve problems dealing with uncertainty and ambiguity. It's a completely different mindset. When you operate in an uncertain environment, you very quickly determine the importance of self-awareness and adaptability.

I would like to round up the interview by asking for your observations over the few days that you have been here and interacting with our students from Command and Staff Course, you met with a group of brigade commanders and this morning you met with our branch chiefs. Would you share some of the observations?

It's always great to be able to return to Singapore . I was here several times while I was on active duty as the Commanding General - US Army Pacific. I participated in Tiger Balm exercises and worked with the Singapore Armed Forces here, in Hawaii and other locations in the Asia-Pacific region. It is always a rewarding experience and I've learned a great deal from my SAF contemporaries.

I've learned that national armed forces are very different. They are organized, trained and equipped to meet the needs and national interests of their countries. Accordingly, no two armed forces are alike. Each has its own merits and vulnerabilities. The information I've provided during this interview is based on the US Armed Forces. That perspective does not directly apply to the Singapore Armed Forces or to the armed forces or any other army in this region or the world. They're unique to the US Army. Singapore must learn from its own experiences while being informed by the experiences of others. Modeling after other armed forces can be detrimental to Singapore 's interests. Each nation's armed forces must seek the identity and capabilities that best suit its strategic interests.

I was encouraged in my dialogue with the officers, especially the senior officers. They understand transformation for transformation's sake can be harmful. It must follow serious internal assessments balanced against external threats.

The senior officers of the Singapore Armed Forces understand the SAF must change to meet the challenges of Singapore 's strategic environment in order to remain relevant. You must next ask yourselves "Ready for what?" When you answer that question, you will know if you have incremental or transformational change on your hands. The former is easy. The latter is a professional challenge of significant scope. "Ready for what?" "What should we change and why?" Once those questions are answered, the related issues will be easier to accept.

Reflections On The New Indo-Pacific Maritime And Naval Environment

by Dr James A. Boutilier

It is widely recognized that the center of world economic gravity has shifted from the Atlantic to the Indo-Pacific region. In this review, that region will be said to encompass the oil-producing states of the Arabian Gulf area, India and Pakistan , Australia and New Zealand , and the states of East Asia from Indonesia to Japan. While trans-Pacific and intra-Asian trade is booming and megaports are burgeoning throughout the region, dramatic changes are also occurring in the naval realm. Clearly, there is a complex and critical relationship between the growth of commercial shipping and the development of regional navies. In addition, there is a number of fundamental realignments occurring in the roles that navies (and, to an increasing degree, coast guards) are expected to play, the threats they are expected to face and the areas in which they are expected to operate. These realignments are a reflection of tectonic shifts that have taken place since the end of the Cold War in the spatial relationships between land and sea; with mercantile activities moving towards the coast and navies moving towards the shore. Simultaneously, the trajectories of weapons and trade have blurred the traditional distinctions between the two domains.

No ocean in the world is as geographically complex, jurisdictionally contentious, and potentially confrontational as the Pacific Ocean . Furthermore, it could be argued that no maritime region is more dynamic and important, locally and globally, than the Indo-Pacific region. This paper reviews the far-reaching changes that characterize the maritime and naval environment that has emerged in the past decade in the Indian and Pacific Ocean areas.

Dynamic Maritime Trade

Economic dynamism is the most striking feature of those areas. Over the past 20 years the export-driven trade of East Asia has increased “nearly twice as fast as world trade in general and has already surpassed that of North America”. 1 The statistics associated with that trade are suitably impressive, no more so than in China which has become the main engine of regional growth. As Andrew Mukherjee noted, China consumes “about a quarter of the world’s steel, a third of its oil and half of its cement”. The People’s Republic, he concludes, “has been a bigger contributor to global growth than the US for the past two years”. 2 When compared with the Gross Domestic Product of other Asia Pacific countries, the wealth generated by the Pearl River delta region of China (less than 1% of the nation’s land area) is almost equal to that of Indonesia or South Korea. 3

China , in fact, is expected to be the “greatest single factor influencing the world’s shipping industry over the next two decades”. 4 That influence manifests itself in at least four ways: ship-ping patterns, shipbuilding, container traffic, and port development. China ’s maritime economy grew 17% per year in the 1980s and 20% per year in the 1990s. Much of it was carried in the nation’s 300,000 (50 million dead weight tons) merchant ships. 5 Central to that traffic is China ’s insatiable demand for energy. China ’s crude oil demand in 1990 was 2.3 million barrels per day (bpd). By 2000, it was 4.6 million bpd. 6 In 1993, China became a net importer of oil. Thus, with China ’s crude oil imports expected to treble over the next decade, the shipping routes or Sea Lines of Communication (SLOCs) from East Asia via the South China Sea , the Straits of Malacca, and the Indian Ocean to the oil-rich Gulf states are becoming increasingly important, commercially and geo-strategically. And regional dependence is also scheduled to keep growing. Oil imports accounted for about 60% of Asian oil consumption in 2000. They will account for nearly 75% by 2010. 7

There are two major SLOCs in the Indo-Pacific region. The first runs from the Straits of Malacca across the Indian Ocean to the Middle East . Roughly 41,000 ships pass along this route every year, double the number of ships passing through the Suez Canal and triple the number transiting the Panamà Canal. 8 The second SLOC runs from the South China Sea northeast to the Sea of Japan . Like China , Japan and South Korea are overwhelmingly dependent on imported energy. So too is India . Over 3,800 oil tankers visited Indian ports in the year 2000 and one of New Delhi ’s greatest security concerns is the need to ensure the uninterrupted flow of Middle Eastern energy to the sub-continent. 9

While vitally important, energy flows are only a part of the overall shipping profile in the Indo-Pacific region. In broad terms, there are two shipping patterns in the Pacific; trans-Pacific and intra-Asian. Asian shipping companies announced recently that they expected to carry between 10% and 12% more cargo from Asia to the US in 2004 than forecasted earlier. 10 Container traffic was up 16% from China to the port of Vancouver in the first six months of 2003 (for a total of 752,819 20-foot equivalent units or TEUs) and overall trade between those two destinations more

than doubled from 1999 to 2002 (1,588,000 metric tons to 3,569,000 metric tons). 11

Significantly, only China appears to have been immune to the Asian economic crisis of 1997 - 1998 and this fact is borne out by the continuous growth of China's (and Hong Kong's) trans-Pacific trade during the 1990s (growing from 613,000 TEUs in 1990 to 3.1 million TEUs in 1999). 12 Equally significant (if not more so) is the fact that intra-Asian trade is growing more quickly than trans-Pacific trade. This phenomenon reflects the power and attractiveness of the China market, the general recovery of East Asian economies in the period after 1997, and the emergence of trade facilitation agreements between China and Southeast Asian states. In 2003, China was the recipient of over US$50 billion in direct foreign investment, much of it at the expense of other regional polities, and as China 's gravitational field becomes irresistible, more and more nations, like South Korea , are redirecting their trade flows towards the People's Republic.

These flows have increased the demand for hulls in the Indo-Pacific region dramatically. South Korea , Japan and China are at the forefront of world shipbuilding and China 's share is growing steadily. Recently, the Shanghai Waigaoqiao Shipyard (SWS), completed the first phase of a US$389 million development program. SWS is one of China 's "key projects" and is by "far the largest and most advanced [shipyard] in the country." 13 Since May 2001 SWS has received over 4 million tons in orders, an amount almost equaling China 's total shipbuilding capacity at present. A second US$121 million phase is planned and when work on the yard is completed in 2005 it will have a capacity of 2.6 million tons per year. SWS is a critical component in Shanghai 's ambition to become the world's largest shipbuilding centre.

With a 500-ship waiting list at shipyards around the globe, and American demand for Asian exports growing faster than the number of hulls available, it seems likely that there will be no lack of work for Asian yards. 14 Two further points are worth noting. First is the fact that the growth of regional shipbuilding capacity has significant implications in terms of indigenous capacity to construct naval vessels. Second, is the fact that ship-building, ship repair, and ship-breaking are all functions that reinforce commercial activities as the central features of the megaports of East Asia .

Regional Navies

The regional navies of the Indo-Pacific region are growing larger and becoming more sophisticated. This is part of a related phenomenon, namely a re-ordering of national priorities away from the land towards the sea. As the age of independence struggles and post-colonial reconstruction draws to a close and Asian nations are drawn more deeply into a global economy, they have begun to focus on maritime commerce and port development. At the same time the army formations that were needed during the nation building phase are returning to their barracks, literally and metaphorically.

Across the region, armies play a smaller overt role in politics, whether in South Korea or Thailand , and national leaders are eager to reduce the numbers of soldiers and render the remainder more professional in their conduct and more technologically sophisticated in their hardware. This is certainly true, for example, in China where the People's Liberation Army (PLA) has been reduced in size and the Central Military Commission, impressed by America 's mastery of the Revolution in Military Affairs in Southeastern Europe and Iraq , has sought to improve the sophistication of PLA assets. Simultaneously, Beijing has recognized that China's own center of gravity has shifted to the provinces facing the Pacific, that China is vitally dependent on ocean-going commerce, and that China must, at the very least, be able to exercise sea denial in the approaches to the mainland.

Thus, we see Beijing devoting greater attention to expanding China 's naval capabilities. This has involved the abandonment of the old Soviet legacy of coastal and riverine warfare and the articulation of green and blue water doctrines. Concomitant with this doctrinal shift has been the need to introduce new generations of warships and submarines. In this regard, the Chinese have pursued two routes simultaneously: build and buy. The latter strategy has entailed acquiring Kilo-class submarines and elderly but powerful Soviet-era Sovremenny destroyers from Russia . The Indian Navy has gone down the same road while actively developing their own indigenous capacity to construct naval vessels. The same can be said for a nation like Singapore , that saw the first of its Lafayette-class frigates, RSS Formidable, launched in France in January 2004. The remainder will be constructed in a local yard.

The Chinese have begun constructing increasingly impressive frigates and destroyers. In some cases, these vessels have been built for foreign buyers. The Royal Thai Navy is reported to have had frigates built in a Shanghai yard. Similarly, in South Korea , the naval industry is capable of building the latest generation of guided-missile destroyers as well as diesel-electric submarines. Hyundai Heavy Industries, for example, is building the first of the KDX III, 7000-tonne, Aegis-class destroyers. This programme, worth approximately US$2.1 billion, will see three

destroyers being fitted out; the first in 2008, the others in 2010 and 2012. 15 Parenthetically, the construction of surface combatants of this size has become a prominent feature of naval construction and acquisition across the region. Virtually all of the navies in the Indo-Pacific are going up-market; acquiring warships with greater displacement and firepower. The Sovremennys are a case in point but elsewhere the Indian Navy has acquired the 6700-ton Delhi-class destroyers, the Japanese and South Korean navies are looking to add 13,000-ton vessels (a destroyer in the first instance and an LPX in the second) in the next decade and the Republic of Singapore Navy has moved from corvettes to frigates. 16

Megaports And Container Traffic

As suggested, indigenous ship-building capability has contributed to and resulted from the development of Asian megaports. Lee's research indicates that 8 of the 10 busiest container ports in the world were located in the Asia-Pacific region in 2000. 17 The Chinese are building what will potentially be the world's largest port at Yangshan near Shanghai. As envisioned, Yangshan will have at least 30 berths with an annual handling capacity of 13 million TEUs by 2020. 18 By way of comparison, Vancouver, Canada's largest port, handled 752,819 TEUs in the first six months of 2002. 19 In order to accommodate the newest generations of container ships, Yangshan will be built on a group of islands and connected to Shanghai by a 30-kilometre bridge. Shanghai was one of the world's busiest ports in 2002 (coming after Hong Kong, Singapore and Pusan) and during the same year Shenzhen leapfrogged both Rotterdam and Los Angeles (Long Beach) to become the world's sixth largest container terminal. 20 It is instructive to reflect upon the fact that only a few decades ago Shenzhen was little more than rice fields on the outskirts of Hong Kong.

China is the largest producer of containers in the world. This is important in at least two respects. First, the concentration of wealth in China 's maritime provinces reflects not only the realities of explosive export growth but the inadequacy of the land-based infrastructure. A key feature of the new "just-in-time", "door-to-door" supply chain that has come to characterize the global economy is the way in which those chains stretch well inland, blurring the distinction between the land and the sea in the process. In China 's case, road transport is probably the most efficient way to move containers within 500 kilometres of a port like Shanghai . The Chinese authorities are dedicated to enhancing the multi-modal nature of their transportation system, but, for the moment, limitations in transportation encourage an even greater concentration of industrial production and commerce close to the sea.

Second, is the growth of the container industry itself. Container traffic from Asia to the US grew by about 10% in 2003 while shipments from Asia to Europe were up 14%. 21 Put another way, US-bound exports from China rose 22% in 2003 and the shares of three of the top five trans-Pacific shipping companies (like Singapore's Neptune Orient Lines and Taiwan's Evergreen Marine) almost tripled in the same period. 22 When we look more carefully we see that the trend is not so much toward more container ships but to bigger ships. Vessels with a capacity in excess of 3000 TEUs made up 67% of the total deliveries in 2002.

More significantly, however, vessels with that capacity made up 79.8% of the ships on the order book. 23 In terms of dead weight tonnage, container ships are one of the two fastest growing categories of merchant ship (so-called "miscellaneous tankers" is the other) with displacement rising from 69,216,000 to 82,793,000 (7.4%) in the period 2001 to 2003, inclusive. This "relatively high rate of increase" reflects the growing proportion of manufactured goods being traded in containers. 24 As Cozens observes, "a container ship leaving New Zealand bound for East Asia could have a cargo value of up to NZ$250 million." 25

Cozen's observations relate to critically important developments at sea: the growing size of container ships and the multiplication not just in the number of containers (a factor with serious security implications) but in the value of the goods carried therein. Certainly the trend towards larger and larger container ships appears unstoppable, at least within the limits of naval architecture and safety at sea. Nippon Yusen KK of Japan , for example, has ordered four 6,200-TEU container ships from Ishika Wajima-Harima Heavy Industries in addition to five already on order. 26 Other analysts talk of exponential growth in the carrying capacity of container ships in the future. Certainly there are economies of scale to be enjoyed from bigger ships. A 6,000-TEU ship probably costs 30% more than a 3000-TEU vessel and requires about the same percentage of extra fuel but needs only marginally more crew.

Security Initiatives

Mariners are well acquainted with the traditional array of seaborne challenges; piracy, smuggling, the movement of illegal migrants, and so forth. Piracy has attracted a good deal of attention in recent years as a result of the number (and more brutal character) of attacks as well as of enhanced international reportage. There is a rich literature on southeast Asian piratical attacks and while piracy has a profound effect on ship owners, crews, and insurance rates

it is a statistically modest affair over and against the tens of thousands of ships plying the world's oceans at any one time. 27

Of greater importance, currently, is the threat of maritime terrorism. The number of vessels that have actually been targeted - vessels like the USS Cole and the M.V. Limberg – is almost infinitesimal but the ramifications of anticipated attack are huge. They are huge in at least two ways. First, are the flow-on costs of maritime terrorism. Cordner and Rentsch have noted that the flow-on costs to the Port of Yemen of the Limburg attacks in 2002 were "approximately US$180 million over six months". 28 Another widely circulated estimate relates to a terrorist 'dirty bomb' (radiological material scattered by conventional explosive) attack on the port of Long Beach, California. The total cost, US$58 billion. 29

Second, are the gargantuan costs associated with trying to safeguard international maritime commerce from attack. Those efforts highlight a variety of vexing problems: intelligence sharing, dealing with unbelievably large volumes of trade, lack of administrative capacity, the expense of new security technologies, different perceptions of threat, and jurisdictional complexities. At the heart of the matter is the tension, in time and money, between economic efficiency and security effectiveness. The US has been at the forefront of promoting the Container Security Initiative (CSI).

What makes maritime terrorism so complex, at its simplest, is that ships, their crews, and/or their cargoes (for example, liquefied natural gas) can, separately or collectively, be vehicles for attack. CSI focuses on the huge traffic in containers; containers that could be used to transport weapons like dirty bombs. What CSI has done, in effect, is to re-order spatial relationships once again by pushing the maritime boundaries of the US outward in a series of concentric rings. At the outermost limit are the 17 or 18 international ports that have agreed to the pre-clearance of containers (frequently by US personnel) before they leave for American ports. Foreign port authorities who fail to embrace the CSI run the risk, in theory at least, of having their cargoes denied entry into the US after July 2004. US Customs officials began patrolling the ports of Klang and Tanjung Pelepas in Johor in September 2002 to screen US-bound cargoes for contraband and suspected terrorist materials. Pre-screening facilitates the entry of Malaysian shipments into American ports and, armed with these assurances, the Malaysian government is continuing with a US$1.5 billion development of the two ports to accommodate bigger container ships. 30

The next ring is the 96-hour ring where incoming merchantmen are obliged to communicate their intentions, crew lists, and manifests. These details should be congruent with the contents of containers that were forwarded to US authorities - in accordance with CSI requirements - 24 hours before their ships depart the Asian port. High Interest Vessels (HIVs) and high-risk cargoes are tracked and subjected to special scrutiny. 31 The magnitude of the task, however, remains daunting. The US Coast Guard, which bears much of the burden of enforcing these new regulations, and the various port authorities are faced with dramatic increases in their responsibilities but only limited increases in funding. It is no surprise, therefore, that only about 3% of the 16 million containers that pass through the 361 ports in the US receive close attention. 32

Another interesting and debatable initiative promoted by the US is the Proliferation Security Initiative (PSI). While anchored in a larger concern about maritime terrorism, PSI is designed to prevent the shipment of missiles, weapons of mass destruction (WMDs) and associated equipment. The PSI has several antecedents. In December 2002, Spanish marines, acting on a request from the US , boarded a North Korean freighter, the So San, crossing the Arabian Sea . Hidden under bags of cements were 15 Scud missiles bound for Yemen . The Yemenis maintained that the purchase was for defensive purposes only and as neither Yemen nor North Korea were signatories to the Missile Technology Control Regime (MCTR) (and the regime only provides voluntary guidelines), the Spanish and the Americans were obliged to let the So San go. As Byers and Droz have noted, "it was the absence of international law, rather than pre-existing rules, that impinged on US interests". 33

The American answer to this shortfall was the PSI; an initiative whose wisdom appeared to be buttressed by the realization that not only had Tehran deceived the International Atomic Energy Agency (IAEA) with respect to the Iranian nuclear programme but that North Korean duplicity, in the form of Pyongyang's failure to honour the Agreed Framework of 1994, and willingness to ship missile components to the Middle East, had severely under-mined the Nuclear Non-Proliferation Treaty. PSI, with 11 adherents including Japan and Australia , argues that the high seas interdiction of vessels should be allowed on the grounds that the right of self-defense which includes preventative action. The legal basis for interdiction of this sort remains contentious to say the least. Nevertheless, joint naval exercises, involving PSI signatories, were held in the Coral Sea , off the Queensland coast of Australia , in September 2003, with a view to promoting intelligence sharing and military cooperation. 34

Spatial Realignments

The US Navy (USN) is at the fore-front of such initiatives and the War on Terrorism in Asia . Its presence in the approaches to the Arabian Gulf in Operation Enduring Freedom (the maritime element of the War on Terror) reflects a profound doctrinal change that has occurred in American naval thinking since the end of the Cold War. In September 1992 the USN articulated a new strategic doctrine entitled “From the Sea”. A more detailed iteration, “Forward From the Sea”, appeared in November 1994.

What these concept papers called for was a dramatic re-positioning of USN assets from the deep ocean, where, in simplistic terms, they had focused much of their attention on hunting Soviet submarines, to the littoral regions of the world. “From the Sea” documents constituted a timely recognition of the complex and unpredictable nature of global threats in the aftermath of the fall of the Berlin Wall. As “Forward From the Sea” observed matter-of-factly, “75% of the earth’s population and a similar proportion of national capitals and major commercial centres lie in the littorals. These are the places where American influence and power have the greatest impact and are needed most often.” 35

Not only has the operational focus of the world’s most powerful navy, and many of its allied and associated navies, moved from the high seas towards the shore, but the reach of those navies has begun to extend well inland, eroding the land/sea frontier. Power projection, utilizing carrier-based aircraft and cruise missiles allows the USN to strike at targets over a thousand nautical miles inland. At the same time, vessels operating in the approaches to the Indo-Pacific littoral do so in what Pentagon jargon calls a “target-rich environment”, vulnerable to shore-based anti-ship missile systems and interceptors.

Paradoxically, the 1990s witnessed a decline in anti-submarine warfare capability in most if not all navies. The Soviet submarine menace had been vanquished, or largely so, and what new threats there appeared to be in the form of incoming missiles. While this remains true, “From the Sea” document commits the USN and other maritime forces to operating in the most difficult of all ASW arenas - the shallow in-shore environment - at the very time when it is becoming more and more densely populated with hard-to-detect diesel-electric boats. Submarine acquisition and construction have been, in fact, an important part of the Indo-Pacific proto-arms race of the past decade. Thus, we find India and France completing negotiations in February 2004 to build six 1,600-tonne Scorpene submarines in India. 36

New Delhi had already under-taken to buy three Russian Kilo-class (Type 877 EKM) and three Amur-class submarines in 2001. Two years later, in November 2003, the Indian Ocean stakes were raised even higher when Pakistan , 1 of 12 countries worldwide to build its own submarines, commissioned an indigenously constructed Agosta 90-B. 37

Coast Guards

The proliferation of powerful war-ships and submarines in the Indo-Pacific region stems, in part, from a new nationalistic self-confidence throughout the region. Indeed, some might say that there is a certain Mahanianism in the air. Big ships, however, are not necessarily suited for many of the lower- level maritime challenges that abound. There are continuous frictions over disputed territories like the Senkaku/Diaoyutai Islands, the Spratlys in the South China Sea , and the rocky outcrop lying part way between Japan and South Korea . Maritime boundary lines and definitions under the UN Convention of the Law of the Sea (1982, in force since 1994) remain sufficiently debatable that tensions flare up on a regular basis. Fishing is also a source of inter-state tensions. In fact, in April 2003, the Indonesian Navy was reported to have attacked several Malaysian boats off Perak on the grounds that they were engaged in illegal fishing. 38 That report was lent further credence when the Indonesian Navy announced that the TNI-AL’s Western Fleet Commander, Commodore Mualimin Santoso “was not afraid of shooting foreign vessels that enter Indonesian territorial waters without permission”. “So far,” Santoso declared, “only foreign fishing vessels have been shot ...” 39

These comments underscore the need for good governance at sea. To meet that need, a growing number of Indo-Pacific nations are either converting existing maritime safety agencies to coast guards (Japan), creating coast guards (Vietnam) or contemplating their creation (Australia). Indeed, as Bateman has suggested “coast guards are a growth industry” in the region. 40 His contention is that navies, in the pursuit of sophisticated weaponry have, in effect, “priced themselves out of maritime policing”. 41 The appearance of coast guards in a realm characterized by intense levels of shipping and overt competition for territory and resources indicates that the third element in Booth’s famous maritime triangle - warfighting, naval diplomacy, and constabulary activities - has come to the fore. Coast

guards are cheaper and less provocative than navies. On the negative side, however, there is a disturbing lack of comparability across the maritime landscape. Some countries have navies and coast guards, some have only navies, and those that have coast guards may not have endowed them with similar levels of authority. While coast guards may be ideal for monitoring maritime pollution, con-ducting search and rescue, or maintaining aids to navigation, they may lack, in the final analysis, the power and/or the legal authority to act in particularly challenging circumstances.

Broadly speaking, northeast Asian waters are the purview of navies while Southeast Asian waters are the natural home of coast guards. This fact reflects the difference in the size and power of the states involved in the two sub-regions, the nature of inter-state relations, and the frequency of constabulary opportunities in Southeast Asian waters. What commends coast guards is that they are more naturally suited for confidence building measures through mutual cooperation. Japanese Coast Guard (JCG) vessels, for example, visited Southeast Asia and South Asia in November 2000 for exercises with the Indian Coast Guard. Furthermore, JCG vessels and aircraft visit Southeast Asia regularly to participate in anti-piracy patrols. 42

Naval Cooperation

There is reassuring evidence that regional navies are adopting a more cooperative attitude as well. Despite the growth of those navies (and the repeated exchange of gunfire between South Korean warships and North Korean vessels in recent years), 43 navies from the Indo-Pacific region are engaging in increasingly higher levels of naval diplomacy and confidence building. Some of these interactions are historic in nature. The visit of the USS Cowpens to Ho Chi Minh city in November 2003 was the first such visit since the end of the Vietnam War in 1975 and illustrated the dramatic improvement in relations between Hanoi and Washington. 44 Similarly, in the same month, the Chinese and Indian navies held their first ever joint naval exercise off Shanghai; a search and rescue exercise described as “the boldest step in the steadily improving relationship between ... the former foes - and a new twist in the Asian security picture.” 45

The press and professional literature are full of comparable examples - the Indian and Russian navies, the Royal Malaysian and Thai navies as well as the marine police, the Japanese Maritime Self-Defense Force and the Republic of Korea Navy – as well as accounts of long-range, flag-waving voyages by the Indian, Chinese, Singaporean and Indonesian navies. 46 These levels of peaceful naval activity augur well in the Indo-Pacific region and suggest a pan-regional consensus that maritime peace is in everyone’s interest.

Conclusion

The Indo-Pacific maritime arena is the most dynamic in the world. There are unprecedented levels of maritime activity. Trans-Pacific and intra-Asian container traffic is booming. Major shipyards and megaports populate the Asian shore. The Indian and Pacific Oceans are linked by vital energy flows and the overlapping geo-strategic interests of the Indian and Chinese navies. Regional navies are growing more powerful, with bigger surface combatants, more submarines, and greater numbers of sea-going missiles. Regional powers, like China , are repositioning their national interests towards the sea while major navies, like the USN, are repositioning their operations toward the shore. Spatial distinctions between the land and the sea are becoming blurred as weapons systems and supply chains connect the oceans and the interior in a more and more profound way. Challenges at sea have spawned regional coast guards; forces that are less expensive and less provocative than navies but ones well equipped to attend to the needs of dense ocean traffic, and disputes over fisheries, boundaries, islets, and deep sea resources. Constabulary functions have become more prominent throughout the two great oceans, and reassuringly, there is increasing evidence that in this, the most contentious and confrontational of all ocean complexes, naval diplomacy and cooperation are on the rise.

The views expressed in this article are those of the author, and do not reflect the official policy of Canada ’s Department of National Defense.

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Effects-Based Operations Equals to “Shock And Awe”?

by LTC Ho How Hoang, Joshua

From the onset of the salvos on 21 March 2003 , it was evident that Operation Iraqi Freedom (OIF) was going to be a different kind of war. As it turned out, OIF was a landmark victory in many respects: the time taken to secure victory was short for a major campaign, precision weapons were used more extensively than in any other conflict and the coalition casualties sustained were relatively low for a major war. OIF also took half as long and required only one-third as many troops to complete the mission in comparison to Operation Desert Storm conducted 12 years ago. 1 The swift and overwhelming nature of the American victory in OIF have prompted many to claim the arrival of a new way of war known as Effects-Based Operations (EBO). Although a lot of material has been written on EBO, much remains unclear on EBO’s actual nature.

Shaping Behaviour as the Key Principle of Effects-Based Operations

EBO seeks to move away from a destruction-centric, attrition-based, and linear approach to warfare. Instead, an effects-based approach to operations seeks to separate the means from the ends by identifying the outcomes desired in a campaign and then deriving the means required to achieve those outcomes. In a sense, EBO is strategy making. 2 Implicit in effects-based operations is the focus on shaping behaviour of the adversary to such an extent that he will choose to surrender and not fight, if possible.

Certainly, the concept of EBO is not new. The thinking on shaping the will of the adversary espoused by effects-based operations resonates with the ideas of prominent strategic thinkers in history like Sun Tzu and Carl von Clausewitz, both of whom talk about the importance of the psychological aspects of war. 3 More recent thinkers on strategy like Liddell Hart and Douhet, have also emphasised the need to influence the thinking and behaviour of the adversary either by strategy or by striking deep with airpower. 4

Concepts of EBO

If the concept of EBO is not new, then what has changed to make it different from strategy-making? It can be argued that the way force is applied has changed, and the conduct of OIF provides evidence of the evolution of EBO. Six different concepts of what effects-based operations are, can be discerned from the literature since the 1990s.

The first concept treats EBO as a planning methodology for the conduct of operations. The planning methodology emphasises the strategy to task links, the integration with other planning processes and the use of both military and non-military means to prosecute the adversary.

OIF provided one such example of this planning process where the national strategy was integrated with the operational objectives. The national strategy of conducting regime change, eliminating weapons of mass destruction and capturing the terrorists in Iraq filtered down to Tommy Frank’s eight operational objectives, which were to: (1) finish the regime, (2) eliminate weapons of mass destruction, (3) capture or drive out terrorists, (4) gain intelligence on terrorists and weapons of mass destruction, (5) secure oil fields, (6) deliver humanitarian relief, (7) create the conditions for representative government, and (8) ensure territorial integrity. 5

In turn, Tommy Frank’s eight operational objectives were translated to the missions of his component commanders, which were in turn translated into tactical action plans. The strength of the planning process lay in the fact that each mission could be traced back to an operational objective. The US Joint Forces Command uses the term “effects-based planning” to describe EBO as a planning methodology.

The second concept treats EBO as efficient targeting. 6 The efficiency approach seeks to exploit the key weak points of the enemy by analysing its capabilities as a total system. 7 It focuses on the destruction of critical nodes rather than the destruction of the entire infrastructure to achieve the desired effect, and on the conduct of parallel operations, 8 which emphasises attacks on all desired targets simultaneously rather than in sequence. The US Joint Forces Command uses the term “effects-based targeting” to describe efficient targeting. 9 Examples, from Operation Desert Storm and OIF, illustrate how this concept is achieved in practice.

In order to render the Iraqi Air Defences ineffective in Operation Desert Storm, the US decided to attack two major sector operations centres (SOCs) providing command and control to air defences. Even though the specifications

stipulated that six 2,000 pound laser guided bombs were required to totally destroy the hardened bunkers of the SOCs, the US chose partial destruction of the SOCs by a single 2,000 pound bomb which then “smoked out” survivors from the building. This partial destruction approach allowed more aircraft sorties to be generated for strikes against four more SOCs discovered subsequently.

During OIF, a less protected communications switch located 200m away was destroyed instead of the command and control bunker that was underneath Baghdad ’s Rashid Hotel. Attacking the Rashid Hotel would have resulted in civilian casualties since there were still foreign journalists staying at the hotel. Destroying the communications switch that served the command and control bunker had the same effect as rendering the bunker ineffective, as it could no longer communicate with the troops under its charge.

The third concept treats EBO as the application of all sources of national power - political, military, economic and diplomatic - to address all elements of adversary national power. 10 It claims that the reliance on a single source of national power will inevitably reduce the overall effectiveness of a campaign and make it relatively easy for an adversary to adapt to this single form of attack. The US Joint Forces Command’s definition of EBO is analogous to the effectiveness approach. 11 Two examples, a negative one from Operation Allied Force and a positive one from OIF, will illustrate how this theory is achieved in practice.

The air campaign conducted as part of Operation Allied Force against Serbia was planned to affect a Serbian military withdrawal from Kosovo. Although, all non-traditional techniques were employed, including the modelling of social networks to persuade those close to Milosevic to influence him to withdraw his troops from Kosovo 12 , NATO’s decision to forgo the threat of a ground invasion 13 meant that the air campaign in Serbia did little to persuade Milosevic to change his policy towards Kosovo. It was the Kosovo Liberation Army ground offensive supported by the US , which proved to be the deciding factor in Milosevic’s withdrawal. However, the extensive damage to infrastructure resulting from the air campaign had the unintended consequence of eroding Milosevic’s political support and led to his eventual fall from power.

OIF also provided a limited example of the use of this concept, at least until the end of the hot war phase. Alternative measures such as economic sanctions against Iraq ’s oil exports after Desert Storm and diplomatic negotiations at the UN Security Council were attempted before resorting to the use of force. The gathering of a coalition for the operation and its execution using combined forces ensured that the US was not acting alone.

The fourth concept treats EBO as rapid dominance or rapid decisive operations. It relies on the employment of a series of unrelenting “waves of powerful strikes across many targets combining sea, air, land and space forces to affect and influence the adversary’s perception and includes the physical capture and occupation of territory if necessary”. 14 The execution of OIF provided a visible example of this theory where cruise missile strikes and air bombardment were conducted on hundreds of targets in parallel with the deployment of manoeuvre forces on the ground. The manoeuvre force moved with such rapidity that they reached Baghdad airport, just 20 kilometres from the city centre in 13 days. Rapid dominance is usually what people refer to when they discuss EBO.

The fifth concept focuses on EBO as the interaction and collaboration between the operational commander and the other key actors in a campaign in order to deal with uncertainty in operations arising from a complex and adaptive adversary. 15 In concept, the interaction between the operational commander and his civilian leaders, his tactical commanders and the sources of knowledge about the enemy as complex adaptive systems are to be learning experiences for the participants, not only in the planning but also in the execution phases of a campaign. Appealing it may be, there is little indication that this theory was applied in the ground battle during OIF, although a limited application was the dynamic incorporation of lessons learned into the coalition’s execution of operations. 16

The sixth concept focuses on EBO as network-centric warfare. The theory also considers the adversary as a complex adaptive system. 17 It proposes that four ingredients are required to deal with complexity and uncertainty: the ability to generate different action options for decision makers by linking diverse sets of engagement and sensor capabilities; the agility to adapt to an intelligent adversary’s actions through shared awareness of an unfolding situation; the ability to coordinate complex actions in synergy at different levels through shared situation awareness and common understanding of command intent; and the ability to mobilise knowledge and expertise to provide timely support to decision makers at all levels. The networking of resources in the entire war fighting enterprise is proposed as the way in which to master uncertainty and deal with complexity. 18

Although no demonstration of the efficacy of this networked form of warfare occurred in OIF since the most networked force in the US Army, the 4 th Infantry Division, was not used in OIF, the dramatic results achieved in the

US Army's Division 21 in advanced war fighting experiments have been cited by the proponents as proof of the efficacy of network-centric warfare. For example, some experiments have shown that 75% of the current combat platforms can triumph over twice the number of enemy forces, in half the time, at over three times the size of the battle space when networked. 19

The Practice of EBO

Not only has the manner in which the application of force changed, the tools available for the application of force have also changed to become more efficient and effective. These tools include the ability to sense, manage knowledge, and create precise effects.

Sensing

Sensing is the first component capability required in the conduct of EBO. Manned, unmanned aircraft and space-based platforms with its attendant sensors used during OIF as well as sensing technologies employed in the war have advanced to such an extent that achieving positive identification for fixed installations and static weapons emplacements has become a reality.

Area-wide search and locate capabilities were provided by satellites, long endurance high altitude and medium altitude unmanned aerial vehicles (UAVs), as well as manned surveillance aircraft. The National Reconnaissance Office (NRO) employed three advanced KH-11 type visible and infrared imaging spacecraft, and two to three Lacrosse all-weather imaging radar spacecraft that provided 24-hour coverage to image fixed installations, detect Iraqi armour, static weapons emplacements and missiles launches. 20 A high altitude UAV, the Global Hawk, was used as a strike co-ordination and reconnaissance asset, and was particularly effective in locating air defence and surface-to-surface missiles through the use of its synthetic aperture radar (SAR) which could see through sandstorms. 21 Medium altitude UAV like the Predator was used as surveillance and autonomous strike assets. Manned surveillance assets such as the U-2 high altitude surveillance aircraft and the Joint Surveillance and Target Attack Radar System (JSTARS) were used extensively to provide dynamic surveillance and targeting during sandstorms.

Besides imagery, another valuable source of sensing information is from signals intelligence obtained via electronic eavesdropping with the RC 135 Rivet Joint aircraft. The platform can be used to sift airwaves for mobile phone transmissions and locate the caller's position. 22 This capability proved particularly useful in locating surface-to-surface missiles and SAM launchers as their operators gave their positions away through too much chatter. The Iraqi leadership was also located when they were forced to use high frequency radio, which was easily intercepted and exploited for intelligence once their fibre-optic landline and public switching networks were interdicted. 23

The combination of sensing capabilities across useable bands of the electro-magnetic spectrum on platforms operating at different altitudes allowed continuous surveillance and targeting to be performed under different anti-aircraft threat situations.

Managing Knowledge

The aim of the sensing component is to collect information about the adversary and the efficacy of effects created by previous actions. Adversary behaviour and his next likely course of action are predicted based on sensing information to generate the next set of actions to be taken by own forces. Both software models and associated hardware are needed in the generation of the courses of action. The models assist in anticipating effects of hitting targets so that sensor platforms can be appropriately positioned to monitor those effects. Equally crucial is the ability to convey the information from the sensors to the knowledge processors and communicate the courses of action to the players who will execute the missions. Both knowledge creation and knowledge communication are the principal components of knowledge management.

Creating Knowledge

Targeting is the process of generating the targets to be attacked and is a basic level of course of action generation. Current linear models centre on COL John Warden's "Five Rings" theory of aerospace warfare, which contend that the war effort should be directed primarily at the enemy's physical side as the moral or human side is beyond the realm of predictability. In his model, the critical core is the enemy leadership, while the orbiting systems are organic essentials like infrastructure, population and the opponent's fielded military forces. 24 Jason Barlow's National

Elements of Value (NEV) model enhances the Warden model by detailing the relative importance of target systems to the national leadership and the relative importance of the target systems to each other. Maris McCrabb attempted a further enhancement of the Warden model and developed a meta-model combining the Warden and Barlow models with an agent adaptation model. McCrabb's model determines the various ways an adversary might react to an attack based on three scenarios: (1) what is most beneficial and what is most restrictive to the adversary, (2) what is known about the adversary's capabilities, and (3) what if the adversary had certain currently unknown capabilities. 25

The linear targeting models assume that the physical effects achieved will translate into behavioural outcomes. Historically, this has not been shown to be true. 26 Behavioural models address this weakness and incorporate both a targeting model and a situational aware, recognition-primed (SARP) decision-making model to determine the actions needed to shape adversary behaviour. The recognition-primed model postulates that all decisions flow from analogies drawn from both the current and previous situations that have been experienced by a person. It asserts that a person frames the existing situation by recognising the patterns from a previous experience, and matches that to the current situation. Subsequently action is taken based on the actions that the person has previously taken. 27 The SARP goes one step further by incorporating prospect theory into the model. Prospect theory allows one to determine an individual's propensity for risk and the kind of actions individuals with different risk profiles would undertake. By incorporating prospect theory, the model does not need a store of the adversaries' previous experiences, but seeks to affect their perception of the situation through alteration of their appetite for risk.

Despite the power of behavioural models like SARP, they fail to recognise the adversary as a complex adaptive system (CAS). A CAS is one system in which its interacting autonomous and semi-autonomous entities can adjust their behaviour as a result of externalities acting on it. CAS models incorporate targeting and behavioural models and include statistical and probabilistic methods to model the non-linearity of adversary behaviour. 28 CAS models are the most powerful of all the models. Because CAS models are so powerful, they require high performance systems that are capable of self-learning to drive the model. Although advances in information systems suggest that such a self-learning system might be technically feasible within the next few years; the development of a cultural-military-economic model is still lagging behind developments in information technology. 29

Communicating Knowledge

Another aspect of hardware is the communications backbone needed to communicate command intent. In OIF, satellite communications were used extensively to convey command intent and aid collaboration between commanders, superiors and peers in the fast-moving battlefield. So heavy was the requirement for bandwidth that commercial satellites were used to meet 84% of the requirements. 30 The Global Command and Control System (GCCS), which can use satellite or radio frequencies for transmission, was also a critical backbone in providing accurate location of blue forces down to the platoon level. Based on the desired need for more bandwidth after Iraqi Freedom, the Distributed Common Ground System (DCGS) will be enhanced to an architecture that is capable of integrating command, control, intelligence and surveillance (C2ISR) operations across globally distributed forces. 31

Creating Precise Effects

The next step, after sensing the environment, deciding on the course of action to take based on an analysis of adversary information and creating knowledge through computer models, is to create precise effects with physical action.

Precision Guided Munitions

There has been a noticeable trend of the increased use of PGMs in conflicts, 32 with the increased usage being attributed to the increasing accuracy of precision-guided munitions developed since WWII. 33 During the war, 1,500 B-17 bomber sorties were required to drop 9,000 bombs to destroy a target of 600m 2 in size. 34 During the Vietnam War, the accuracy of precision weaponry had improved to such an extent that the same 600m 2 target only required dropping 176 bombs from 30 F-4 sorties. During Desert Storm, the laser guided bombs proved so accurate that they accounted for 75% of the damage upon Iraqi strategic and operational targets, even though they constituted only 4.3% of the total tonnage expended. 35 The technology had improved to such an extent that by the time of Operation Enduring Freedom and Iraqi Freedom, up to 24 similar targets could be targeted by one B-1 sortie with the GPS guided Joint Direct Attack Munitions (JDAM). 36

Parallel improvements in stealth capability of aircraft have also allowed the bombing missions to be carried out more

effectively. As vital installations and other high value targets are well protected by radar-guided guns and missiles, a force package of aircraft is usually assigned with the bombers to neutralise air defences in order to get bomb-dropping aircraft in and out of the target area safely. During Desert Storm, a force package of 33 aircraft required to protect eight bombers embarked on a bombing mission, translated to an escort ratio of about 5-to-1 aircraft. 37 By the time OIF was conducted, the in-creased use of stealth aircraft meant that a bomber could proceed for a bombing mission with literally no escort aircraft, that is, one F-117 sortie was able to deliver two bombs to just as many targets. 38

Hence, dramatic improvements in accuracy of precision weapons over the last 60 years and the parallel development in stealth technology have made it possible for the US to conduct strikes on infrastructure deep in enemy territory with limited collateral damage to civilian personnel and infrastructure as well as the ability to facilitate the conduct of EBO.

Mobile Forces

Another tool used to create effects during OIF is the deployment of mobile forces like armour and armoured infantry. Although the air campaign did much to reduce Saddam's ability to command and largely reduced the combat power of the Iraqi Army, 39 pockets of resistance by irregular forces still held out. 40 The coalition knew that it had to insert forces into the capital quickly in order to force the regime to capitulate. The 5 th Corps bypassed urban areas and headed straight for the jugular, reaching within 50 miles of Baghdad in five days. 41 The sight of M1 tanks and M2 Bradley fighting vehicles entering the capital was more than sufficient to convince the Iraqis that Saddam's regime was no longer in control. The pulling down of the statue of Saddam Hussein provided the final straw that broke the regime's back.

Special Forces

The employment of Special Forces was also a key feature in OIF. Active mainly in the north and west of Iraq, Special Forces comprised nearly 8% of the combined force package and managed to narrow the battle space from a California to a Connecticut-sized space. 42 In effect, it was Special Forces coupled with air power working in concert with the lightly-armed local Kurds and the 173 rd Airborne, which effectively replaced the 4 th Infantry Division, and formed the Northern Front. Special Forces were also involved in the liaison with Kurdish forces to ensure that they took no action to prompt Turkey to invade. 43

The Special Forces proved to be so useful that they were assigned multiple roles: directing air attacks and raids against a terrorist camp on the Iraqi-Iranian border, searching for Baath leadership along the highways from Baghdad to Tikrit, seizing selected targets like oilfields to prevent them from being set ablaze, holding dams to prevent the leadership from flooding large parts of the country, occupying airfields for subsequent use by the coalition as well as denial of its use by Iraqis who may have intended to launch Scud missiles at Israel. 44 They also held key towns in the north and important buildings like the presidential palace in denial missions, disrupted internal Iraqi lines of communication in Baghdad and other command and control facilities, as well as provided information on the whereabouts of Iraqi leaders, which ultimately aided attacks against Saddam Hussein and his cousin, General Ali Hassan Majid ("Chemical Ali"). 45 There were also reports that the US military, the Central Intelligence Agency and Iraqi exiles conducted a broad covert effort inside Iraq three months before the start of the war to forge alliances with Iraqi military leaders to persuade them to cooperate and not fight. 46

The multi-role capability of the Special Forces and its civilian equivalent, the CIA, was a highly desirable factor in EBO as they could fulfil and perform a variety of missions ranging from surgical destruction, psychological operations, persuasion, and liaison that contributed to the overall creation of effects.

Information **Operations**

During OIF, a psychological war was waged with over 50 million leaflets dropped over Iraq and hundreds of hours of radio/television broadcasts made to scare the Iraqis into inactivity or desertion. 47 Many of the leaflets were dropped even before the war began. They contained instructions on how to surrender and gave warnings of the consequences for anyone thinking of using chemical or biological weapons. In addition, text messages were sent to the mobile phones of individual Iraqi commanders to persuade them not to fight. Jamming of communications nodes was another strategy used to neutralise the Iraqi air defence system without destroying them. 48 Other information operations included "communications herding", whereby most frequencies were jammed, forcing the Iraqis to broadcast from a small set of other frequencies that were more easily disrupted or exploited for intelligence. 49

Besides persuasion, deception was the flip side of information operations. Saddam was led to believe that the war would start later than it did by deceiving him into thinking that the 4 th Infantry Division was a vital part of the war, even though it was not. This was achieved by keeping the 4 th Infantry Division floating off Turkey after it was clear that they would not be allowed to transit through Turkey , and by sending troops of the 4 th Infantry Division slowly to the Gulf to give the impression that the US needed to open the northern front in order to succeed. Both actions caused Saddam to leave the oilfields in the South relatively undefended. 50 Further enhancements to information operations is likely to focus on further integration of information operations with military operations and the development of platforms that provide integrated Electronic Support Measures in addition to Electronic Counter Measure capabilities with previously unachievable location accuracy. 51

The Potential and Challenges of EBO

EBO holds promise for the future of warfare as successful execution may allow militaries to economise on the employment of force, and possibly reduce the number of troops needed on the ground. The economy of ground force employment can limit own casualties as well as adversary casualties, and reduce collateral damage by minimising damage to infrastructure. However, achieving economy of effort on the battlefield is not a simple task. A whole array of resources are required, starting with the need to have a comprehensive awareness of the battlefield by employing pervasive and persistent sensors, the ability to manage the knowledge created of both expected enemy courses of action and own responses, and the ability to effect those outcomes through precise application of kinetic and non-kinetic means on the targets of choice.

The range and depth of assets employed by the US during OIF suggest that the acquisition of resources to conduct EBO is also costly. The US attained its current superior military position by out-spending everyone else; in fact its 2002 military budget is greater than the combined total of the next 14 top spending countries in the world. 52 Even then, the US has not been able to fulfil all aspects of EBO due to the weaknesses inherent in its existing combat systems. The US has probably reached a high level of attainment in effects-based planning and targeting, and possibly the conduct of rapid dominance, but has some way to go in employing all sources of national power in conflict resolution, as evidenced by the post-war difficulties experienced in Iraq .

The US also has some way to go in terms of collaboration as a means to deal with uncertainty and the use of networking. It is unlikely that full collaboration will be achieved until all the forces are networked in a common architecture with the ability to track everyone’s position automatically.

Conclusion

So far, the US approach to EBO has focused mainly on the instrumental, or the technological aspects, but not the existential aspects of war. If we believe that despite our best efforts to instrumentalise war, Clausewitzian fog is inevitable, it will also be necessary then to focus on the human aspects of war, or what will enable the soldier to better operate in a complex environment. Of primary importance is professional military education. The ability of the soldiers to find work around solutions to problems encountered on the battlefield and to continue to operate, despite imperfect equipment, was a strength highlighted time and again in lessons on the conduct of Iraqi Freedom.

Hence, the successful conduct of EBO requires capabilities as diverse as precision-guided munitions, persistent sensors, and computer models. It also requires one to have capabilities to conduct information operations, special operations and manoeuvre warfare. If one does not possess the full spectrum of such capabilities, the conduct of EBO is likely to be limited. More importantly, it requires the humans in the loop to know the adversary and self so well as to allow one to effectively dictate the pace of war and render the adversary struggling to keep up. This brings to mind General Krulak’s idea of the strategic corporal having to exercise an exceptional degree of independence, maturity, restraint and judgement in the conduct of operations in the 21 st century. So important is this requirement for the mastery of knowledge that one commentator has dubbed effects-based operations “PhD level warfare”. 53

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Viewpoints: IKC2: I Can See Too

I wonder whether IKC2 is an appropriate term to describe our evolving operational concepts. Apart from me, there are a number of officers, and some of them fairly senior, who share the same view.

Not too long ago, I met up with Commandant , Singapore Command & Staff College. He told me that the new POINTER sought to encourage open debate and discussion. It is with this view in mind that I write this piece, in the hope that it would help POINTER generate more open discourse on matters of professional interest. IKC2 is still very new. As such, there will certainly be different perspectives.

It is my contention that any short-hand expression of a new concept must capture the essence of the idea. In this regard, the term IKC2 has fallen short.

The Power Of Network

The SAF has embarked on the journey to build the 3rd Generation Force (3G SAF). What it seeks to do is not very different from that which is currently under way in leading military forces. Different terms have been used to express this new concept. The US coined the term Network-Centric Warfare. Sweden called it Network-Based Defence, and the UK , Network-Enabled Capabilities. They do so, I guess, to mark a departure, a shift in paradigm. In all three, the term network is the common denominator.

There is a reason for this.

The new operational concept is made possible by advances in technology. Sensors are more pervasive; weapons can strike more precisely, even from a great distance; and networks can connect up platforms and units in ways not conceivable before. Indeed, in the West, network-centric concepts are presented as particularly useful for countries with budget constraints.

It is this network connectivity, and what it can achieve, that would change the face of battle. The difference is made clearer by contrasting the notions of " network " and " platform " . In the past, combat power is measured by the number of platforms. Today, it is not merely numbers, but how well the platforms are connected that determines overall capability.

Remember Metcalfe's Law? The power of the network is proportional to the square of the number of nodes in the network. The network is a force multiplier.

Knowledge or Information – Which Says It Better?

Knowledge, as a term and buzzword, has gained currency in recent years. Many books have been written on it. Read any of them and you will find terms like tacit and explicit knowledge. Tacit knowledge is in the head, often informal and contextual. Explicit knowledge is external, codified and shared.

The concept of knowledge is, in a sense, a much higher level of knowing and understanding. Information, on the other hand, is something more concrete. We need to be knowledgeable about a subject in order to make the right decisions based on the information received. Knowledge suggests expertise in field and deep insight that comes from experience. Information is related to the facts as we know them.

So, which is the better term to capture the essence of an idea and to make an important point of emphasis for focus and clarity – knowledge or information?

On balance, it is information. The key idea here is the ability to pass information derived from sensors in the network to potential users. The information is to enable situation awareness – where we are, where the enemy is, and where the friendly forces are. Hopefully, we have reliable, up-to-date information that will remove uncertainty.

With situation awareness, we make better situation assessment and exercise better situation control through our actions.

This is not to say that knowledge systems have no role. We could develop knowledge-based, artificial intelligence, software applications that can potentially act as software agents and command advisers, such as making recommendations on courses of action. But no knowledge systems can be conceived without first having the ability to gather and distribute the information.

Information To The Edge

IKC2 has two other operative words – command and control. The notion of command and control, at least understood by the ordinary meaning of the words, is bound to what a headquarters does. Command suggests an authority issuing orders and instructions to subordinate forces; and control, as once explained to me by a learned friend, suggests a feedback loop. It is this feedback that enables the command to make changes as the plan of operation unfolds.

While new technology certainly enhances the exercise of command and control, the purpose goes beyond solely making the headquarters more effective.

More importantly, new technology brings information to the edge, where this edge is taken to be the sharp end of fighting. It is about the ability to give information needed by any aircraft, ship and tank in combat. Every platform will have situation awareness by pulling in real-time information from sensors, within the network.

This new concept is therefore more than improving the exercise of command and control. It is about putting information in the hands of warfighters out there in order to get the job done.

Should We Change?

So, should we change the term IKC2? I think, perhaps not, even if the words may not convey adequately the new ideas. IKC2 has entered into our lexicon. It resonates in someway and sounds much like “I can see too.” It is something we can call our own.

But in developing the new way to warfare, let us be clear that it is about precision strikes and pervasive sensors, stitched together by comprehensive networks. It is about giving warfighters situation awareness and the ability to tap on the resources found in the network to get the job done.

BG (Ret) Sin Boon Wah

Viewpoints: IKC2: A Look Behind The Scenes

The monograph Realising Integrated Knowledge-based Command and Control was published in early 2003 as a point of departure to generate further discourse on the SAF's framing of warfare in the Information Age - IKC2. It might interest readers that the **concept** itself can trace its roots to the SAF's exploration of the **capability** Comprehensive Awareness (CA). As a living concept, IKC2 has continued to evolve, just like similar concepts developed by leading military forces, such as the US Network-Centric Warfare (NCW), Sweden 's Network-Based Defense (NBD) and the UK 's Network-Enabled Capabilities (NEC). Its growth has been nourished by lessons learnt in the course of putting in place the component systems, as well as debates between local and overseas thinkers, systems developers and practitioners. But the contents of these discourses are often focused in scope, and are sometimes classified, thus limiting their utility as negotiating texts for discussions with the larger defence community.

The recent POINTER article "The Limits of Technology in Military Innovation" by LTA Ng Pak Shun, who is currently studying in an overseas university and the letter "IKC2: I Can See Too" by BG(Ret) Sin Boon Wah, Deputy Chief Executive, Defence Science & Technology Agency, are therefore welcomed essays that will hopefully catalyse more open discussions on the IKC2 concept. Afterall, according to the theory of NCW, value creation is a function of both richness and reach, and in the Information Age environment, these two will now be mutually reinforcing rather than trading off each other. This means that sharing will enrich one's "wealth" rather than deplete it. It is in this spirit that some of us who have a keen interest in the subject are offering this response.

Which is a Better Framing – IKC2 or Network and Information for the Power to the Edge?

Let's begin by re-examining the ideas encapsulated in the shorthand expression, IKC2. In the monograph, it is framed as comprising three key elements: (1) Integrated Warfare Network-enabled; (2) organising around Knowledge; (3) for effective Command and Control. BG(Ret) Sin, in his letter, has argued that the term has fallen short in capturing the essence of the new operational concept in the Information Age that the SAF should focus on.

The points that BG(Ret) Sin raised in his letter are very practical concerns, especially from the perspective of systems developers, whose main priority is the delivery of combat systems into the hands of operators in the shortest time. These concerns are, in fact, crucial for the SAF to pluck the low hanging fruits of what available technology can offer. So is the framing of IKC2, and even the shorthand expression itself, missing the point? Some of us think otherwise and our opinions are explained below.

We think that in selecting the shorthand for a concept, one important consideration should be what to emphasise - the means or the desired effects/outcomes? Network, or network connectivity, is the new means in the Information Age to an end. What is this end for the SAF? In the monograph, former CDF, LG(NS) Lim Chuan Poh, elucidated that at the operational strategy level, "Integrated Warfare", the term first incepted in 1994, though the thinking can be traced further back, is the epitome of how the SAF will fight. Looking at the emerging trends of operational thinking in the SAF, the facets and degree of integration is going to be deepened. It is this end rather than the means that we think needs to be highlighted in the shorthand IKC2, though the importance of network is not lost in the framing.

This is not to say that terms like NCW, NBD or NEC have all gotten it wrong. But the proponents of these concepts could not have emphasised enough about "network" being a verb rather than a noun in their frameworks – the purpose of connectivity is to enable the networking of people to share, collaborate, and eventually, synchronise actions. IKC2, NCW, NBD or NEC are as much about the technology and processes that enable it as it is about commanders, staff and soldiers who are at the centre of this human affair called warfare. Translation from information to knowledge to decisions and finally into military actions in the Information Age will continue to be a complex process that needs people who are properly educated and trained, and willing to embrace new concepts. Ultimately, the superior capability in IKC2 is that it is people-based rather than system-based.

The IKC2 concept is in essence an operational framing, rooted in the operational strategy of Integrated Warfare, to help the SAF develop warfighting concepts in the Information Age rather than a purely technological framing. This means that technologists and systems developers would need to translate the concept into supporting architecture, infrastructure and combat systems instead of the other way round. It follows then that "knowledge" should be emphasised over "information" in IKC2. While information might arguably be more useful as a currency for sharing and more amenable for implementation in information systems, it is the knowledge in the heads of commanders,

leading to effective decisions and actions, that matters. The need for capable information systems as fundamental building blocks for warfare in the Information Age is not disputed. But this is a waypoint rather than an end goal for warfighters because the translation of information into decisions and actions requires knowledge, whether purely in the cognition of the warfighters or with the aid of knowledge systems. And the development of information and knowledge systems need not be one sequential to the other. They should in fact be mutually reinforcing spirals, as there will probably be no end-states in the form of ultimate systems for either of them.

Finally, in thinking about the issue of the place of the term "Command and Control" in the shorthand for the concept, we wish to point out that militaries around the world actually have diverse notions of what these two "C's" really encompass. It is true that many have associated C2 with some form of command post (CP) or headquarters. But an experienced and respected foreign general once told senior leaders in MINDEF and the SAF that the CP is not a fixed physical location but where the commander is. Yet, another equally experienced and respected general even suggested that the word "control" should be dropped from the military lexicon in the Information Age, as it often connotes a certain Industrial Age model of how an organisation should operate. Indeed, using old vocabulary to describe new concepts sometimes will cause undue confusion, as people often have pre-conceptions of what the terms mean. We see the coining of the term "IKC2" as an attempt to invent new vocabulary from old words that can capture the essence of the new concept, although strictly speaking, we know that the British model of C2 that covers the entire decision chain did influence the framing of the second part of the concept. At the end of the day, we think the more important point is to understand that IKC2 is really describing a new theory regarding warfare for the SAF in the Information Age - it will be more fruitful to debate on the theory itself rather than the semantics of the shorthand.

Next, we would like to point out that the potential of advances in InfoComms Technology (ICT) to bring more and better quality information to the sharp end of fighting is actually well documented in the monograph. But related to this point, it may be worthwhile to look at one quote:

"This network will provide powerful, persistent and pervasive coverage of the battlespace that is also innately robust as all sensors operate as part of a netted whole. *The networking of sensor resources will therefore enhance the shared situational awareness among forces at all levels, across all Services*." IKC2 monograph, p15 (Emphasis added).

The passage rightly pointed out that "the sharp end of fighting" will not be the only one in the SAF which will benefit if the SAF gets it right in harnessing the potential of advances in InfoComms Technology. Forces at all levels, across all Services, will stand to gain from the information and knowledge advantage. But a more pertinent point is that knowing and understanding do not automatically confer the authority to act. So, who in the future, should plan and decide when, where and what to do? "Power to the Edge", an attractive new model as highlighted by BG(Ret) Sin, implies giving combat entities on the ground more autonomy to decide and act in greater self-synchronisation based on broad guidance of effects to be created from the higher command. This means that the ability of commanders and operational planning staff to discern the right effects that can break the opponent's will and logic, to invoke them at the right place and time, and to adapt and reframe dynamically with feedback received, will be as important as the provision of means and empowerment of authority for the combat entities on the ground to act. These are, in essence, complex Command and Control issues that need to be examined and resolved for warfare in the Information Age beyond simply addressing the technological challenges of "putting information in the hands of the warfighters".

IKC2 – A Technology-biased Concept that Has Over-estimated the Potentials of Technology?

Interestingly, LTA Ng Pak Shun's reading of IKC2 is almost the antithesis of BG(Ret) Sin's critique of the concept. LTA Ng's underlying logic in his article is that "...the ability to marry breakthrough technology and concepts" does not necessarily lead to successful military innovation", and he stressed in his conclusion that "...It is imperative that technology must be viewed in both its successes and failures in guiding warfare; the sceptre of technological misuse/over-use must be a concern that MINDEF and the SAF have to address in its push towards military innovations". This perspective has led him to caution that IKC2 is too technology-biased, and has over-estimated the potential of technology in terms of the advances that are possible and what they can achieve to realise the four tenets of Pervasive Battlespace Aware-ness (PBA), Superior Battlespace Understanding (SBU), Knowledge-enabled Decision Superiority (KeDS), and Dominant Battle Management (DBM). To build his case, he draws on examples mainly from Vietnam War, and a few from the Cold War and Gulf Wars.

Hopefully, the clarifications in the earlier section in response to BG(Ret) Sin's letter would have addressed LTA Ng's first point and helped to debunk the myth that IKC2 is all about technology. Contrary to the myth, the potential of IKC2 is hugely predicated on how the thought and innovativeness of the individuals can be brought out to make the right

decisions and enable the right actions in a network-centric, knowledge-based environment. Notwithstanding this, the concerns, pitfalls, vulnerabilities and limitations of technologies in, as well as for IKC2, are in general real and shared by many proponents and developers of the concept. The road ahead is going to be difficult, and it is not easy to achieve those ideas highlighted in the monograph. But at the end of the day, we need to ask ourselves: "Do we truly believe that technology is our edge?" and "Do we believe that advancements in ICT are driving a revolution that will fundamentally change military affairs?" If answers to both questions are positive, then the conclusion to the earlier concerns cannot be that "IKC2/technology is limited/difficult and therefore we should not do them". Instead we should take those issues seriously and actively resolve them as we move forward. The transformational potential is there - but nobody says it's already here. It is then for us to work it out and see whether it is for real.

In conclusion, the purpose of this letter is not to assert what is right or wrong. Nor is it to provide an "official" response. Rather, it hopes to highlight some of our views of the underlying logic that went behind the scenes during the formulation of the concept, and serves as a negotiating piece for further discourse.

LTC Roland Ng,

LTC Foo Khee Loon,

Dr Kenneth Kwok

Book Review: On the Psychology of Military Incompetence by Norman F. Dixon

by CPT Adrian Choong

Incompetence, as defined in Dr Dixon's book, refers to the chronic inability to do a particular job or activity successfully. Incompetence may be due to a lack of adequate training, skill, aptitude or experience

Incompetence can be found in any industry, field or discipline. But incompetence in war takes on a significance far greater than in any other field.

Because the conduct of war involves vast sums of money, the application of a massive amount of destructive power, and the fact that millions of lives are at stake, a study of military incompetence is directly relevant and important to all persons involved in the field.

This book examines the issue in three parts. Part One presents examples of incompetence in British military history over the past hundred years, from the Crimean War to the Allied defeat at Arnhem , during Operation Market Garden. Although the study of military incompetence is universally relevant, the inclusion of the loss of Singapore lends this book some welcomed local relevance. Parts Two and Three examine the common features of military incompetence and seek to find the origins of this incompetence from a psychological point of view.

The Nature of Incompetence

Dr Dixon raises many instances and examples from British military history, from both great wars and small actions. Through all these wars, he picks out some common characteristics of military incompetence, for example:

- A fundamental conservatism and clinging to outworn tradition, as well as an inability to profit from past experience.
- A tendency to reject, suppress or ignore information which is unpalatable or conflicts with pre-conceptions.
- A tendency to under-estimate the enemy and over-estimate the capabilities of one ' s own side.
- An undue readiness to find scapegoats and suppress news about military setbacks.
- A predilection for frontal assaults and the belief in brute force rather than the use of surprises or ruses.
- Indecisiveness and a general abdication from the role of a leader.
- A failure to exploit a situation due to the lack of aggressiveness.

There are obviously other reasons for failure in war, such as the lack of training, technological inferiority, the lack of proper intelligence equipment, failure of logistical support, ineffective flow of information and communication as well as the destruction of morale. However, those factors are external to the leader, whereas military incompetence is an inherent fault in military leadership. All else being equal, a well-equipped, well-trained fighting force will be made ineffective by the presence of an incompetent leader, and no amount of military intelligence, regardless of how accurate and timely it is, will be used effectively by an incompetent general. Therefore it is clear that a military leader is one of the most important force multipliers of any military organization

Intellectual Ability or the Lack Thereof

Dr Dixon examines in the subsequent chapters the possible causes of military incompetence. He examines, firstly, the premise that incompetent generals are also those lacking in intellectual ability. This was true for the British Army, up to the early years of the 20 th Century, due to three main reasons.

Firstly, the officers of the Army were selected primarily for their position in a higher class in society, on the virtue of the importance and social status of their fathers, and other social connections. These people were sometimes wholly inadequate for their job, and some displayed mediocre intellectual ability at best.

Secondly, the examinations for entry and graduation from Staff College and the Royal Military College were not

wholly relevant to what was actually required for competent generalship, and could be passed with flying colours simply by memorisation of answers and learning by rote. This meant that officers with poor intellectual ability were not filtered out by the system

Finally, in such military training establishments, prowess in games, muscle and masculinity then constituted the main criteria by which a man was judged, and anti-intellectualism was prevalent in the armed services.

Dr Dixon then examines the pro-position that military incompetence, manifested in the phenomenon of incredibly poor decision-making, was a direct result of poor intellectual ability. However, he could draw no direct link between decision-making and intellectual ability, and therefore rejected the suggestion that military incompetence is a result of poor intellectual ability.

This review agrees with Dr Dixon. Intellectual ability is best suited to an intellectual profession. Furthermore, I believe that intellectual ability and innate intelligence are not directly related, and that a person can be highly intelligent, inventive and cunning without being intellectually gifted.

There are lessons here to be found from Dr Dixon's argument. Firstly, we have to ensure that officers are chosen based on their own merit, and not due to their relationship with any class in society, hereditary reasons or because of race or religion.

Also, training in a military institution must prepare officers professionally for the task they will perform. In addition, examinations must test the officer candidate adequately. Those who set examinations must be clear on what qualities they are supposed to examine, and be clear on the distinction between memory and ability.

Finally, any officer candidate must not be hindered in his recruitment or professional advancement based on academic qualifications obtained outside the military establishment. Nonetheless, the premise that a highly educated person makes for a more capable officer is questionable. Instead, an officer should be chosen and promoted based on his performance.

The Organisation as the Source of Incompetence

Dr Dixon goes on to postulate that it is the military organisation that contains the potential to create incompetent leadership or to promote incompetent persons to positions of great power and responsibility. He lists several characteristics and values which the military holds in high esteem and strives to achieve, as well as their negative consequences. Among these are:

- Uniformity, to the extent of oppressive conformity and the crushing of individual thoughts and the devaluation of initiative.
- Hierarchy and the importance of proper authority, to the extent of a fear to report bad news to superiors, the rejection of suggestions or corrections from the lower ranks, and hostility towards those of lower rank who initiate action without permission, however effective or necessary the action was.
- A love of regularity and regimentation and an inability to think outside of drill.
- The fact that ambitious and achievement-oriented officers are highly esteemed and respected in the military, so much so that self-serving and vainglorious officers are sometimes promoted to high leadership, with disastrous consequences.

The factors listed above correlate to the nature of incompetence as previously listed. However, the values which can so easily lead to generation of incompetent leadership and organisations are also crucial to the success of any conventional armed forces. The learning point here is that a balanced application of these values is required. As with all methods to achieve military readiness, these methods must be applied with their objective in mind, and not be applied for their own sake. The objective here, as in all military forces, is the efficiency and effectiveness of the military.

For example, drill is a vital part of military training. Drill trains the military operator to carry out military action fast, efficiently and without error. However, drill when taken to its extreme, robs the military of flexibility and wastes time. A love of drill hinders the development of novel fighting techniques and prevents the adaptation of military forces to new fighting environments. A striking example of this can be found in the Boer War, where British forces were so steeped

in drill that they did not evolve a new process of attack which could counter the Boer's novel idea of using trenches as cover. For the British, massed formations and open frontal assaults were the drill, which proved especially costly against the Boer ' s use of cover and concealment.

Incompetence Today

These four factors are less prevalent in modern fighting forces. By and large, modern militaries understand the importance of flexibility, initiative and feedback, vital especially to situations where communications are unreliable and information is of questionable accuracy. Additionally, the years of rapid technological change after WWII highlighted the importance of innovation, technology and ability to adapt to rapidly changing situations.

It is a pity that this book (published in 1976) is unable to include the Vietnam War, which is arguably a good example of military incompetence by an advanced nation, or the Gulf War, which is commonly acknowledged to be a " textbook " campaign, an example of how to conduct a war successfully. A survey of global events in the past three decades suggests that incompetent leadership has, by and large, become a less significant problem than it used to be a hundred or even fifty years ago. After the Vietnam war, it seems to this reviewer that administrative incompetence and strategic in-competence have become the leading problems, taking the place of the incompetence of tactical or theatre leadership.

Administrative incompetence refers to the inability of an organisation as a whole to adapt to change and innovation as well as the inability of an organisation to learn from past mistakes. This bureaucratic inefficiency is not caused by any one person, but by organisational culture as a whole. Organisations, like physical masses, possess a kind of inertia that resists change, and it takes a great force to effect significant change. One solution to this is to put in place mechanisms whereby change can be implemented. This has to take place at many levels, from the ground up, as well as from the top down. This reviewer feels that this is one manifestation of incompetence which deserves greater exploration.

Another form of incompetence raised in the book is strategic incompetence. This refers to incompetence at levels beyond the military, occurring when the decisions made in deploying or withdrawing the use of military force. Often this incompetence takes place at the political and national level. Some examples are:

- Sending a military force to a situation without a clear mission or objective.
- Sending a military force into a situation without the legal ability to defend itself or the mandate to fulfill its role effectively.
- Leaving a military force in a situation where it becomes progressively more committed, to the point where it is unable to withdraw safely, or when resources and lives have to be continually poured into a situation with no clear end.
- The lack of political will to sustain losses, or an unrealistic political definition of "acceptable losses".
- Withdrawing a military force before the successful completion of objectives.

Recent notable example like the Somali "mission creep" debacle and the US War in Iraq (OIF) readily come to mind.

Conclusion

Today, with realistic and effective training, innovative use of new doctrines and technology, effective feedback as well as the understanding and effective use of military intelligence, incompetence on a personal and tactical scale can be eliminated. However, the malaise of incompetence in this era arises more from organisational inefficiency and ineffective political direction which can be important topics for another book.

The above mentioned title is available for borrowing at the SAFTI MI Library. The catalog references are:

On The Psychology of Military Incompetence
Norman Dixon
U22.3 DIX

Featured Author: Michael O'Hanlon

Michael O'Hanlon is currently a Senior Fellow (Foreign Policy Studies Program) at the Brookings Institution and Adjunct Professor at Columbia University . He received his MA (1988) and PhD (1991) from Princeton University and has served as Research Assistant at the Institute for Defence Analyses, Peace Corps Volunteer in the Congo and Weapons and Arms Control Analyst with the National Security Division of the Congressional Budget Office in Washington before under-taking full-time lecturing and research work.

He is the author of 14 books as well as numerous journal articles and has researched on arms treaties, Asian and European security issues, civil wars, Iraq policy, military technology, missile defence and peacekeeping operations. More recently, his research focus has been on space and security, defence strategy and budgeting, defence transformation and Effects-Based Operations (EBO).

Of these, the concept of EBO has gained currency in recent times and has been mooted as a way of explaining how the most recent Iraq War, Operation Iraqi Freedom (OIF), was waged and won. As it turned out, OIF was a landmark conflict in the sense that the time taken to conclude major military operations was surprisingly short for a major campaign of this magnitude.

Observers have noted that the US had shifted to wage a lean and decisive battle in place of the more commonly fought war - the destruction-centric all-out-assault which they had employed in previous conflicts. This shift in orientation can be attributed to the adoption by US forces of EBO concepts. O ' Hanlon has been grappling with these concepts in his writings for more than a decade and they are useful for the insight they bring in understanding the evolution of the US defence posture.

In The Art Of War In The Age Of Peace (1992), O'Hanlon posits an alternative military force posture and strategy for the US by taking into account recent developments in the global security environment as well as enduring realities of international politics. The study shifts away from a US global force posture for the post-Cold War era by focusing on the role of US conventional forces in non-European theatres. Among the radical recommendations is a call for substantial cutbacks in various categories of US combat forces, by 40% to 50% in most cases relative to 1991 levels. He reiterates that this alternative military posture would, by no means, require gutting the military and would not sacrifice readiness and sustain-ability. Instead the emphasis is efficiency through a new force posture that is lean yet should sufficiently robust to convince potential aggressors that the US is not disengaging from its global interests but only moving towards a more efficient military.

Defense Planning for the late 1990s: Beyond the Desert Storm Framework (1995) explores how the US fashioned a defence policy based on the assumptions of having strong and reliable allies, no major enemies as well as the best military in history and yet, at the same time, having a host of worries about its future security and a strong sense that the world is anything but safe.

At the same time, the pressure to stretch their budgets means that governments all over the world are being asked to become more efficient. Thus the book argues that the US could prudently cut defence spending by as much as 10% without risking its ability to respond to simultaneous regional crises or maintain global commitments. Again, the emphasis of military reform here is EBO to tailor the manner in which force is deployed to better achieve the desired effects and goals. He calls for efforts to be channelled towards deploying precision-guided munitions, employing of special forces and information operations.

Technological Change and the Future of Warfare (2000) provides interesting insights into the performance of American high-technology weaponry in the 1991 Persian Gulf War as well as the breath-taking pace of innovation in the field of Information Technology. In this book, he suggests that the US is on the threshold of fundamental changes taking place in military affairs and argues passionately for major changes in Pentagon budgetary priorities and even in American foreign policy, so as to ensure that resources are expended towards enabling the US Military to undergo transformation before other armed forces succeed in doing so.

O'Hanlon speaks in favour of transformation and it is important to understand his interpretation of transformation does not necessarily only mean replacing out-dated weapons. His focus is the fact that the accuracy and destructiveness of weapon systems are approaching the limits imposed by physics. Thus what is required is a shift away from a damage-centric concept of warfare to an effects-based concept of warfare, which attempts to separate the means

from the ends, by stipulating the desired goals and subsequently going about pro-curing the weapons and developing the doctrine and organisation to achieve those goals. It is also important to note that O'Hanlon not only argues for a more effective and efficient military but also emphasises that the political decision to use military force must be a carefully considered one.

In conclusion, Michael O'Hanlon's has consistently argued that while important developments are indeed in process, especially in Information Technology, the limits on weapons systems imposed by the laws of physics will prove to be a serious obstacle. Coupled with the radical changes in the post-Cold War security environment, he calls for correspondingly radical changes in military budgeting priorities, force structure and doctrine, such as EBO, are required. In essence, the world is transforming and that the military has to transform so as to be able to fulfil new roles and new missions more effectively.

All the above-mentioned titles are available in the SAFTI MI Library.

Personality Profile: Percy Hobart

Major General Percy Hobart (born June 14, 1885) was a maverick British officer whose pioneering work in armoured doctrine inspired the German armour advocates led by Heinz Guderian. Ironically, his own side was often sceptical, if not outright hostile, towards his ideas and innovations. Instead it was the German Army who adopted Hobart's concepts to swiftly crush Allied resistance in the Battle of France. Despite having his theories proved by the enemy's victory, Hobart continued to endure and fight against constant professional persecution and was only vindicated, with the support of British Prime Minister Winston Churchill, after a long struggle.

After graduating from the Royal Military Academy at Woolwich in 1904, Hobart was commissioned with the Royal Engineers. He served in India and then fought in France and Iraq during WWI, where he gained his reputation as an outstanding and creative officer. In the early 1920s, he was transferred to the Royal Tank Corps as a military engineer, joining the pioneers who felt that the tank was the decisive land weapon of future wars.

With his diverse background and creative imagination, he was able to assimilate the works of two outstanding British theorists, J.F.C. Fuller and B.H. Liddell Hart and use them to underpin new strategic concepts and doctrine. Perhaps the most important cornerstone was the concept of strategic mobility where massed armoured fighting vehicles would rapidly break through enemy lines and cause severe disruption to their forces and supply lines. This was heresy at the time given the experience of WWI's predominant characteristic of slow and attrition-based trench warfare.

Besides mastery of abstract concepts, Hobart also worked relentlessly to operationalise his ideas by tackling practical problems. He planned for the use of air-drops, instead of horse-drawn wagons, to keep the fast-moving armoured columns supplied. Rations were to be carried by the tanks and refuelling done in mobile dumps in enemy territory so as to preserve maximum mobility and range. He fought for expensive and high quality radios which were critical for effective command and control of armoured manoeuvres.

Not surprisingly, resistance to these radical ideas surfaced. Some in the old order found the concept of strategic mobility preposterous while others opposed the motorisation of forces due to a very strong sentimental attachment to the horse and cavalry. Even the military conservatives who saw some value in tanks could only conceive of their deployment in a scattered manner as support for infantry formations.

By 1934, Hobart, now a brigadier general, became increasingly prominent in British military circles. He was the sole surviving senior officer who actively advocated armoured warfare. Others, such as Major General J.F.C. Fuller, had been forced into retirement. Hobart toiled to show the worthiness of his ideas. His professional expertise, coupled with his ability to motivate his officers and men, inspired high morale and esprit de corps in the 1st Tank Brigade, the world's first permanent modern armoured unit.

In a series of war games, he proved the feasibility of driving into the enemy's rear with fast moving armoured units and crippling enemy organisation. He showed that armoured units could both travel and fight by night and that this innovation necessitated a complete revision of strategic and tactical concepts, for it placed old-style military units at the mercy of armoured fighting vehicles.

These unsparing efforts by Hobart were actually responsible for spawning the basic techniques of Blitzkrieg, the new mode of warfare that was to force Britain to the brink of defeat. The victors of WWI were clearly not as receptive to change while the Germans managed to change the rules of the game in their favour.

While Hobart was adored by those under his command, by the late 1930s, he had more bitter foes in Britain's War Office than any other officer in the British Army. Deeply passionate about the idea of armour, he had become involved in heated arguments with many of Britain's military bureaucrats and senior officers. Even the Chief of the Imperial General Staff (head of the British Army) complained that Hobart had been "intolerably rude" to him.

By the time, Britain tardily began the formation of its first armoured division, the Germans already had four and were building more. Realising the precarious situation the British military was in, the War Office pressured Hobart to leave the Royal Tanks Corps and oversee all army training - the ostensible reason being that his drive and knowledge of armoured warfare would be infused throughout the British Army.

Hobart was now deep in “enemy” territory. When the British government decided to appease Hitler over the Munich crisis for the sake of peace, this provided the right climate to post this outspoken advocate of aggressive concepts to a remote command. He was assigned to raise and train Britain’s second modern armoured division, based in Egypt . However this did not demoralise or faze Hobart in any way and in his new environment, Hobart buckled down to build the 7th Armoured Division into the kind of armoured division which he had always envisioned. Later in 1940, Western Desert Force Commander, Lieutenant General Sir Richard O’Connor would praise the 7th Armoured Division as “the best trained division I have ever seen.”

However, Hobart had the misfortune of serving under a commander who hated him. And three months after the outbreak of WWII in September 1939, General Archibald Wavell recommended that Hobart be removed from his command and retired. His division was handed over to officers who had very little understanding and experience in handling large armoured formations.

Back in Britain, Hobart was posted to the Home Guard with the rank of corporal. Six months after Hobart’s abrupt removal, the British Army narrowly avoided total annihilation by Guderian’s armoured panzer divisions, barely escaping across the English Channel in the largest naval evacuation in the history of modern warfare. Guderian (also featured in the Personality Profile of POINTER V29N3) had avidly studied the war game reports of the 1st Tank Brigade and drew much of his inspiration from Hobart .

The shock of defeat led to a massive review of the military and in October 1940, Churchill personally ordered the reinstatement of Hobart as a Major General in the British Army. He was subsequently entrusted with the responsibility of raising and training the 11 th Armoured Division, earmarked to fight in North Africa . Also, the impending liberation of Nazi-occupied Europe required a host of new-type tanks and armoured vehicles and men who would have to be trained in the specialised tasks of manning these new weapons. Hobart was called in to train a unit in handling specialised armour, the 79th (Experimental) Armoured Division. The latter was to be the biggest division in the world, and also the first all-armoured division.

The Supreme Commander of the Allied Forces in Europe, General Dwight Eisenhower, recognised Hobart’s vital role and his unique abilities in developing specialised armour for functions like swimming, climbing walls and destroying obstacles. Eisenhower gave his unstinting support by slashing red tape. US factories were told to give top priority to manufacturing the odd-looking tanks and attachments required by Hobart. Collectively called “funnies”, Hobart’s inventions included the Crab whose revolving flails detonated mines in its path and the Crocodile which had a flamethrower instead of a machinegun. These innovations helped the 6 June 1944 D-Day landings to succeed with less loss of life and material. After breaching the Atlantic Wall, the 79th Division went on to participate in many battles in the Allied invasion of Germany itself.

Hobart received his long overdue recognition from the British establishment when he was knighted in 1943. He subsequently retired in 1946 and died on 19 February 1957. His passing saw him being widely mourned - to have “served with Hobo” was seen as a real distinction in the British Army. Hobart was truly a maverick and innovator of the first order. He was a brilliant and independent-minded officer who had the rare talent of being able to effectively couple deep under-standing of abstract concepts with hands-on realism to operationalise his vision and ideas. His major failing was to have made too many enemies in high places and he would have vanished into obscurity if not for the intervention of Churchill. However, that would not be out of character. Mavericks are mavericks because they fight against the status quo and the established order. Hobart’s achievements can be seen as being all the more impressive in view of all the opposition he had to overcome.

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