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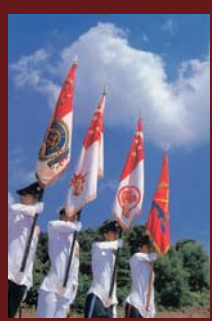

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pointer
http://www.mindef.gov.sg/safti/pointer Vol 32 No 1 [2006]

CONTENTS

CONTENTS ...cont'd

EDITORIAL

"All's right with the world."

Robert Browning (1812-1889)

How far removed from the truths and realities of this world can the above statement be in this 21st century. Growing threats of terrorism and pandemics, transnational crime and power rivalry belie a seemingly stable world. In a highly globalised environment, a simple threat, a verbal exchange or non-exchange, or an isolated incident in any part of the world can potentially disrupt the peace that we have enjoyed thus far. As military men and women serving as guardians of peace and security, it is contingent on us to keep a watchful eye over unfolding world events and the interactive and intricate play of geo-politics and geo-economics for a firm grasp of key security issues and concerns.

In this regard, *POINTER* strives to contribute to raising the awareness and knowledge bar of SAF officers in the area of geo-strategic and security issues.

In this first issue of the year, we hope to set the geo-political context for readers to better understand the challenging times ahead in the security arena. In our lead article, we are pleased to reproduce Mr Teo Chee Hean, the Minister for Defence's speech at the recent Asia-Pacific Security Conference which outlines the new geo-political realities in which a few major powers are reshaping the strategic and security contours in the Asia-Pacific region.

We are also honoured by the contribution of Dr Bengt Anderberg, the former Director-General of the Swedish Defence Research Agency (FOI) and the third Swedish official to have been conferred the Singapore Defence Technology Distinguished Fellowship. In his article, Dr Anderberg discusses the need to widen the scope of transformation to outside the military to achieve success in fighting global terrorism.

In the article "Experimenting with Experimentation" jointly written by COL Loh Kean Wah, MAJ Tony Ong and CPT Kelvin Fan, the authors re-examine the traditional concept of military experimentation and contend that the perception of experimentation should be expanded to become a tool to "generate"questions rather than one that "answers" questions through hypotheses-testing and effects-measurement.

In another jointly written article "Making A Difference: RSAF's Role in Peacetime Operations" – by LTC Chin Pak Chuen, LTC Gan Siow Huang and MAJ Ng Sin Kian, the authors posit that air power has proven its utility in a wide spectrum of operations other than hot war. The RSAF in particular, in its indigenous application of air power, has

made a significant difference in an array of peacetime operations that contribute to regional stability.

In his article "Optimizing Learning in the 3rd Generation SAF", LTC Karuna Ramanathan, Head Learning Development Project Office, expounds on a topic that is close to his heart. He outlines the various learning possibilities that can help to prepare the 3rd Generation SAF officers as knowledge warriors and adaptive individuals capable of operating in dynamic, complex and uncertain environments.

We are also pleased to publish two of the Merit essays of the 2004 CDF Essay Competition. MAJ(NS) Aaron Chia's essay on "The Complex and Chaotic Military" addresses the importance of military networks, by first proposing a framework for assessing the effectiveness of military networks, and then showing how this network analysis can improve the flow of information and shorten the OODA timeframe.

LTA(NS) Toh Boon Ho's essay on "Harnessing Transformation: The Interwar Experiences of the German and British Armies" explores the interwar record of the British and German armies in harnessing transformation, by examining the lessons learnt from World War I by both armies and how those lessons influenced their views toward future war, and in particular, their response to the trinity of organizational, doctrinal and technological change in the interwar period.

Under the Tech Edge section, CPT Matthew Tong shares his research on broad-band U-slot microstrip patch antennas for apertures and opportunistic arrays. The inherent advantages of opportunistic arrays are known to offer potential for a wide variety of army and air force applications in the area of rapid deployment of land-based radar networks within urban centres in crisis areas.

Under the Personality Profile section, we examine the career and achievements of Field Marshal K. M. Cariappa, the first Indian Commander-in-Chief of the Army after the Second World War. Field Marshal Cariappa was instrumental in overseeing the peaceful and orderly division of the Indian army into two national armies due to the partition of the Indian continent in 1947. He also played important roles in the Indian army's ejection of the Japanese army from Burma during World War II and the Indian success in the Kashmir conflict against the Pakistanis in 1947-8.

Last but not least, we would like to thank BG Bernard Tan, Director, Joint Intelligence Directorate, for sharing his thoughts on a recently published Tech Edge article, "C2 Team Collaboration Experiment (TCX)" (Vol. 31 No. 3). BG Tan's observations and suggestions for a more realistic C2 team experiment contribute to a healthy exchange of professional ideas. We urge more readers to pen their afterthoughts from articles and contribute to building a vibrant *POINTER* community where regular contest and sharing of ideas can take place.

Editor, *POINTER*

Enhancing Security in a Time of Flux

by Mr Teo Chee Hean, Minister for Defence

Source: Pioneer

Introduction

Since 2002, the geopolitical landscape of the Asia-Pacific region has shifted quite significantly. The US is still pre-eminent, wielding superior military power and political influence. But US pre-eminence is now juxtaposed against the rise of the two biggest countries in the world, both in Asia – China in the east and India in the west. This new reality is reshaping the strategic contours of the region, and indeed of the whole world.

China and India

Over the last 20 years, economic reforms in China and India have unleashed powerful productive forces which have linked the destinies of 2.3 billion people – over one-third of the world's population – to the international economy. These two countries are now critical engines of growth not just for Asia but for the world. China is the world's fourth largest economy after the US, Japan and Germany, and it continues to attract huge amounts of foreign direct investment. India's economy ranks only behind Japan and China's within Asia, and it is powering ahead with a forecast of 6-7% economic growth over the medium term. China and India also already rank among the major users of the world's resources. They are now the world's second and sixth largest consumers of oil respectively, and they have been reaching out to places as diverse as Sudan and Siberia to secure the energy resources to fuel their development. The rate and scale of the growth of these two giants – especially as they are taking place concurrently – is inevitably giving rise to both strategic and economic consequences on a global scale, both in impact and in reach.

China and India have both abandoned autarky and now seek and depend on economic linkages that go well beyond their immediate borders on land and at sea. They are now both major trading and energy

importing nations. As they develop, their search for overseas sources of raw materials and markets, as well as their dependence on them, can only grow. Both China and India now have an interest in the security of sea routes, and of their energy sources.

There is no question that China and India's growing prosperity have implications beyond the economic realm. Both countries recognise that they can continue on their growth trajectories only if there is a secure and stable external environment. This has propelled their efforts to carve out a larger international space for themselves by strengthening their political and economic ties with other countries, especially those in their immediate regions. It has also propelled them to enter into some strategic partnerships, including with other global players. China and India will invariably also leverage on their "soft power" to expand their access to markets and to secure their access to critical resources. As these two largest countries in the world continue to grow, with their growing economic power and expanded security interests will come enhanced military capabilities and assertiveness. How they then conduct themselves and engage others will determine the complexion of the security landscape in the Asia-Pacific region.

Japan

The situation is made more complex by the fact that the rise of China and India is set against other regional developments that, while perhaps less dramatic, are certainly not insignificant. Japan has always been an important country in the Asia-Pacific region, and it is set to take on a more active role. Japan has emerged from a decade of economic stagnation with a new-found confidence and expansiveness. The Japanese economy remains the second largest in the world – some three times the size of China's and seven times that of India's. Japan possesses technology and advanced productive capabilities unmatched by any other country in Asia.

Today, Japan's fundamental strengths are combined with a rising national confidence. There is a desire to attain the status of what the Japanese term a "normal" country, by which they mean a country that is able to fully project itself on the international stage and, among other things, deploy its military forces in roles beyond the defence of the homeland. The Japanese characterise this as moving from being simply a "peace-loving country" to becoming also a "peace-supporting" country. Indeed, the fundamental changes in Japan's security outlook and posture are already well in motion. Today, Japanese soldiers are assisting in reconstruction efforts in Iraq, and Japanese naval vessels ply the Indian Ocean in support of coalition operations. This time last year, Japan had sent one of the largest contingents to Aceh for the tsunami relief effort.

New Geopolitical Realities

A rising China and India and a revitalised Japan, all seeking larger and more active roles, together with a pre-eminent United States – these are the defining geopolitical realities of our

region today. The interaction of these four geopolitical poles in Asia, among themselves and with the rest of the region, is likely to make for increasingly complex regional dynamics.

The prospects for regional stability and peace will depend on finding a new equilibrium in which the multi-dimensional interests of all the major players are accommodated. That will require much effort and good sense given that the geopolitical sensitivities are also overlaid with a complex web of cultural and historical differences. We see that most starkly today in the relationship between Japan and China, which is burdened by historical baggage and suspicion on both sides. Fortunately, there are strong incentives for cooperation in the economic arena given how important they are to each other's economic well-being. How the Sino-Japanese relationship evolves will in large part determine the future of the Asia-Pacific region. China is trying to understand what a normal Japan next to it means and Japan is trying to understand what a peacefully-rising China next to it means.

We can clearly see the very complex interplay of relationships among the four key countries – the US, China, Japan and India – both in bilateral pairs as well as at the various trilateral and quadrilateral levels. And that is not all – Russia is not likely to sit aside once it has settled some of its more immediate internal problems and is in a position to exert geostrategic influence, especially with the clout it can wield using its energy resources. Over the next few decades, the Asia-Pacific will be the region where the big powers actively jostle for power and influence. None of us would want to see fierce competition deteriorating into conflict. We have been fortunate to have had several decades of peace and stability which has allowed us all to develop and meet the aspirations of our people. We should all work closely together to ensure that peace and stability and growth continue to prevail.

ASEAN

The Association of Southeast Asian Nations (ASEAN) can play a constructive role in this effort. Southeast Asia lies at the crossroads between China and India. It sits astride major sea lines of communications, including the Malacca and Singapore Straits which are key arteries for global trade and energy flows. The ten countries which make up ASEAN have a population of 500 million and a sizeable economy, with significant natural and human resources. ASEAN can and must play a role to shape the emerging regional strategic landscape.

There is broad consensus among the ten ASEAN member states that ASEAN cannot remain stationary in the face of the dramatic developments unfolding around it. They recognise that to be able to play a useful role, ASEAN will have to broaden and deepen its integration, while at the same time adopting a pragmatic, outward-looking orientation and tapping into the dynamism of the major powers on its periphery. Only then can ASEAN influence the development of constructive relationships which enhance stability in our region.

An ASEAN that is diffused and uncoordinated can only lead to a Southeast Asian region that is eventually fragmented by the stresses and strains triggered by China and India's rise, and the inter-play of tensions among them and the other major powers. With these strategic imperatives in mind, ASEAN is now working on an ASEAN Charter which will articulate a long term vision for ASEAN and the role it should play.

ASEAN can build on the useful role it has been playing in recent years to help maintain a stable balance amidst the geopolitical transformations taking place in the Asia-Pacific. ASEAN has been the driving force behind regional arrangements such as the ASEAN Plus processes, the ASEAN Regional Forum (ARF), and the recently inaugurated East Asia Summit. These multilateral forums are useful tools for building confidence and mediating tensions. With ASEAN initiating these mechanisms and driving them, there is also assurance for the major powers that an honest broker sits in the driver's seat. These arrangements will be important building blocks of the security architecture that we must work together to develop so as to ensure peace and stability in the region in the years ahead.

Towards a New Security Architecture

The outlines of a larger East Asian community became clearer after the inaugural East Asia Summit meeting last December. This brought together the leaders of ASEAN and six major regional partners – India, China, Japan, South Korea, Australia and New Zealand, a grouping that collectively accounts for half of the world's population and a third of global GDP. This annual Summit provides a long-term mechanism for strategic dialogue and cooperation among 16 countries that together will shape the future of the Asia-Pacific region.

The security architecture of the Asia-Pacific is still a work in progress. The East Asian Summit – which is not yet fully formed – sits alongside other more established regional groupings such as the ASEAN Regional Forum. The ARF provides a valuable forum for regional countries and those with a stake in the security of the Asia-Pacific region, such as the European Union, to come together for dialogue on the pressing security issues of the day. One important achievement of the ARF over the last decade is that it has built up habits of open dialogue and patterns of cooperation in a region where none had existed before. The dialogue facilitated by the ARF has gradually, but steadily, enhanced confidence-building. It is a credit to the ARF that sensitive issues like territorial disputes in the South China Sea can today be discussed openly and candidly.

With the development of the parallel track for ARF defence officials in recent years, there has also been a sharper focus on transnational security challenges such as terrorism, maritime security, and the proliferation of weapons of mass destruction. It is encouraging that we now see a growing interest among ARF defence establishments to move beyond merely dialogue to more concrete forms of cooperation such as capacity building or exercises.

ASEAN can and must play a central role in shaping how the regional security architecture evolves. China and India will have to be actively engaged so that they integrate peacefully and constructively into not only the regional, but also the global, economic system and security architecture. The US must play a key role in actively shaping the security architecture. As must Japan, and as will Russia. Europe too will have to be engaged, for what happens in this region will shape Europe's external environment in a fundamental way in the coming decades.

We must ensure that cooperation is the order of the day, and not contention, and certainly not conflicts. In shaping the new equilibrium, we shall have to work towards an open and inclusive security architecture that takes into account both the region's diversity as well as the growing integration and inter-dependence among nations as a consequence of globalisation.

Inter-dependence and Shifting Notions of Security

This greater inter-dependence has had a profound effect on how states now perceive their security interests. Take China and India. The fate of both countries is increasingly tied to factors outside their own borders and beyond their immediate national control. Factors such as international trade, imported energy and global capital have forced them into a fundamental shift in their strategic calculations. When China and India were insular self-sufficient countries in the last century, security was primarily a function of securing their national borders against external aggression and ensuring domestic stability within. Today, with their development and prosperity dependent on the outside world, the notion of security has extended beyond their geographical borders. Such issues as energy security and the security of sea lanes become vitally important, and a change in their approach to security is inevitable. For these are issues that no single country, no matter how powerful, can adequately address on its own.

Greater economic inter-dependence has given rise to new models of cooperation which bring together like-minded countries, not only from within the region but also from outside the region, to address issues of common strategic concern. Aside from the ongoing work of the multilateral groupings that I referred to earlier, there are new forms of cooperation emerging on a sectoral basis. One area where we have had useful progress is maritime security. Since this became a serious concern and there was consensus on the need for action, there have been some important developments. For instance, there have been forums such as the IMO-sponsored Jakarta Meeting on the Straits of Malacca and Singapore (which took place in September 2005 and will be followed up with another meeting in Kuala Lumpur in the later part of this year), and a number operational initiatives such as the bold idea of Malaysian Deputy Prime Minister and Defence Minister Dato' Sri Najib Tun Razak to mount multinational maritime air patrols in the Malacca Straits – known as "Eyes in the Sky" – which he raised at the Shangri-La Dialogue in June 2005 and which was launched in quick time three to four months later.

Conclusion

We will require innovative approaches such as this to build a robust security architecture that can strengthen regional cooperation and enhance regional peace and stability, at a time when our nations' interests and fates are more closely inter-linked than they have ever been. These are challenging times when stresses and tensions will inevitably arise as a number of major powers emerge and want their neighbours and the world to reckon with them.

*This article is a reproduction of a speech by **Mr Teo Chee Hean**, Minister for Defence, at the Third Asia-Pacific Security Conference held on 19 February 2006.*

Mr Teo Chee Hean is the Minister for Defence, and has previously held the appointments of Minister for Education and Second Minister for Defence. Prior to election to public office, he served as Chief of Navy and held the rank of Rear Admiral. He was awarded the President's and SAF Scholarships, and holds a Bachelor of Science (1st Class Hons) in Electrical Engineering and Management Science from the University of Manchester Institute of Science and Technology, a Masters of Science (with distinction) in Computing Science from the Imperial College in London, and a Masters in Public Administration from the Kennedy School of Government at Harvard University, where he was named a Littauer Fellow.

Force Transformation in a Changing World

by Dr Bengt Anderberg

Introduction

We certainly do live in interesting times. The events of 9/11, the fight against terrorism, the war in Iraq, the tsunami in Asia, and the recent earthquake in Pakistan and India are all events that are changing the perception of our security.

Pakistan Quake 2005

Remains of World Trade Center after the 9/11 attack

Security is the protection of normal functioning of society from risks and threats, and must be a top priority to any nation. The ability to meet and deal with security problems is an indicator of the stability of the nation and of the region.

Risks originate from nature or man-made systems. The recent tsunami that hit Asia in December 2004 is an example of a disaster of unusual magnitude. It represents one end of a risk scenario that in the other end might have small accidents. The difference is that main disasters are unusual but have devastating consequences while accidents occur every day with severe impact only on a small part of society.

Threats are different in nature from risks as they originate from human antagonism. But it is important to keep in mind that terrorists or other actors might very well turn risks into threats. It is possible to turn a lorry transporting gas into a powerful bomb. The lines between risks and threats are not very precise.

Threats and risks are not static. New technology not only offers economic growth and increased welfare but also opens up opportunities for aggressive

small groups and individuals to misuse science. Increased knowledge in the medical field is used to fight diseases but could also be used as a basis for biological weapons. The use of civilian aircraft in the 9/11 attack is another example of how technology developed for a perfectly peaceful purpose might be turned into a weapon.

All nations face basically two very different kinds of threats. One is a more or less conventional threat from another nation or group of nations using military force to achieve their political goals. This also includes state terrorism that may be inflicted by a state upon its own citizens or those of another state.

The other is a global, non-state threat from terrorism. Global terrorism and crime are increasing not only the number of important actors but are also widening the scope of aggressive means and methods.

Defending against armed aggression from another state has since long been the responsibility for the armed forces supported by the civil society. It is not in the same way obvious who should be responsible for defending against terrorism. A number of national organizations like police, customs, coast guard and armed forces are more or less involved. Banks, industry, health services and aviation authorities are also examples of bodies that could have a role.

Modern nations are faced with the challenge to prepare for defending the nation at home or taking part in coalition forces abroad and simultaneously execute long periods of asymmetric anti-terrorist warfare.

New concepts for defence are discussed against a background of known and "unknown" risks and threats. Many nations including small high-tech nations like Singapore and Sweden are involved in a transformation of the Armed Forces to meet a new and different situation. Discussions, studies and planning for the future use of the military forces are ongoing. However, the deliberations seem to be more or less limited to the need for transformation of the military forces. Other organizations in the society are more or less left outside the discussion about transformation.

This has been outlined in a NATO report which concludes that the threat from terrorism and its impact on civil populations coupled with recent events caused by natural disasters has shown a weakness in the handling of civil emergencies. It furthermore concludes that a terrorist chemical/biological attack on a city and the resultant impact on crowd movement and protection bear many similarities to the impact of natural disasters such as the Tsunami in December 2004 and the Hurricane Katrina in August 2005. In both these cases and in many others, the authorities were unprepared and were not in possession of any cohesive planning that could have alleviated many of the resulting problems and deaths.[1]

These examples show that many important activities will be independent of each other instead of being coordinated. The different organizations will work in parallel instead of jointly and the coordination will be lacking or far too complicated.

...A NATO report concludes that the threat from terrorism and its impact on civil populations coupled with recent events caused by natural disasters has shown a weakness in the handling of civil emergencies.

It will not be easy to achieve a real coordination of planning and execution of operations. There are a number of reasons behind this. There are limitations built in within the present structures. The divided responsibility and funding in a peacetime society offers a number of "showstoppers". Psychological factors like "not invented here", "not my responsibility", "my money" and "we have never done it that way" should not be underestimated. It will be hard work to utilize the synergies and coordinate action of all relevant forces.

Need for a Change

The need for a change on the military side has been reflected in the last ten to fifteen years by the debate on the Revolution in Military Affairs (RMA), a concept of Network-Centric Warfare (NCW) and Effects-based Operations (EBO). The abbreviations stand for new ideas or sometimes well-known ideas used in new ways.

The debate reflects ideas for development of the armed forces partly as an effect of introduction of new technology offering new possibilities. One problem might be that the discussions have given us a sense that everything is new and that old established knowledge and ways of thinking are outdated.

It is necessary to take a broad approach when we discuss – but it is also good to go back to former days. We should remind ourselves of why we are in the present position in defence planning. We have to ask what is really new and different when we are planning for the transformation of the armed forces.

The cold war was for nearly fifty years the baseline for military force development. NATO and the Warsaw Pact planned for operations with huge armoured forces supported by deep strike and close air support. Protection of sea-lanes and bases, as well as amphibious operations were other important elements.

The threat from nuclear weapons influenced security policy more than the actual military planning of operations. Other weapons of mass destruction played a less important part in our military thinking. Weapons of mass destruction (WMD) are more important today for our perception of future wars and the fight against global terrorism. The increasing number of nuclear states and the possible use of WMD by terrorist groups are two very different but widely discussed threats.

The conflicts and wars in the Middle East have heavily influenced the military thinking in many countries. The operations of the Israeli Armed Forces have been the subject of numerous analyses; explanations and the results have influenced the development in other countries. The impact of the

operational and tactical methods used by the different parts of the Israeli Armed Forces has been considerable.

The conflict in Vietnam could be described as a mixture between a counter-insurgency war and a more conventional war. The experiences from that long-lasting conflict have not influenced the military thinking outside the countries that took part in the war in the same way as other conflicts. Some of the lessons learned from fighting a counter-insurgency war disappeared in the time span between Vietnam and the ongoing war in Iraq. It is remarkable as the similarities between the challenges fighting today's terrorists and fighting yesterday's guerrillas are striking.

The fight against terrorism and guerrilla are frontless even if terrorism is global and guerrilla is a more local activity. You have to expect the unexpected as the initiative mainly rests with the opponent. There are no really safe areas and no borders. The non-state terrorists are organized in loose networks on the basis of a common idea. They have the initiative in choosing targets, means, methods and time for their attacks.

A war against non-state terrorism involving one-sided coalition or national forces (either military or police) and on the other side, organized terrorism could certainly be characterized as asymmetric. The terrorists are asymmetric in means, methods and motivation. They have few restrictions in their engagements. They are willing to offer their own lives and try to achieve maximum effects by causing as much collateral damage as possible.

The fight against terrorism is challenging. A basic level of protection is vital but will not solve the problem. What is required in the long run is to defeat terrorism. That will not be easy, as we do not even know what such a victory looks like. We might have to look for a combination of political, military, legal, economic, and social means that in combination lead towards some kind of stabilization and in the end something that could be called victory.

The experiences from the cold war arena and from the conflicts and wars during the last century have now to be tested against new threats from terrorism.

The United States as a Model

Many defence planners are looking at the United States when they plan for transformation of their national forces. The US development is carefully studied and there is a tendency to copy or use the way the only remaining superpower is developing its military forces. This is a natural consequence of the global military presence and the fact that the US has been more or less constantly involved in military operations. Another factor is the need in many countries for interoperability with US forces.

The US accounts for half of the global spending in the military field. This means US$380 billion compared to US$370 billion for the rest of the world.[2] No other nation is even close to the US in military spending. Small nations can only afford to spend a tiny fraction.

The rapid development of US forces is based on the enormous resources

spent on research and development of technology. R&D for the armed forces and also for the civil industry has created a technology gap that seems to be constantly widening compared to all other nations. This development might lead US forces to strategic concepts based on their advanced technology that could not easily be adapted by coalition partners.

A small nation has to concentrate its resources to carefully selected niche areas adapted to national security policy. Doing this, there could very well be disadvantages for a small nation trying to copy the way the US is utilizing technologies for the development of its armed forces. It could lead to development of capabilities that are unbalanced and in the end not fully introduced due to limited resources.

The Influence of Technology

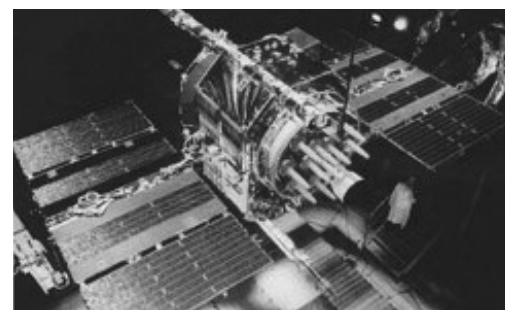
Technology offers us a number of improved possibilities when we compare with what we had a few decades back.

Navigation is no longer a problem. It is possible to navigate anywhere on the globe with an accuracy down to meters or less. The exact location for own forces and weapons and enemy targets can be established. This has made a whole range of precision-guided munitions possible. Smart and relatively cheap bombs like the Joint Direct Attack Munitions (JDAM) can hit a target at a distance of 40 kilometres independent of weather conditions and darkness.[3]

Sensor technology offers new ways of finding enemy forces and small targets. Sensor fusion and information fusion makes it possible to extract the critical information from very complicated battlefield scenarios. It is often said that there is no place to hide on the battlefield. That is not entirely true but the existence of new and more efficient sensors and precision-guided munitions have changed the behaviour in combat.

Communications technology makes it possible to distribute data and information in networks involving all actors and combat units. It is still difficult to get a broad and common situation picture in real-time but it will come closer and in the end offer a much higher degree of battle-space awareness.

There are other developments worth mentioning like stealth technology that protects against sensor systems, embedded digitized technology that allows high capacity systems to be built into platforms and then linked into systems of systems, and space technology supporting communications and surveillance.



NAVSTAR GPS – An example of satellite navigation system

Development of technology is constantly offering new possibilities to fight a successful military campaign.

The invasion of Iraq is an example. The enemy forces were defeated within a few weeks with small human losses on the US and UK side.

But what followed past the fighting on the battlefield has, in spite of all available technology, been very different. The fighting arena has changed. The forces have to fight a counter-insurgency, anti-terrorist type of war. The losses are mounting and the possibility to end the fight seems far away.

Counter-insurgency and global terrorism poses a fighting arena where it is difficult to identify who is the enemy and what that enemy is planning to do. The initiative rests mainly with the enemy with a high degree of unpredictability of result. More technology is not the answer to the problems. A new level of initiative, coordination, flexibility and effects has to be in place if the fight is to be widened to more than a passive protection.

The role of global media has changed considerably and offers an extreme level of public insight in what seems to be going on. This influences politicians and other decision makers and might even lead to difficulties to take the most appropriate decision.

Some Things Do Not Change

In ongoing and future conflicts it is still a question of using people. Even if they are supported by modern technology they will still have to risk their lives and it will still be required from them to kill or get killed. Close combat between individuals is still a task mainly for the sharp end of our military forces.

The Gulf War in 1991 sparked the ongoing discussion on EBO

We will, even if modern technology will assist us to get closer to real-time battle space awareness, still have to face uncertainty. Knowing the truth, the whole truth and nothing but the truth on what the enemy is planning to do or is actually doing is not possible. Missing and misleading information will still lead to wrong decisions and lost battles.

Effects-based Operations

It is not easy to find a red line between all the buzzwords that are part of the ongoing discussion on the road ahead. Effects-based Operations (EBO) is a recent follow-up to Revolution in Military Affairs (RMA) and Network-Centric Warfare (NCW). It has a wider scope covering not only military operations but

also any other way of influencing the opponent to try to reach the selected political goal. EBO is the combined use of power and means selected from all available sources – political, military, economic and diplomatic. The methods could be a carefully selected mixture of brute force, threats, deception, blackmail, promises, broken promises and every other method that is considered useful and lawful.

According to the US Joint Forces Command, EBO are operations that focus on influencing or changing system behaviour or capabilities using the integrated application of selected instruments of power in order to achieve directed policy aims. EBO provide the ability to be more responsive and discriminating by focusing on the desired end-state behaviour and the specific effects that would bring about this new behaviour.

Furthermore, EBO provide a more comprehensive understanding of a given adversary and of the various elements that enable this adversary to behave and function in a particular fashion. Armed with this knowledge, military commanders are afforded a more flexible and effective means to prosecute activities ranging from cooperation to conflict by focusing on the "effects" they would need to create to achieve a behavioural change in an adversary.

EBO also provide a powerful instrument for a greater unity of effort among the various instruments of power. Inter-agency coordination and participation must be an organic component in the commander's effects-based operations process.[4]

The ongoing discussion on the military side exemplified by Joint Forces Command seems to indicate that EBO is a question for the military. If we accept that the basic idea with EBO is to stress the political goal and to use all available and relevant civil and military means and methods, the discussion should be a political one. Military operations are only one of several options to reach political goals.

Is EBO really a new way of fighting a war? Or is it only a new abbreviation to describe the total effort required by any state or non-state actor to conduct a war? The answer to this might be that it is both. It is an interesting way to focus on the complex problem of combining all means and methods, military and non-military to achieve the desired result.

Transformation should in the light of the combined risks and threats and in the light of how EBO is defined- not be a military question only. It is a question of coordinating all different resources of a Nation into a combined organization that can cope with terrorism, military aggression as well as disasters. Coordination could be manifested on the political level by creating a ministry that deals with the total scope of security. Such a ministry could include some of the tasks of the present ministries including the Ministry of Defence. Even if it is not possible to go that far, the requirement for coordination will still be there and has to be met in some way.

Below the political level, security involves not only military functions but also a number of authorities like the Rescue Service Agency, Emergency Management Agency, Board of Health and Welfare, Environmental Protection Agency, Migration Board, Police Board, Institute for Infectious Disease Control, Food Administration, Nuclear Power Inspection, Civil Aviation Administration, Energy Agency, Customs, Coast Guard and the Maritime Administration.

All these organizations need to work effectively together either in one organization or within a well functioning network. They have to achieve a sufficient level of readiness, enough resources and a high degree of flexibility to meet asymmetric risks and threats.

A New Doctrine

Transformation is a process of renewal and adaptation to the environment.[5] It has to be based on a new and overriding doctrine. It means that we have to change not only our military doctrine but introduce a national security doctrine meeting all threats and risks where the military doctrine is only one component. This will be a difficult work as military operations have a special character and a set of rules dictated by the element of violence. It will in some aspects not be possible to fully transfer ideas from the military to the civil and vice versa.

Even if the concept of EBO is not new and could be traced back to Sun Tzu and Carl von Clausewitz[6], it could still be used to understand and form a new doctrine and organization not only for the military but also for all other authorities involved in the defence against terrorism.

There is a need to stress effects not only from military forces but also from all other international, national and regional organizations that have a responsibility for protecting our citizens and different functions in our society. We need new ways of bringing all these military and civil forces to bear on the threats and risks. The thinking behind EBO might be one tool for breaking the borderlines between authorities and functions and achieve coordinated planning and execution.

A new doctrine should bring strategic and operational clarity and make it possible to bring in all relevant effects and achieve a new and more efficient level of coordination and cooperation in the field.

It should bring a new kind of interoperability between all authorities in the country including the military. This also means increased possibilities for international interoperability in all fields. That will allow the nation not only to take part in military coalition forces but also widen the scope to be a part of any coalition, civil and military.

A new doctrine should guide the development and training of civil as well as military forces. It could be the basis for forming a new kind of combat unit composed of both military and civil units. As the differences between various elements in such an organization

are substantial these units should be organized partly on a permanent basis and partly ad hoc. But it has to be recognized that forming an organization in the same moment as need arises is difficult and might lead to a less efficient operation. A coordinated training effort is needed to reduce the risks.

The new doctrine should be reactive as well as proactive. It should aim at jointly destroying, disrupting, deceiving, delaying and avoiding terrorist activities as well as protecting against attacks. It should support training, self-synchronization, civil-military operations and trust. It should use graded weapons effects and the operations should be based on intelligence resulting in a near real-time common situation picture. The doctrine should also support the planning and use of the forces in national and international humanitarian relief operations after major disasters.

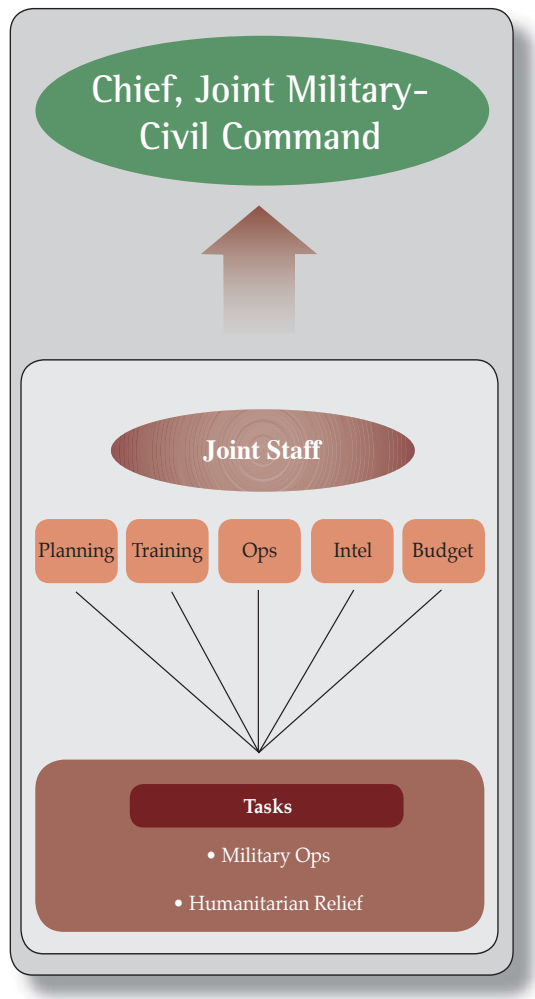
Command Structure

An important prerequisite is to form a joint civil-military command structure with one chief supported by a joint staff for rapid coordination of the basic military and civil functions. The chief should be the best person for the job and not necessarily a general.

The staff should be responsible for the budget and tasked with long as well as short term planning. It should lead training and be responsible for readiness and execution of operations. All relevant authorities should be represented. Intelligence should form a strong element and support long term planning as well as execution of operations.

It is likely that the tasks will involve anything from humanitarian relief in disaster areas or attacks by terrorists or individuals in urban areas, to coordinated military operations. The combined tasks will put changing demands on command and coordination of national and also allied, foreign military, rescue, police and other units.[7]

Coordination with coalition partners in other countries, military as well as civil, should be a major responsibility.



The command system should be based on a network including all civil and military bodies. The requirements will not be different from what is planned today on the military side. The system should include an open architecture, which allows combat units and civil organizations to be easily integrated. Secure communications links that allow fast and reliable information transactions between all subscribers independent of environments are a basic need. The joint command should be supported with a joint situation picture, compiled from all different civil and military units.

The Forces

The joint civil-military forces should be organized along the same principles as we already know from the military with some exceptions. The organization should have a much higher degree of flexibility meaning that the forces can be immediately adapted to the changing needs on the fighting arena. This means joint civil-military forces based on small building blocks where each block should be either civil or military in character. It should be possible to work jointly on the battalion size level and still use the military elements in the battalion independent from the civil when need arises.

The forces should be characterized by an extreme mobility and flexibility. They should be able to execute effects that could be graded in the whole spectrum from negotiations to the use of all weapons effects available. They should be supported by logistics allowing for action over long periods of time – even years.

A joint civil-military force structure should be organized on a permanent basis allowing for an extensive and flexible training to support efficiency and cooperation between units with very different backgrounds.

The weapon and equipment portfolio should allow effects to be carefully controlled. The possibility to grade effects in each engagement to the actual need should be a prioritised requirement. Weapon systems with extreme ability to pinpoint and identify the target avoiding indiscriminate effects are a prerequisite. A high proportion of remotely controlled equipment to increase efficiency and lower risks should be introduced. The information and command systems should allow for an extremely short reaction time. The forces should be highly mobile locally as well as on a global level.

The forces should constantly strive for the initiative. Protection against attacks from an adversary will certainly be important but only as a complement to an operational method that should mainly be offensive in character.

An operational method that allows greater variations in operations and tactics compared to a more conventional way of operating military forces should be introduced. It could include elements like small, dispersed, specialized and independent units acting in an operation ranging from denying terrorists financial support to infiltration and outright military

attacks. The method should include a varied mission tactics that is well-suited to the operation in question.

There are certainly a number of problems hidden behind a development like this. Closely mixing entities like police, military, coast guard and customs raise legal as well as command challenges. Doing that in coalition operations only adds to that problem. Fighting terrorism and criminality without affecting the human rights of ordinary citizens and securing that innocent third parties get out of harm's way are other problems that have to be carefully addressed.

Summary

It is necessary to widen the scope of transformation outside the military if we want to be successful fighting global terrorism. It is highly demanding and requires a new way of planning, training and execution of operations and a substantial change of mindsets.

It might not in a short perspective be possible to aim at a totally integrated civil-military force but we should strive at as much coordination and cooperation as possible. A joint civil-military command and training structure should be a step in that direction.

Endnotes

1 See NATO document *M&S FOR CIVIL EMERGENCY PLANNING IN CONTEXT OF DEFENCE AGAINST TERRORISM (CEPinDAT),* 2005.

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4 *The Effects-based Operations Process, Concept of Operations (CONOPS), Version 0.61, 04 November,* Joint Forces Command, Joint Experimentation Directorate, EBO Prototyping Team, USA, 2004.

5 Alberts, David, *Information Age Transformation: Getting to a 21st Century Military.* (Washington, DC; CCRP, 2002).

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7 Brehmer Berndt & Sundin Claes, *ROLF 2010, Overall Joint Command and Control in Crises and War,* Swedish National Defence College, The Department of War Studies, Stockholm, Sweden (2005).

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Experimenting with Experimentation

by COL Loh Kean Wah, MAJ Tony Ong & CPT Kelvin Fan

Introduction

The concept of military experimentation is not new. We know it is important. We know it is integral to force and capability development. But we believe that within our unique operating environment and the widened spectrum of operations, there is a need to expand the traditional definition of experimentation and re-look the way we perceive and use experimentation in the military context. In particular, this essay contends that we must expand our perception of military experimentation to become a tool to "generate" questions and not only as a tool to "answer" questions. We term this process one of experimenting with experimentation.

The History of Experimentation

> "War is a matter of Darwinian dominance or survival for states, and of life or death for individuals. When an army confronts new or different weaponry or practices on the battlefield, it must adapt to them."
>
> John A. Lynna[1]

Military historians concur that competition is a powerful factor in the spread of military innovations and the basis for experimentation. The literature on the sources and outcomes of military-technological innovation is large, but is chiefly concerned with its impact on the conduct of war. Considerably less attention has been paid to the systemic consequences of revolutionary military capabilities and practices despite the differing capacities of military organizations to adopt new methods. What are the root causes of this disparity? Various theories exist and make different hypotheses about a military organization's response to successful practices abroad, scope of diffusion, and the rate of adoption. Military experimentation in the form of war games, simulations, and especially exercises has proven to be a key and oft-essential element of innovation and transformation over the last few decades. Why is there a need to embrace experimentation? Who should be involved in the process? What are the organizational and

A realistic cockpit view from flight Simulator.

operational changes that have taken place when other institutions are accosted by the information revolution? More pertinently, how do we ensure that our experimentation-enabled transformation journey yields fruitful results? This essay attempts to address these questions with the ongoing revolution in military affairs (RMA) as the backdrop.

The appearance of very different military organizations has been a key indication of past military transformations. Military forces all around the world have been involved in experimentation in one way or another as a transformation-enabling tool and history bears testimony to the many changes that have taken place. Noteworthy classical examples from World War II include establishing aviator organizations onboard ships – carrier-based flight squadrons, combined arms formations of WW II capable of rapid and deep penetrations – *blitzkrieg*, and British air surveillance radar advances. The concept of the massed air strike as perfected by Japanese naval aviation was another genuine revelation. Other examples included the humble drop tank, which enabled the Royal Air Force (RAF) to mount long-range escort missions to protect their bombers against interception by preying fighters as well as German technological efforts in rocketry that led to the V-1 and V-2 rockets – precursors of modern day Land Attack Missiles (LAMs).

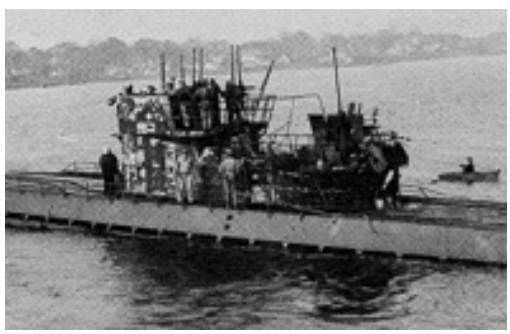
Even more striking is the observation that not all transformations are fuelled by radical technologies alone, but instead an amalgamation of changes in doctrinal concepts and organizational structures. Indeed, most revolutionary military advances have technological, organizational, and macro-social dimensions. The tendency is to focus on the tangible technical capabilities that typically underwrite military advances, which increase the lethality, range, and/or defensive capability of the military units that employ them. But historically, the organization and macro-social dimensions have been more significant for explaining dramatic increases in combat effectiveness. These periods of uncertainties and disruptive changes have traditionally favoured the strategic/operational offence as the military organization that embraces experimentation is conferred with the first mover's advantage. Employed correctly, experimentation becomes a crucial force multiplier that enables its wielder to effect major impact on an adversary at the operational/strategic level.

Up until 1941, the US saw its Pacific forces with its ports and airbases as deterrents, with the vast ocean providing a strategic buffer from potential adversaries in the Far East while she concentrated on the Atlantic battle. On the other hand, Japan was counting on the pressing war demands in Europe, and the rapidity of the first phase of her conquest, to make the Far Eastern situation more acceptable to her, or at least unchallenged by the US. In response to the Washington Naval Treaty[2], the Imperial Japanese Navy as well as the United States Navy would pursue their strategic objectives by diverting resources toward experimentation efforts using a new organization – applying air power from carrier strike forces. In the Atlantic, Germany unleashed its U-boats on the precarious cross-Atlantic oceanic

umbilical cord, terrorizing merchant shipping carrying aid from the US to Britain. Fortunately, Admiral Karl Dönitz only had ninety-one U-boats and could only maintain a few out at sea at any one time. The war's first four months have been described as the USN's worst defeat and an "unparalleled massacre"[3]. A staggering 2.5 million tons of war material were sunk in the Atlantic in the first four months of 1942 vis-à-vis the loss of only eight U-boats. Ultimately, the employment of escorts, better intelligence, radar and sonar, and air patrols turned the tide. The focus of Britain remained very much on battleships and cruisers – a myth that was sunk with the sinking of the then state-of-the-art battleship *Prince of Wales* and her cruiser escort *Repulse* by Japanese carrier-based aviation off the eastern coast of Peninsular Malaysia.

"I did not comprehend the violence of the revolution effected since the last war by the incursion of a mass of fast-moving, heavy armour. I knew about it, but it had not altered my inward convictions as it should have done."

Winston Churchill.[4]



German U-boats

In the land domain, Germany's military during the 1920s and 1930s focused much of their experimentation efforts on the problem of overcoming the operational stalemate coming out of WW I static trench warfare. Here, innovation in military technology was not the deciding factor. Pound for pound, the French had superior tanks compared to the Germans. That problem was solved with new and very different organizations, including the Panzer division working with strike aircraft, that were capable of rapid and deep penetrations into the adversaries' rear lines – *blitzkrieg*. The result was a spectacular operational and strategic loss for France, which even had allied assistance from the United Kingdom. Against combined military might of the two countries, the Germans had overrun much of France within two months, forcing the British Expeditionary Force comprising 350,000 men into a hasty evacuation back across the English Channel. Despite staring at ominous defeat in the face, Britain's radar network provided the means for early warning and effective ground control, allowing the RAF to gain air superiority over Channel in the Battle of Britain. The combination of radar, ground control set-up, and fighter pilots had effectively caused the Germans to shelve their invasion plan permanently with Churchill proclaiming, "Never in the field of human conflict was so much owed by so many to so few."

The 1991 Gulf War was a new turning point. Where air superiority had become a pre-requisite for land and sea operations in WW II, the continuing upward trend in development had reached the point where air superiority was the pre-requisite for winning the war. The decisiveness of air operations from the point of the initiative

and the final result of the campaign was proven with exceptional clarity even though Iraq possessed formidable forces with modern equipment and weaponry. What was lacking was the right philosophy of air warfare and an appreciation of the decisiveness of air power. Against the stunning combination of stealth, precision, responsiveness, and information technology, that attacked its centre of gravity simultaneously at all levels, the Iraqi leadership was systemically paralysed and condemned to losing the war.

Experimentation is not restricted only to military institutions. At the opposite end of the scale, terrorist organizations are also engaged in a similar process. Moving on from early means of armed struggle which involved small-arms conflict on a local scale, hijacking of airliners, and taking of hostages to exact propaganda value, these organizations have now evolved. Against the military might of conventional armed forces, terrorist organizations have started to weave asymmetric suicide bombing and mass destruction tactics into their repertoire of capabilities. The conversion of airliners into flying weapons of mass destruction in the 9/11 tragedy is a case in hand.

Is Experimentation for the 3G RSAF – The Pros and Cons

Properly wielded military experimentation can be a source of great competitive advantage, yielding great operational advantages and providing its practitioner with a management tool to optimize finite resources. The numerous characteristics and advantages of experimentation include the following:

- Reduce uncertainty with regards to the best way of meeting emerging threats.

Airforce Wargame System (AWS)

- Force structuring tool to determine the proper portfolio (i.e., mix and match) of investments in emerging and legacy systems. This avoids the "big bang" approach in defence capability acquisition and mass obsolescence.

- Enables militaries to diversify its portfolio of investments through the acquisition of options on emerging operations, which can be exercised (i.e., fully and rapidly developed) if and when a threat emerges.

- Complicate, to some extent, the planning of would-be enemies by developing access to a wide range of military capabilities and forms of operation.

- Enables innovation and transformation within limited means by helping to avoid:

  - Large-scale production of legacy forces that are declining in value.
  - Premature serial production of emerging systems.
  - Production of systems that may appear promising, but actually offer little in terms of military capability.

- Identify and solve the practical problems involved in developing new operations, force structures and systems that cannot be determined though studies and analyses alone.

Due to these characteristics, military experimentation continues to be relevant and all the more crucial during prolonged periods of high uncertainty and rapid technological changes. The RSAF must remain nimble in this highly dynamic environment, capable of dealing with the rapid advances in military-related technologies that seem likely to effect a RMA though dynamic leaps in military capability and effectiveness within a short period of time. On the other hand, RMAs are also characterized by great uncertainty with respect to new military systems, organizations, concepts of operation, and force elements that will emerge. Consequently, the potential for surprise is high during such periods, but the time available to respond to unexpected events is often small.

As a consequence, we cannot risk staying on the current path in the face of all the uncertainties that the 3G SAF/RSAF must be prepared for in a future that is marked by two certainties. Firstly, the incentive is high for our would-be adversaries to mirror our defence build-up efforts over the last twenty years and rapidly close the gap. Secondly, the proliferation of military technologies and rapid progression of military-related technologies will offer our would-be adversaries the means to achieve such a goal. Not only is the current path involving outright capability acquisition predictable, it can be easily nullified through acquisition of the corresponding counter-capability.

Experimenting with the Definition of Experimentation

The way we perceive and use military experimentation stems, in part, from how we define it. A survey of the literature shows that the definition of military experimentation has evolved over time. The earlier and more traditional definitions of military experimentation confined it within the domains of measuring effects and testing hypotheses. For example, David Albertse[5], Director of Research and Strategic Planning of the Office of the US Assistant Secretary of Defence once defined military experimentation as being made up of the following:

- Discovery experiments are conducted "to determine the efficacy of something previously untried".

- Hypothesis-testing experiments are used to advance knowledge by "seeking to falsify specific hypotheses".

- Demonstration experiments recreate known truth to "display existing knowledge to people unfamiliar with it".

More recently, militaries started expanding the scope of military experimentation to allow for the less-constrained "exploration" purpose. For example, the US Naval Studies Board (NBS)[6] defines Military Experimentation as a "military activity conducted not only to discover, test and demonstrate, but to also explore future military concepts, organizations, and equipment and the interplay among them, using a combination of actual, simulated, and surrogate forces and equipment". Such a definition underlies the importance of conducting experimentation to explore the unknowns and not just to test hypotheses which are predicated on something known.

F-16C/D OFT capable of simulating emergencies, weather conditions and setting up 500 different scenarios

In a similar vein but representing a more significant departure from previous practice, the Institute for Defense Analyses' (IDA) Joint Advanced Warfighting Program contends that the actual definition of military experimentation is not as useful as understanding that military experimentation is a learning process – one which supports discovery and invention – far more than it is a hypothesis-testing process that verifies theoretical cause-and-effect relationships. Their novel way of perceiving and using military experimentation see the use of military experimentation for the purposes of evaluation, goal-seeking and grand innovation:

- Evaluation: These experiments are conducted to measure the effects of proposed or newly fielded capabilities. They can also be used to measure relative performance so as to facilitate resource allocation decisions between competing projects.

- Goal-seeking: These experiments are conducted to improve the performance or overcome the deficiencies of a particular military capability.

- Grand innovation: These experiments are to provide the opportunity to observe military phenomena, to learn something about what is unknown and to generate questions. The exploratory nature of some experiments make it hard for hypotheses to be generated, instead heuristics are used.

So what can we conclude from this cursory survey of definitions?

Generally, the perception of military experimentation can be categorized into two broad schools of thought. The more traditional perception of military experimentation is that military experimentation are used to measure effects, test hypotheses and obtain tangible outcomes; in other words, to "answer" questions. In contrast, the 'grand innovation' school of thought expands the use of military experimentation to the area of unbridled exploration where more questions are "generated" rather than "answered". This generation of questions results in a heuristically-guided investigation which sits uneasily with many military planners as there are, normally, no immediate and tangible benefits in terms of enhanced military capabilities. However, the case for grand innovation is actually quite appealing.

There are broadly two reasons why grand innovation seems appealing at the theoretical level. The first is based on the principle that "we don't know what we don't know", and thus there are benefits in conducting exploratory-based experimentation. The second reason is based on the fact that a creative and innovative culture is required to cope with the dynamic environment we operate in, and grand innovation is one way of fostering such a culture.

Firstly, several militaries still embrace the view that experimentation is used primarily for measuring effects and testing hypotheses. However, military experiments cannot be designed in the classical, scientific, or statistical sense. These experiments are often too complex to boil down to the investigation of one or two variables that can be evaluated to accept or reject a hypothesis. In particular, in situations where there are many unknown variables, a more qualitative and exploratory-based experiment may be more appropriate to find out the unknown unknowns. In addition, transformation is never the result of a one-time improvement, but a sustained and determined effort. Military experimentation must thus be viewed as an "iterative process of discovery" which lends support to the idea of grand innovation.

Secondly, the environment we operate in is getting increasingly more complex. The spectrum of threats is widening. The pace of technological advancement is increasing. And the call to optimize resources is getting louder. What this means for the military is that its capability edge must be continually enhanced with increasingly less resources. Effectively, more needs to be done with less, and this calls for creative thinking, innovative ideas

and novel warfighting concepts. Grand innovation advocates that every experiment, no matter a success or failure, results in knowledge acquisition, especially so when it uncovers something we did not think about previously. By embracing such a philosophy, grand innovation can foster a culture of creativity and innovation.

Contextualizing Grand Innovation for the 3G RSAF?

So is Grand Innovation for the RSAF? Can we afford to engage in exploratory experiments which may generate more questions than answers? Let us analyze a few points.

The RSAF is undergoing a transformation towards being a 3G RSAF that is capable of delivering integrated, mission-level competencies for the SAF. What this also means is that the RSAF will face challenges of developing and assimilating new advanced technologies and hardware. At the same time, these technologies and hardware are ubiquitously available to potential adversaries, technologies change rapidly, threats adapt even more swiftly and warfighting concepts become obsolete more quickly. As such, maintaining a capability advantage over potential adversaries require several measures, amongst which, are innovative warfighting concepts which are not so easily copied or acquired. Capability superiority can thus be sustained through a culture of continual renewal and invention where the development of innovative concepts is supported by an iterative process of discovery, validation and assimilation. Military experimentation, perceived in a grand innovation manner, can inculcate a self-sustaining culture of ideas generation as well as provide an ideal tool to enable and risk manage the transformation process of the RSAF.

The second point revolves round the unique operating environment and dynamic demands faced by the RSAF. In the aftermath of the September 11th incident, the RSAF will have to adopt an enhanced vigilant posture at all times so as to contend with a widened spectrum of threats ranging from transnational terrorist threats to peace support operations (PSOs) to conventional war. In addition, with the global trend towards integrated warfare, the paradigm of air power is shifting towards one of influencing the surface battles by exploiting the air dimension. In line with this integrated warfare philosophy, the RSAF will have to innovatively develop structures, doctrines and concepts to be an integral force for the overall SAF. This is further compounded by the resource constraints of manpower talents, budget and airspace. Taken together, there is a need for the development and successful employment of innovative concepts so as to overcome the resource constraints and deal with the complex operating environment. Grand innovation facilitates this exploration and development of innovative concepts to solve difficult problems.

A third point is that grand innovation gives the perception that the military undertaking it is advanced and possesses innovative operating concepts. Experimentation gives a hint of advanced technologies and concepts and provides a mystique factor which enhances strategic deterrence. In our geo-strategic

environment, deterrence is of paramount importance and grand innovation goes a long way in enhancing it.

Experimentation can be used to measure effects, test hypotheses and grandly innovate. However, it must be kept in mind that experimentation is only a means to an end. Ultimately, the purpose of experimentation is to generate military capabilities that can be used by national leaders in pursuit of national interests. Innovation, by itself, does not win the war; but if harnessed properly, innovation and creativity can be translated into the generation of better warfighting concepts which facilitates the winning of war. As such, there is a tension in allocating resources between grand innovation to explore future concepts for transformation and hypotheses-testing experimentation to develop immediately applicable outcomes for capability development.

What can be concluded is that Singapore is a small country with limited resources. Our strategic environment necessitates a state of sustained vigilance and as such, a significant amount of resources must be channelled to maintaining this state of high operational readiness. However, at the same time, the RSAF needs to transform to meet future challenges better. There is thus a need for a balance of both hypotheses-testing experiments to answer questions as well as grand innovation-type experiments to generate questions. Through the complementary use of these two broad types of experimentation, the RSAF will be able to harness ubiquitously-available technology to enable a sustainable capability edge.

Conclusion

This essay agrees with the general consensus that military experimentation is only a means and not an end for military capability development. However, we believe that more leeway should be given to the use of experimentation. Specifically, experimentation should no longer be used just to "answer questions" through hypotheses-testing and effects-measurement. Instead, experimentation can and should be used to "generate questions" so that greater inroads into the unknown unknowns can be made.

It is believed that having a complementary mix of experimentation to "generate" and "answer" questions would inculcate a culture of dynamism and flexibility which is able to better deal with the complex operating environments. Military forces are inherently complex non-linear organizational systems and such small incremental changes in individuals' attitudes and perceptions of experimentation can produce quantum leaps in capability development over time.

Endnotes

1 John A. Lynn, "The Evolution of Army Style in the Modern West 800 – 2000", *The International History Review*, Aug 1996, p509.

2 Ratified at the Conference on the Limitation of Armament on 6 Feb 1922, the Washington Naval Treaty restricted the major naval powers during the era from constructing newer and bigger battleships. Aircraft carriers were also separately addressed within the Treaty. However, it was not evenly applied and some countries were more constrained in terms of tonnage than others.

3 Eliot Cohen and John Gooch, *Military Misfortunes: The Anatomy of Failure in War*, (New York Free Press, 1990), p59.

4 Winston Churchill's 1949 admission is typical of many military observers of the interwar period.

5 Co-author of *Code of Best Practice for Experimentation*.

6 *The Role of Experimentation in Building Future Naval Forces* (2004), Naval Studies Board.

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Making A Difference: RSAF's Role in Peacetime Operations

by LTC Chin Pak Chuen, LTC Gan Siow Huang & MAJ Ng Sin Kian

Introduction

Over the last decade, we have seen the employment of air power in many operational scenarios other than hot war. The new security environment had compelled governments and international organizations to use armed forces differently to achieve new security objectives. Rather than fighting conventional wars, armed forces of many nations have begun, mostly by necessity, to reconfigure themselves to deal with the new demands of unconventional warfare, homeland defence and peace support missions. Air power has similarly evolved to contribute to these new missions and operational requirements.

Homeland Defence

The events of 9/11 had triggered the most significant change in the use of air power. Right after the attack on US homeland, the North American

Air Defence Command (NORAD) had sealed off the airspace of the United States, giving new meaning to the term "homeland air defence". Fighter crews were trained not only to engage other fighter aircraft in combat, but also to engage any aircraft that poses a threat to the nation's buildings and infrastructure. Similarly, military air traffic controllers and ground-based air defence units have adapted their operating procedures to deal with these unconventional threats.

The air forces of many nations have since adopted this operational requirement to safeguard territorial airspace as one of their core missions in peacetime. To this day, this mission of guarding territorial airspace has not only continued, but also expanded to include the use of air assets in securing borders and territorial waters. In the United States, agencies such as the US Coast Guard and Border Patrol had stepped up the use of air assets such as helicopters and light fixed wing aircraft to patrol both maritime and land borders. In the future, long endurance unmanned aerial vehicles (UAVs) may take the place of manned aircraft for these missions.

Air power has also proven its utility in related missions such as counter-proliferation and anti-smuggling, especially in countries with long and isolated borders. Aircraft, when coupled with the appropriate surveillance equipment, is the ideal platform to detect and counter speedboats and other vehicles of choice of smugglers.

UN Peace Support Missions

UN interventions in volatile areas such as the Balkans have depended on highly mobile forces with good intelligence on the ground; two key operational requirements which air power is well placed to fulfil. To these peacekeeping or stabilization missions, air power is also the key to control of the air, the sustenance of deployed forces and the effective patrolling of large swathes of territory.

One illustrative example was the NATO-led Stabilization Force (SFOR), which had been deployed in Bosnia and Herzegovina from 1995 to 2004 in what was essentially the alliance's first peacekeeping mission. The air assets of SFOR had been used in new and innovative ways. NATO fighters in conjunction with surveillance aircraft have been patrolling the skies to enforce no-fly zones and monitor the movement of major ground units of the belligerent forces. These efforts had helped to quell further violence in the volatile region and facilitated the peace process. Air assets were also indispensable to rapid deployment units. Besides ferrying supplies and troops, Chinook helicopters had allowed the British Gurkhas in SFOR to maintain a round-the-clock riot control response.

NATO aircraft patrolling the skies over Bosnia.

Humanitarian Assistance and Disaster Relief (HADR)

The recent tsunami and earthquake disasters that hit Indonesia and the surrounding region highlighted the key roles that air power plays in humanitarian assistance and relief efforts. Airlift assets such as tactical transport aircraft and helicopters proved to be instrumental in transporting large amounts of aid material and disaster relief teams to the affected areas quickly. Helicopters were frequently the only transportation platforms that could reach into areas that had been rendered inaccessible due to the complete destruction of the local transport infrastructure. The US Pacific Command sent the aircraft carrier *USS Abraham Lincoln* and amphibious assault ship *USS Bonhomme Richard*, both of which carried large numbers of helicopters onboard. The French Navy dispatched the helicopter carrier *Jean D'Arc*. The Republic Singapore Air Force (RSAF) contributed Chinooks and Super Puma helicopters, among other essential rescue and recovery elements, to the relief efforts in Thailand and Indonesia.

The demand for air mobility assets, helicopters in particular, was clearly evident in the latest relief operation in September 2005, after Hurricane Katrina hit the southern coast of the US and caused catastrophic damage to the states of Louisiana, Mississippi, and Alabama. The RSAF acceded to the request of the US Government and deployed up to four Chinooks to aid in the relief and rescue efforts in Louisiana. These aircraft and crew were part of a long-standing RSAF Peace Prairie Detachment in the neighbouring State of Texas, and together with their Texas Army National Guards partners, deployed in-theatre and assisted in various missions – from search and rescue of stranded civilians, and resupply of food, water and medicine, to underslinging of sandbags to repair the damaged levees.

RSAF Chinook providing aid during Hurricane Katrina relief operation in Louisiana, USA.

Indeed, the importance of air mobility has been so crucial in peace support and humanitarian and disaster recovery (HADR) missions, that one of the key drivers of transformation in many armies is to create forces that are light enough to be transported and sustained by air. The Airmobile Brigade, staffed by British and Dutch forces, is a prime example of such units.

Importance of Air Power in Peacetime

The application of air power in peacetime is important from three perspectives. At the national level, demonstration of air power and other military capabilities is one of the most effective ways of projecting *deterrence*. Air power, being highly flexible and responsive, can also be used in humanitarian and disaster relief operations, thereby allowing a country

to extend its *defence relations* with others. Further, as air power plays a critical role in peacekeeping operations, peace support operations and maintaining national security, it contributes towards regional stability.

Promote Regional Stability

Air power's utility in peacekeeping and peace support operations has been witnessed in numerous operations in the last ten years, the most recent one being Operation Enduring Freedom. Being part of the military force, air power serves in peacekeeping to help preserve a fragile peace and discourage further conflict. Air power can enhance both effectiveness and efficiency as peacekeepers perform their many tasks. Although measures of effectiveness are extremely difficult to define in peacekeeping, there is little doubt that one can accrue benefits and advantages from air capabilities. The synthesis of air-enhanced communications, mobility, and force protection will greatly assist peacekeeping tasks. The latter include armistice observation, preservation of law and order, guarantee of right of passage, interposition of buffer forces, show of force, and supervision of disputed territories, withdrawals, Prisoner of War (POW) exchanges and cease-fires. The humanitarian airlift operation in Bosnia, and employment of airborne C2 assets to coordinate fighter escort and identification of threats provide examples of the potential of fusing various air power assets[1].

Source: www.aseansec.org

Importance of regional security to Singapore.

It is in the interest of Singapore to do what we can to promote regional peace and stability. Regional instabilities will have a direct impact on us – investors' confidence will be shaken, there may be fallout from lawlessness and poverty in terms of illegal immigrants, piracy and other security problems. Thus we need to do our part within the constraints of our limited resources. Otherwise, the affected area may sink into anarchy and chaos, and taint the whole region. If the UN is not here, the burden will fall on the regional countries, including Singapore.

Deterrence

Demonstration of air power in peacetime can be viewed as a means of deterring potential aggressors. While the Singapore Armed Forces (SAF) prepares and trains for conventional war, our primary strategy is to use deterrence and defence diplomacy to prevent an outbreak of war. In this regard, air power has an important role to play in both peace and war.

For peace enforcement type of operations, one of the primary advantages of air power is the improvement of overall efficiency, which would bolster deterrence against breaking a fragile peace. First, air power's ability to closely monitor the situation through electronic means and to move personnel over vast distances could discourage disputing parties and factions from attempting

to disrupt the peacekeeping process. Second, air power's ability to quickly provide show of force could help diffuse potential hostilities. Third, the ability to provide intelligence sharing could lead to improved trust and confidence among disputing parties. Finally, the presence of air assets could provide tacit deterrence when disputants recognise the ability of these assets to quickly change peacekeeping into peace enforcement. Countries or terrorist organizations with hostile intents may also be deterred by a strong peacetime showing of a nation's readiness.

Defence Relations

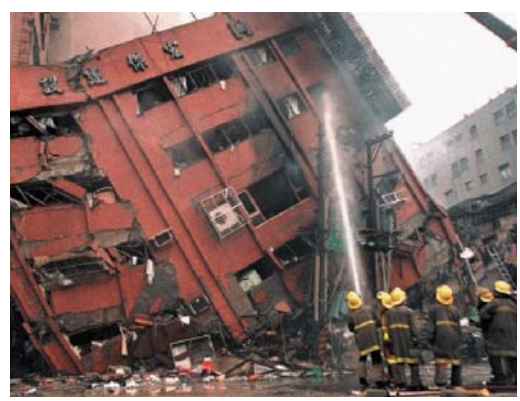
It is important for small countries like Singapore to build up a reservoir of international goodwill and to enhance our standing as a responsible member of the international community. It is also in our interest to support the UN in promoting order, behaviour and international norms that are congruent to the interests of small states such as ours.

To this end, the military's strengths can be leveraged upon to serve the wider purpose of defence diplomacy. Together with the Army and Navy, the Air Force enables nations to contribute in international peace efforts and directly foster defence relations among defence forces. For instance, airlift and aeromedical evacuation operations sustain lives and confidence in peace operations, and humanitarian airlifts help to hold at bay the fractious forces of famine, illness, and disaster. Using air power to enforce no-fly zones in an intervened state, for example, contributes to the environment of stability by restraining violence. While contributing towards regional safety, participation in these areas also promotes transparency between the militaries, thus promoting greater cooperation and healthy relations[2].

Indeed, the SAF's contribution to peacekeeping operations has elevated our professional standing in the international community. For example, in 1999, the SAF worked closely with the Taiwanese authorities to aid in the rescue of earthquake victims. The SAF's contribution in the Tsunami Disaster Relief Operation has deepened our friendship with our neighbouring armed forces. More recently, our assistance in the Hurricane Katrina relief operation has also re-affirmed our strong friendship with the United States.

The RSAF Advantage in Peacetime Operations?

The traits that normally characterize peacetime operations may include



1999 Earthquake in Taiwan – RSAF air transported personnel and equipment to assist in recovery efforts.

several of the following: situational uncertainty; unstable or evolving environment; short response; remote or difficult terrain; complex circumstances; difficult Rules of Engagement (ROEs); multilateral cooperation. The RSAF is the force of choice to respond to several of our peacetime operations, whether as a complete force package or as a part of a joint force with our sister Services or other national agencies. The RSAF is able to meet such wide-ranging demands because we possess two important characteristics: having the right virtues and the right organization.

Right Virtues

The enduring virtues of air power are speed, reach, flexibility, precision, and mobility. One of the main reasons why the RSAF plays such a dominant role in peacetime operations is that these are the exact virtues that are needed to respond to the demanding traits that characterize peacetime operations.

In physical terms, air platforms are the fastest vehicles today and these are unbounded by terrestrial obstructions. As a weapons platform, such as our fighters and attack helicopters, the RSAF is able to bring an array of firepower to bear on a hostile target in a matter of seconds, if necessary, during counter terrorism operations. As a transport platform, such as our C130s and lift helicopters, the RSAF is able to deliver critical payloads or forces swiftly into virtually any theatre of operation. Therefore, the weapons and transport platforms of the RSAF indeed play a crucial role in time-critical operations where speed and responsiveness are key factors in operational success.

The RSAF indeed has reach, as proven in the recent series of tsunami/earthquake relief operations around the region. The RSAF is able to support the conduct of large-scale relief work thousands of miles away from the home base, into remote areas like the town of Meulaboh that initially had no land or sea access. The air bridges created in-theatre were key enablers of the relief efforts. The inherent tactical flexibility in air operations also allowed assets to be swung from one theatre to another overnight, as demonstrated from the redeployment of helicopters from Phuket to Medan to respond to the evolving situation there. Meanwhile, our continued air delivery of relief supplies to places as far-reaching as Sri Lanka is testament not just of RSAF's reach but operational capacity to conduct large scale peacetime missions as well.

Finally, one of the most deep-rooted virtues of the RSAF that is most desired in peacetime operations is its emphasis on operational safety. The RSAF has a well-established safety culture that has been ingrained into everybody,

Relief supplies loading on RSAF C130 bounded for Meulaboh.

from the Chief of Air Force down to the individual airmen. Safety processes are established in every functional area, such as policy-making to mission planning, and operational management to tactical execution. The RSAF boasts one of the best safety records among other airforces in the world. As more peacetime operations are conducted, its personnel will bring with them safety processes that will enhance the operational safety of the missions, minimizing further attrition of lives and damage to property as the operations continue, and bring confidence and assurance to the overall community involved in such operations.

Right Organization

Effective command and control is central to all successful military actions, and unity of command is central to the unity of effort in every mission[3]. Likewise, a well-established and pervasive command and control structure is critical to the success of peacetime operations. Such a structure will overcome the cloud of uncertainty that usually form around massive peacetime operations, where there are many agencies working in-theatre, and communication infrastructure may have been damaged or is unreliable. The RSAF organization is deep-rooted in the concept of centralized command and control, and decentralized execution. In addition, the strong communication linkages between its deployed units and operational HQs back home ensure good overall situational awareness. Therefore, with strong and robust links back to home base, RSAF forces are deployed into theatre with full situational awareness of what is happening, what is needed to be done, and how theatre-level operations can be systematically conducted.

The RSAF's extensive network of linkages to numerous agencies during peacetime makes the organization an ideal and ready partner in crisis management. This is reflected in its strong connection within the SAF with the sister Services; within the homeland structure with security agencies like Police and SCDF for homeland security matters; with medical agencies like hospitals for air-evacuation processes; and with aviation agencies like the Civil Aviation Authority of Singapore (CAAS) for civil aviation matters. Very importantly, our global diplomatic engagement outlook allows us to connect well with airforces from other countries; from regional countries for relief operations, to more sophisticated airforces like the US and Australian airforces for peace support/keeping coalitions. We interoperate with and engage them frequently and regularly. Issues relating to deployment have been ironed out with the frequent training deployments of our people and assets overseas. Other than permanent training detachments in the US, France and Australia, the RSAF also has numerous deployments to other countries, from Thailand to as far as Canada for training exercises. Resolving issues related to overseas deployments has become second nature to RSAF personnel and this is a valuable attribute when operating in a real crisis, where there is little time for reactionary or forward planning. Overall, our familiarity with inter-agency dynamics in a multi-force environment put us in good stead for peacetime operations, in which we can

put the otherwise additional burden of establishing contacts and work processes aside, and immediately focus our attention and resources in the actual peace operations from the onset.

Another important facet of the RSAF's organization, is its structure as a "modular" organization that can operate in scalable, modular groupings. This so-called "plug and play" nature allows it to be task-organised quickly to support differing needs in differing profiles of peacetime operations. Specific forces can be quickly right-size to deal with various situations.

In order to conduct any peace operation, a force needs to be equipped, protected, and sustained. The RSAF is well-equipped to do all these for any force it deploys. It can also operate under the gambit of a joint force, and extends the equipment, protection and sustenance support to that force. In today's context, joint force deployment for peacetime operations is likely to be the norm rather than the exception, as can be seen in the recent tsunami relief missions. The RSAF's success in these tri-service missions shows the preparedness and competency to participate as an integral component of a joint force in any peacetime operation.

RSAF in joint operations: Joint Task Force Commander interacting with RSAF personnel.

The Way Ahead

While the RSAF may possess the right virtues most needed in peacetime operations, and has the right organizational outlook through its extensive global and national networks of engagements, its current structure is nevertheless designed for the defence of the nation, and not for the support of peacetime contingency operations. This is evident in its mission statement: that the RSAF is "a crucial part of the overall SAF's mission to deter and to win a swift and decisive victory if deterrence fails." In order to truly transform the RSAF into a full spectrum force and triumph over the brave new world of peacetime operations as effectively and efficiently as the defence of the nation, changes in three key domains will have to be effected: operational mindset, organizational structure, and training.

Operational Mindset

As the saying goes, the first step in the introduction of a fundamental change in any organization is the adoption of the right frame of mind by its people. In the conduct of peacetime contingency or military operations other than war (MOOTW), some of the key principles like restraint, perseverance, and legitimacy, can be very different as compared to principles like offensive, surprise, and mass, required in the all-out war scenario[4]. The operational mindsets of RSAF personnel will have to adapt to these differences. For instance, in peacetime

contingency operations like the tsunami relief operations, the considerably greater participation of civilians and non-government organizations and relief agencies is a common sight. Working shoulder to shoulder with non-military relief agencies, RSAF personnel need to understand and give due consideration to their working culture in order to contribute more efficiently as a civil-military combined community in giving aid and relief services.

RSAF personnel working shoulder-to-shoulder with NGOs.

Another example is in the RSAF's participation in peacekeeping operations in places like Iraq or Timor Leste. Under such complex circumstances, RSAF's personnel are often provided with stringent sets of ROEs, for their interactions with different groups of people in the area of operations. ROEs are usually designed to encourage restraint and minimize the possibility of accidents and misunderstandings that might lead to an increase in violence. As important as they are, ROEs are only as effective insofar as they can be understood and applied by forces carrying out the peace operations[5]. Therefore, the RSAF takes great pains to ensure that the commander's intent is formulated and explained to the forces on the ground, so that they will be better able to apply the ROEs to meet the objectives of the commander and the organization as a whole. While ROEs must be clear, the requirement for restraint demands greater judgement on the part of the individual. This consideration may go beyond that which is required in a more conventional war scenario.

Organizational Structure

The existing organizational structures of many airforces are primarily built for handling hot war operations. With the growing applications of air power in non-conventional operations, there is an impetus for airforces to restructure to be even more effective in planning and executing MOOTW missions[6]. Specifically, restructuring may be necessary to ensure adequate resources are devoted to develop such capabilities in operations. Restructuring is especially important, given the increasing demands to sustain these operations over extended periods of time.

In the case of Singapore, tight integration between the Ministry of Defence and other ministries such as the Ministry of Home Affairs will facilitate better coordination of counter-terrorist efforts. As part of the larger SAF set-up to deal with post-9/11 type of scenarios, the RSAF needs to establish a specialized command and control structure at the headquarters to undertake all the necessary planning,

coordination, and control requirements with the other sister Services within the SAF, as well as with external agencies like the Police, SCDF and CAAS. This command structure will become the "one-stop agency" for all these external agencies and the other Services in the SAF.

Training

While highly conversant in professional skills needed in an all-out war scenario, RSAF personnel in general may not be equally conversant in skill sets specific to peacetime operations, like having a firm grasp of the power and boundaries of the various ROEs. Structured training in appreciation of ROEs will enhance the personnel's understanding and familiarity of these important peacetime rules. Another aspect that can be trained is cultural understanding of the community within the areas of operation, and that of typical Non-Governmental Organizations (NGOs) like the United Nations and international aid agencies. The importance of cultural understanding is often understated. Not only will a clear understanding of cultural norms facilitate better awareness and working relationships, it is often the primary factor that determines the level of local support that one receives and that could make or break the mission.

In addition, RSAF personnel need to be trained in managing the media. Media participation in peacetime operations is the norm in today's world. It is important to train deployed personnel to interact effectively with the media community to provide constructive media interviews and updates, so as to help build consistent national consensus and favourably shape public opinion.

Conclusion

As with the US military[7] and other advanced armed forces, the conduct of peacetime operations by the RSAF has moved from being a "peripheral" task to one of the most important and critical missions of the RSAF today. The array of peacetime operations spans across a wide spectrum of operating conditions and environments, and is always characterized by uncertainty, unfamiliarity, and fluidity. The RSAF, through its ingenious application of air power, has demonstrated its core significance in peacetime operations, in being able to project deterrence, extend defence relations, and contribute to regional stability. The RSAF makes a significant difference in almost every peacetime operation because it triumphs over the adverse conditions in peacetime operations by its right virtues of speed, reach, flexibility, precision, and mobility, as well as through its inherently flexible organizational construct. Finally, in order to soar to even greater heights in what will be the RSAF's brave new world in the domain of peacetime operations, the RSAF needs to transform the operational mindset, organizational as well as training structures. The RSAF will continue to develop new doctrine, tactics, organizations, and procedures, to be better poised to confront the ever increasingly complex challenges that characterize peacetime operations in the future.

Endnotes

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Optimizing Learning in the 3rd Generation SAF

by LTC Karuna Ramanathan

Introduction

It is now common knowledge that the world will continue to change at an unprecedented pace, and for the Singapore Armed Forces (SAF), this translates into an immediate need to adapt to a dynamic operating environment, and correspondingly, a faster shift in operating culture, processes and attitudes. Just like we increasingly acknowledge that warfighting in the new world will be small, anonymous, borderless, quick, and difficult, the corporate world also has a similarly new frontier, where knowledge beckons as a possible fifth factor of production. The changing landscape, both for the military as well as the corporate world, is the inevitable consequence of the rapidly maturing information age.

As this new world unfolds, its suddenness suggests that it may not be enough to adjust current structures to

accommodate change. Transformation has been exalted as the new order and the 3rd Generation (3G) SAF will demand knowledge warriors: adaptive individuals who, with a deeper sense of core values, seek to optimize technology. Our people will be thrust into increasingly joint, dynamic, complex and uncertain environments, with little or no reference, prior examples or model answers, other than their own intuition and experiences. Our recent experiences in East Timor and Aceh as well as the ongoing operations in the Gulf attest to this new challenge.

This article surfaces learning possibilities within the SAF to prepare our people for change in this 3rd Generation military force.

Re-balancing Training Time

SAF personnel graduate from vocational training in initial years, into specialist training and general military education, to prepare them with the knowledge, skills and attributes to function effectively as leaders and team members in "joint" environments. The current lacing of the training system with competency based learning methodology is a bold step in the direction to produce leaders and thinking soldiers, sailors and airmen.

In the SAF, we regard training as the instruction of personnel to enhance their capacity to perform specific military functions and tasks. Unit(s) training exercises are also conducted to enhance combat readiness[1]. Therefore training extends beyond the schoolhouse to the units, where training cadres implement operational training programmes for individual and team training.

Certification to perform is the predominant concern in training, and structured programmes are designed to evaluate specific learning outcomes through individual and team assessments based on ideal performance benchmarks. Through participation in defined curriculum and systematic instruction, formal learning is assumed during training events. Much of our vocational training is carried out in this format. As a military force structured to operate in dual environments, the peacetime preoccupation of the 3G SAF will continue to be in training. Individual training provides the foundational knowledge and skills which our people will go on to build during field exposure.

Education is the development of human faculties and powers through instruction and experience. In the 3G SAF, education will centre on the three areas of learning to learn, creativity and thinking. Military education will equip SAF personnel with cognitive capacities, desired behaviours and attitudes. The intention is to develop adaptive and generative capacities, to enable them to think on the job, enhance their situation awareness and appreciation, and to equip them with common subject meanings. As an example, the teaching of Effects Based Operations (EBO) methodology is part of the education to equip planning staff with a common language and thinking format to plan in a joint environment. In education, much of the learning occurs at the informal and incidental level, when individuals interact with one

another to socially construct common meaning to address cognitive gaps.

What we will need to re-balance for the future is the preparation of our personnel to operate in complex and dynamic environments, as traditionally narrow training approaches will not be adequate to nurture these new competencies. In the 3G environment, we will be challenged to demonstrate adaptability and knowledge creation, whether in the use of EBO methodology during conflict management, or in multi-agency or coalition arrangement in peacetime operations. A broader military education, anchored in values inculcation, and emphasizing jointness and service and inter-ministry interoperability, will prepare our people to perform effectively in the future workplace. Much of middle and higher level officer curriculum is currently being reformed as *education*, and the emphasis realigned on construction and discovery as opposed to instruction.

Infusing Jointness

The emphasis on jointness calls for the systematic infusion of jointness into our training and education programmes. Though the SAF will continue to be organized around service centricity, jointness in our context will be premised on distilling common knowledge, behaviour and meaning in order that SAF personnel develop a common organization identity. This requires the instituting of SAF values and leader traits, common language, common methods and frameworks, and the facilitation of social networks for personnel from the three Services to come together at key touch points to develop bonds of mutuality and trust.

This suggests a departure from conventional training models that advocate Service attendance at common courses. The SAF cannot afford to do this for all levels, given our SAVER[2] and Premium Plan[3] contexts. As an alternative model, joint packages ranging from the awareness levels to the planning and doctrine levels could be systematically introduced into Service-run courses to facilitate effective transfer of common SAF knowledge and procedures.

Optimizing Schoolhouse Time

For officers in particular, given shortened SAVER careers, the time spent in the schoolhouse will need to be optimized in order that the posting cycles can be maintained. On average, most SAF officers will spend up to 30% of their careers in schoolhouses. While this may be regarded as relatively high, it will be helpful to think of the training time as "double-dose"; training to be

ready and prepared for conflict – from a peacetime workplace.

So this 30% can be interpreted as necessary time required to build operational readiness although we need to ensure that such time is spent optimizing learning strategies. Internal to the SAF, we should invest in indigenous capability to develop learning and teaching strategies that will be optimal for our unique context. However, such expertise usually resides outside SAF, and we will have to ensure that purchases of these expertise are based on demonstrated value.

In addition, the SAF will need to continue to leverage on technology to make available non-residential alternatives to counter increasing requests for time away from work to attend schoolhouse courses. In positioning SAFTI Military Institute (MI) as a knowledge repository to optimize learning for the SAF officer population, technology can be leveraged upon to reduce the knowledge latency currently separating doctrine and instruction. Such a repository could be made available to the officer in his workplace, in order to reinforce learning opportunities, and to support continuous learning.

Modular and on-demand courses based on *just-in-time* requirements (as compared to the current *just-in-case* structures) will also provide for time optimization. A faculty approach to managing the instructor pool in SAFTI MI will facilitate such laterality. In time to come, SAFTI MI faculty could be tapped for the Specialist and Warrant Officer Institute (SWI), and vice-versa. The faculties in both SAFTI MI and SWI could be seen as knowledge sources, rather than instructors. In similar fashion, inter-service knowledge access will be made possible through service repositories rich in updated content.

Common Language

Confucius, when asked what he would do if he ruled a country, said that his first act would be to 'fix the language'.[4] In moving towards jointness, the unification at the conceptual level for common meaning can be through common language. As the SAF begins to institutionalize effects based operations at the higher tactical and operational planning levels, the language used to analyze, debate, derive and review the effects must permeate to the various levels in the schoolhouses, as it will prepare our people to recognize common meaning through common language. A deliberate effort to infuse EBO language into the corners of the SAF will yield near term returns.

Workplace Learning

McKenzie asserts that what people learn about their work role in an organizational context is often a direct result of how they learn it.[5] It is tempting, in our already over-taxed workplaces, to continue to look for ready examples of what was accomplished earlier, in order not to reinvent the wheel. This attitude is, to a large extent, driven by earlier acquired behaviour; notably in schools that promote exam preparation through referencing ten-year series. Even in local universities, undergraduates are hand-

held with past exam papers that provide summaries of must-study topics.

In SAF schoolhouses, exam repetition has long been a norm allowing format, content and scope to remain fairly consistent over the years. This perpetuates the ten-year series mentality that arguably finds its way into the workplace. In largely static environments, such an orientation will undoubtedly contribute to workplace efficiency.

What will be required in the 3G workplace would be to develop in our people a certain degree of "knowledge hunger", a sense of inadequacy, such that the individual will continuously construct his knowledge base at work.

In dynamic environments of the 3rd Generation, such attitudes could contribute towards confusion as the workplace grapples with shifts in context and conditions. What will be required in the 3G workplace would be to develop in our people a certain degree of "knowledge hunger", a sense of inadequacy, such that the individual will continuously construct his knowledge base at work. In order that the SAF worker of the future can indulge in such continuous inquiry, he should, not only be exposed to such initiatives as Organizational Learning, but the methodologies and structures in our schoolhouses must also be realigned to reward new thought and to discourage the "DS (or Directing Staff) solution". One way to do this would be to clearly differentiate between information and knowledge. Much of what has been repeated in the past should be treated as information, whereas new thought should be promoted as possible knowledge sources to be internalized by the individual.

Legitimizing Alternative Opinion

> "One sensible operating rule is that whenever organizations adopt one prescription, they should adopt a second prescription which contradicts the first. Contradictory prescriptions remind organizations that each prescription is a misleading simplification that ought not be carried to excess". [6]

Dewey[7] (1954) and Kuhn[8] (1970) have put forth the argument that all knowledge development rests on *unity* of interpretations. Yet learning, which is also the development of new knowledge, is based on *diversity* of interpretation[9]. What this means for the SAF is that we will need to be increasingly aware of the need for our people to both agree and disagree.

For instance, in the 16-step Battle Procedure, there exists the necessary format to question and put forth alternative opinion, which could result in a radically different Own Course of Action (OCA). As a contradictory prescription, the other OCA serves as a constant reminder to the oversimplification of the situation. In agreeing to pursue one OCA, a consensus is built by the planning group through shared frames of reference, as the group learns collectively through the planning process.

In a dynamic environment, we may have to be aware of the danger of entrainment, as Mary Douglas (1966) points out:

> "...whatever we perceive is organized into patterns for which we the perceivers are largely responsible... As perceivers we select from all the stimuli falling on our senses only those which interest us, and our interests are governed by a pattern-making tendency, sometimes called a schema. In a chaos of shifting impressions each of us constructs a stable world in which objects have recognizable shapes, are located in depth and have permanence... As time goes on and experience builds up, we make greater investment in our systems of labels. So a conservative bias is built in. It gives us confidence."[10]

Collective learning is not simply the sum of individual learning effort. It requires groups of people to adopt the contradicting practices of generating diversity and building consensus. In a peacetime military decision making environment, inquiry, or the act of asking why, is arguably a difficult attribute to surface. Traditional military values systems reward conformance and non-questioning "just do it" orientations as positive demonstrations of discipline and in-system behaviour.

In the 3rd Generation, as diversity of opinion is increasingly recognized as necessary for creative solutions, one must also question the legitimacy of alternative opinion in the SAF. In addition, while alternative opinion flourishes in loudly democratic Western models, Asians are nurtured in somewhat less noisy and conservative environments. So it may take us a while in the SAF to cultivate such inquiry and expression of alternative opinion – and a good place to start would be the non-attributable training environment. Over time, such attitudinal change could transfer to the workplace.

Snowden (2002) in his discussion on sensemaking, cautions us on the preoccupation with the assumption of order:

> "…that there are underlying relationships between cause and effect in human interactions and markets, which are capable of discovery and empirical verification. In consequence, it is possible to produce prescriptive and predictive models and design interventions that allow us to achieve goals. This implies that an understanding of the causal links in past behaviour allows us to define "best practice" for future behaviour. It also implies that there must be a right or ideal way of doing things."

The assumption of order is a necessary and efficient outlook for structure and stability. In the dynamic 3G environment, the intervention for own advantage questions the validity of this assumption.

Continuing Education Opportunities

Davenport affirms that education builds human capital the way fertilizer grows plants, and that more education means more capital to invest and potentially greater returns on investment[11]. For long, the SAF, just like the public sector, has been regarded as an iron rice bowl. Lifetime employment however can no longer be the anchor for human capital in the SAF. For the SAF to retain its current attractiveness as an employer of choice in the 3rd Generation, two issues concerning education will require reconciliation – first degree qualifications in the early stages of career, and postgraduate qualifications to facilitate successful transition.

First degree qualification is a common aspiration of many in the current generation, and will continue to

preoccupy youth in the next generation. Presently around 40% of the SAF officers are granted sponsored study within the first years of their career. As we continue to attract more university eligible officer cadets, these numbers will likely increase, and could result in a much higher percentage of graduate officers if we keep to the current system.

As a principle, it will be difficult to argue against an all-graduate SAF officer corps, though specialized vocations like pilots and divers would form the exception. An all-graduate officer corps would also inject the necessary market creativity to refresh existing management structures with new concepts and approaches. A quick glance into the local classifieds ads will affirm the prerequisite of a degree in order to enter the job market at the executive level.

SAF Officers aspire to academic upgrading.

However, it may not be optimal for the SAF to grant all university eligible applicants their requests for study, for reasons of budget and manning. If there is a perception of competition for study places in the SAF, then aspiring applicants may weigh their options elsewhere. Therefore, we will have to look for creative options to afford all SAF personnel who qualify for local university, the means to pursue their aspirations. This could mean seeking distance learning and non-residential options for them to pursue first degrees while continuing to work.

A higher state of education in an individual promises a higher yield in an individual to an organization. It also nurtures lifelong and continuous learning attitudes, though some may prematurely argue that night classes and e-education could result in distractions in the workplace. In fact, on the contrary, a five-day workweek could encourage further study.

Later in their careers, SAF officers will be increasingly concerned with transition. Middle and upper management job positions today require postgraduate qualifications and aging SAF officers will increasingly look towards equipping themselves to facilitate transition. To guard against distraction, accreditation may be the way to help officers acquire postgraduate qualification. Indeed, accreditation not only provides officers with a shorter route to postgraduate qualification, the SAF also benefit when the officer recommits his newly acquired skills and knowledge to the workplace. With the recent liberalization of SAVER funds for education, this is an immediate possibility.

SAF Learning Architecture

The SAF could look into the following sub-systems to reposition learning, training, education and development:

a. ***Learning Needs*** To determine why and when we learn, it is necessary to differentiate the three models of learning and the assumptions and instructional approaches that come with these models. From research, the predominant learning models are essentially the classical *Absorption model*, on which our training development system is based; the *Behavioural model*, on

which approaches like competency-based learning is premised; and the more recent *Cognitive model*, which is strengthened by the emerging research on knowledge acquisition and construction. As we investigate these models, a broader view of learning will emerge and this will facilitate a wider understanding of learning needs and intervention strategies by the training community.

b. ***Performance Requirements*** Learning at work and about work should be based on an organization's performance expectations interwoven with the individual's interpretation of these expectations. The systematic translation of these expectations will allow for the closer alignment to individual expectations, and should offer higher performance outcomes. And if in the SAF we are able to facilitate higher performance outcomes in the workplace, then the training efforts will be further justified.

c. ***Design and Transfer*** Systematic investigation of learning needs and performance requirements will allow for constructive design strategies to facilitate knowledge transfer. For training design, the current SAF training development system will need to be strengthened in two areas: the rationalization of needs analysis to address actual workplace requirements and performance gaps, and the provision of suitable design templates, either electronically or manual-based, to facilitate expedient and frequent use.

Lastly, the faculty development system will have to be formalized, and this will include the suitable preparation of instructors to undertake both design and delivery of knowledge to learning audiences.

Conclusion

The changing security landscape and operating environment necessitate a shift in human capital development, and this calls for suitable interventions to be made in the training and education domains of the SAF. In the revamped learning system, the SAF will need increased dosages of joint packages in vocational and specialist courses to meet the need for interoperability at working levels. Our officers will be increasingly exposed to education efforts in order to nurture the capacity to think and adapt. In similar fashion, a review is currently in progress for Warrant Officer training and education, led by the newly created SWI. What is left to be seen, however, is to what extent we will carry the transformation forward whether we boldly change structure to deal with a new tomorrow, or we temper the radicality, acknowledging in the process that each approach has its own merits.

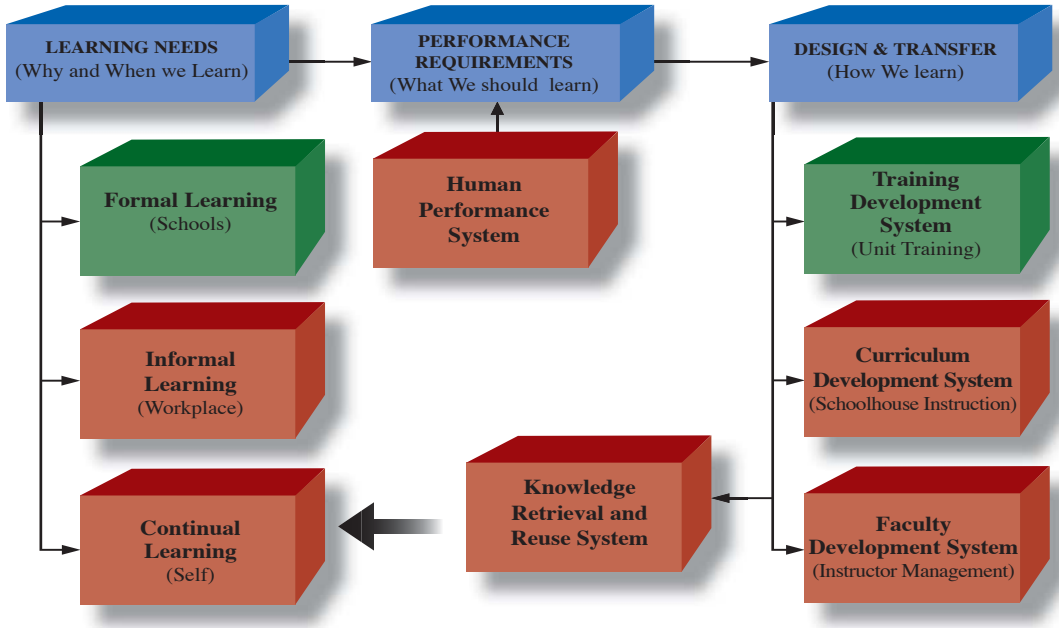

Diagram 1. Architecture for learning, training, education and development.

Endnotes

1 SAF Dictionary.

2 SAVER is the SAF's **S**avings & **E**mployee **R**etirement scheme for uniformed officers. The scheme is premised on a 23-year career for military officers.

3 The SAF's Premium Plan is a service scheme premised on a 10-year career for Specialists.

4 J Pfeffer, *Competitive Advantage Through People: Unleashing the Power of the Work Force*, (Boston: Harvard Business School Press, 1994), p109.

5 K M McKenzie, "Transferring Expert Knowledge: Interpersonal Knowledge Exchange between Extreme Knowledge Workers", *Journal of Information & Knowledge Management*, Vol. 3, No.2 (2004), (iKMS & World Scientific Publishing Co), pp127-134.

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10 M Douglas, *Purity and Danger*, (Routledge, (1966).

11 T O Davenport, *Human Capital*, (San Francisco, Thomas O. Davenport and Jossey-Bass Inc., Publishers, 1999), p10.

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The Complex and Chaotic Military

by MAJ(NS) Aaron Chia Eng Seng

Introduction

> "Now that science is looking, chaos seems to be everywhere… Chaos appears in the behaviour of the weather, the behaviour of an airplane in flight, the behaviour of cars clustering on an expressway… That realisation has begun to change the way business executives make decision about insurance, the way astronomers look at the solar system, the way political theorists talk about the stresses leading to armed conflict."
>
> James Gleick[1]

Military theorists and analysts have frequently turned to the sciences for insight into the nature of warfare. For the past several centuries, classical physics was extensively used to frame theories of warfare.[2] Military theorists borrowed a number of concepts from classical or "Newtonian" physics and applied them metaphorically to war: friction, centre of gravity, mass, and momentum, to name a few. Yet classical physics cannot describe many classes of natural phenomena and systems – the vast majority are non-linear. One method of approximating the behaviour of non-linear systems involves linearising them, then employing linear systems analysis to the approximated system.[3] Unfortunately, such techniques suppress or even eliminate many of the important dynamical characteristics of non-linear systems; for example, chaos cannot exist without non-linearities.

This essay first explains how the military uses linear dynamics via the Newtonian paradigm for analysis in military affairs. It then briefly describes the theories of non-linearity, complexity and chaos. Next, it illustrates with examples how they can be exploited in the study of warfare and in military weapons and systems. It concludes that expertise in complexity and chaos applications in warfare and military technologies may lead to secret edge capabilities.

Linearity and the Newtonian Paradigm

Warfare under the Newtonian paradigm is linear and deterministically predictable, its effects are in principle calculable from their underlying causes.[4] If there is enough information about the current state of a conflict and armed with "laws" of combat, a commander should be able to precisely determine the outcome of the battle. For example, the commonly used three-to-one rule of combat is a linear law, which claims that to win a battle we require a combat strength three times that of our opponent. A consequence of determinism in war, then, is the drive for greater quantities of intelligence from which the commander can make more precise predictions of the

future. With intelligence and situational awareness approaching perfection, the Newtonian paradigm is supposed to reduce friction[5] in war to a bare minimum.

Reductionism is another important consequence of the Newtonian paradigm. The analyst breaks the problem into its constituent pieces, solves each piece separately, and then sums the results from the pieces to obtain the overall solution to the problem. This is a natural consequence of superposition. For example, air planners generally break the enemy into a series of target systems, analyze each target system independently of all others to determine aim points, and then sum the results to obtain the overall air campaign.[6]

Moreover, the Newtonian paradigm views systems as closed entities, isolated from their environments. Outside events do not influence such a system; the only dynamics are those arising from its internal workings. The analyst thus has an inward focus, with a concentration on efficiency. Numerical measures of merit, such as body counts, tank kills, and aircraft losses become paramount in analyzing the flow of the battle and determining strategy. However, conflicts that are truly isolated from the outside world are increasingly rare, if they exist at all.

Based on this paradigm, warfare is highly procedural, with methodical approaches to the conduct of military operations.[7] It is based on doctrine and rigidly structured, with checklists and procedures. It has precise command and control, with rigid command and support relationships and employs highly orchestrated or synchronized schemes. Detailed plans and orders are also commonplace.

Non-linearity and the Complexity/Chaos Paradigm

Complexity, chaos and non-linearity are sometimes used interchangeably, although they are not the same. Chaos is the study of how simple systems can generate complicated behaviour while complexity is the study of how complicated systems can generate simple behaviour. A dynamical system does not have to be "complex" in order to exhibit chaos. Similarly, a complex system does not have to be chaotic. Chaos and complexity are not possible without non-linearity. Non-linearity relations are not sufficient for chaos and complexity, but some form of non-linearity is necessary. A non-linear system can exhibit both chaos and complexity behaviours. Non-linearity means that the output is not directly proportional to the input. Instead, the ratio of output can rapidly grow larger or can de-escalate to a minuscule value. They do not obey the rule of additivity – the sum of inputs A and B does not equal the same result if each of these is input individually and their results summed. Non-linearity forms the basis for complexity and chaos theory.

Complexity

A complex system has several defining characteristics.[8] First, it is composed of a large number of interacting parts or "agents". The interactions between the agents are non-linear.[9] The interactions and behaviours of the agents influence the environment in which the system exists. Changes in

the environment in turn influence the agents and their interactions. Second, the agents characteristically organize into hierarchies. Agents at one level of the hierarchy cluster to form a "super agent" at the next higher level. A bureaucracy or military organization illustrates the concept: a number of soldiers form a section, several sections form a platoon, and several platoons form a company and so forth. Third, there are intercommunicating layers within the hierarchy. Agents exchange information in given levels of the hierarchy, and different levels pass information between themselves as well. Finally, complex systems have a number of disparate time and space scales. For example, military operations at the platoon level are highly localized and may occur very rapidly compared to events at the corps level.

Complex systems exhibit a number of common behaviours. The first is emergence: the interactions of agents may lead to emerging global properties that are strikingly different from the behaviours of individual agents.[10] These properties cannot be predicted from prior knowledge of the agents. The global properties in turn affect the environment that each agent "sees", influencing the agents' behaviours. A synergistic feedback loop is thus created, interactions between agents determine emerging global properties that in turn influence the agents. Consider a ship in tactical operations during a conflict. The myriad of such tactical operations interact and define the courses of the operational and strategic levels of war. However, the characteristics of the strategic level of war cannot be extrapolated from individual tactical engagements. The strategic environment in turn shapes future tactical engagements for the ship, thus completing the cycle. A key ramification of emergence is that reductionism does not apply to complex systems.[11]

A second fundamental behaviour of complex systems is adaptive self-organization. As Kauffman notes, "contrary to our deepest intuitions, massively disordered systems can spontaneously 'crystallise' to a very high degree of order."[12] Self-organization arises as the system reacts and adapts to its externally imposed environment. Consider a losing battle where the troops of a brigade are disorganized and in disarray. Suddenly, due to the courage and leadership of one man, an organized and effective force materializes and the battle is won.

A third key behaviour of complex systems is their ability to process information.[13] The systems sense their environments and collect information about surrounding conditions. They then respond to this information via a set of internal models that guide their actions. For example, intelligence collection and analysis are essential in any military to any war effort.

The final important behaviour of complex systems is evolution at the edge of chaos. Complex systems have the ability to balance between order and chaos. This balance point – called the edge of chaos – is where the system is in a kind of suspended animation between stability and total dissolution into turbulence. This will be described in more detail in the next section.

Chaos Theory

Chaos is not randomness and it does not arise from the same stochastic forces that cause random behaviour. Instead chaos arises from the same knowable conditions that give rise to order and predictable behaviour. As a result, chaotic systems can often be mistaken for random systems. There is an underlying structure to chaotic systems that sometimes allow us to make predictions about its long-term trend and very short-term behaviour. Some chaotic systems can be driven in and out of chaos, i.e., chaos can sometimes be controlled.

Chaos arises from repeated iteration or feedback. A system, whether physical or mathematical, starts in some initial state. That initial state provides the input to a feedback mechanism, which determines the new state of the system. The new state then provides the input through which the feedback mechanism determines the system's next state, and so on. If a non-linear system exhibits sensitive dependence on initial or later states, then at least three long-term outcomes are possible: (1) the system eventually settles down in some single state and remains there despite further iterations (long-term stability); (2) the system settles on a series of states which it thereafter cycles through endlessly (periodic behaviour); or, (3) the system wanders aimlessly or unpredictably (so-called "chaotic" behaviour). In the third case, detailed predictability of the actual state of the system can be lost over the course of a large enough number of iterations.

The classical example to illustrate chaos is the Lorentz's logistics equation, $p_{n+1} = kp_n(1 - p_n)$ where p is the population level as a fraction of that which the environment can support at any given instant, k is the reproduction rate and n is the generation number.[14] All examples given here are illustrated based on this equation using Matlab©. The sequence of states a system passes through in time is called its orbit. If the system is dissipative, i.e., it loses energy in some way (and most systems do); the orbits converge to one of a small subset of all possible states called an attractor. The simplest kind of attractor is a single point: the system becomes stationary. The system is said to be stable or in dynamical equilibrium (Figure 1). Another type of attractor is called a limit cycle: the system oscillates at a stable frequency and amplitude (Figure 2). A system may have numerous attractors, and the initial conditions determine to which attractor the system will converge (Figure 3 has 2 attractors). This is known as bifurcation. The set of initial states for which the system converges to a particular attractor is called the basin of attraction of that attractor. Figure 4 shows the system in chaotic behaviour. Figure 5 shows the system in bifurcation, first to two states (represented in time series by Figure 2), and then to four states (represented by Figure 3), doubling each time until the system is in chaos (represented by Figure 4). When chaos occurs, the attractor cannot be described in simple forms such as limit cycles, straight lines or points; the attractor has a fractal shape. A fractal shape shows detail at every possible magnification. Attractors with this peculiar property are usually called strange attractors (Figure 6). It is possible to determine the degree of chaos: the Lyapunov exponent. If the exponent is low,

the system is not very chaotic, and medium to long predictions remain accurate over considerable periods of time. If it is high, errors increase rapidly, and only very short-term prediction is possible. Other measures of degree of chaos exist, most notably the fractal dimension of the attractor, which is a measure of the complexity of the shape of the attractor. The more complicated the attractor, the higher the degree of chaos.

Chaotic systems are not necessarily predictable. Determinism means that given knowledge of an initial condition, the condition at some later time can be determined. However, the initial conditions cannot be known with infinite precision and there is always some small error in knowledge about that starting state. In non-linear systems, an almost infinitesimally small error in initial conditions can blow up to enormously large error in the

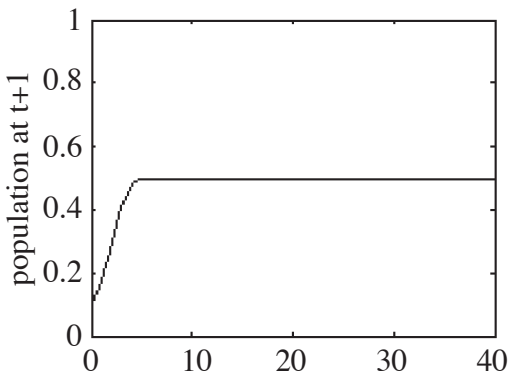

Figure 1. Steady State (k = 2.0)

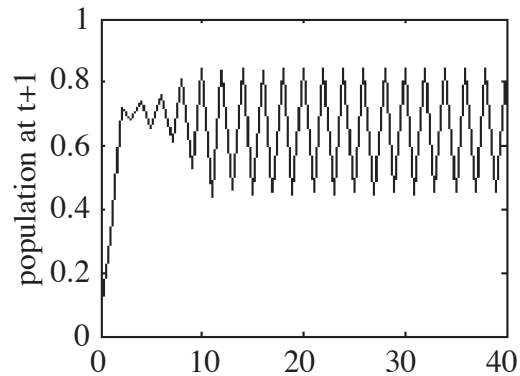

Figure 2. Period = 2 (k = 3.4)

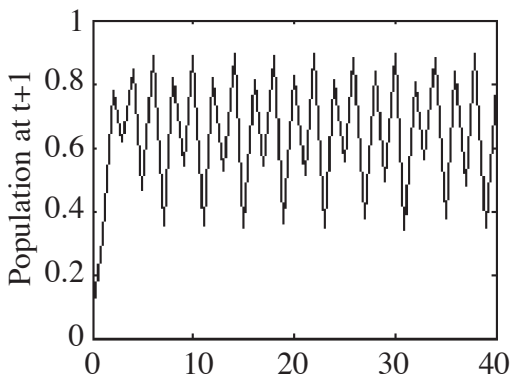

Figure 3. Period = 4 (k = 3.5699)

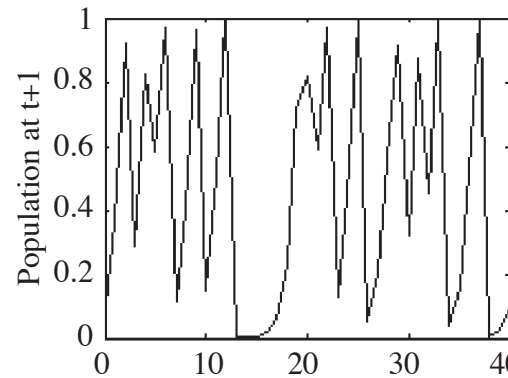

Figure 4. Chaos (k = 4.0)

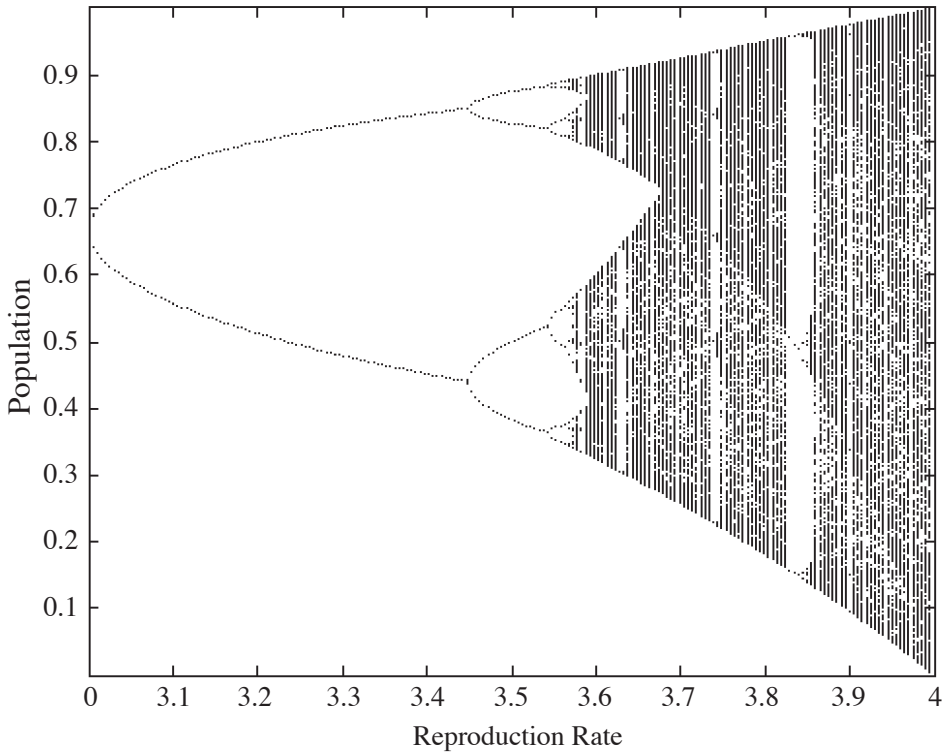

Figure 5. Bifurcation

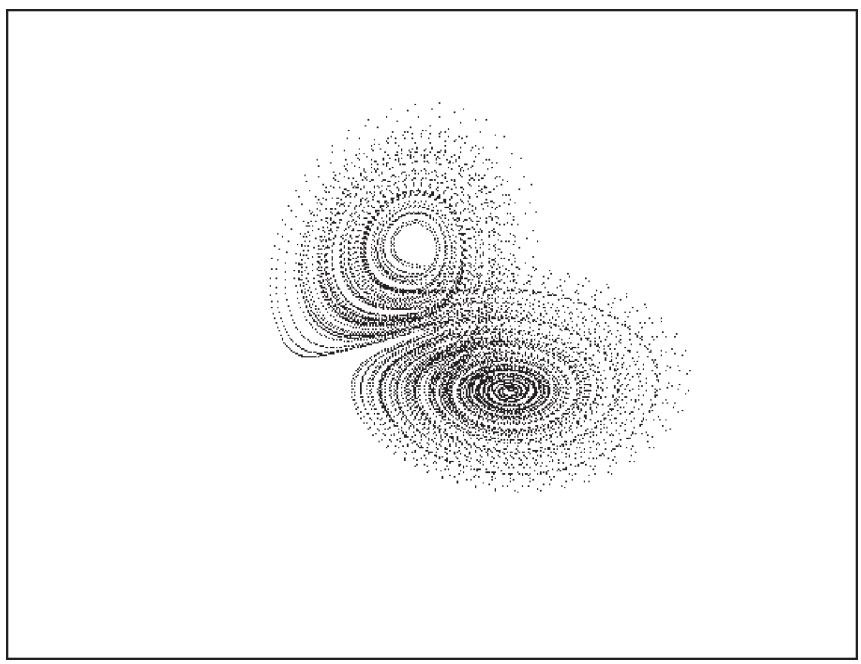

Figure 6. Lorentz Strange Attractor

predicted value of the final condition. Sensitivity to initial conditions means that, given two seemingly identical inputs to a system, as time goes by, their two paths will start to diverge. But there is a period of time during which their respective trajectories lie very close to each other and within this range, the ability to predict is relatively good. This implies that any dependency of planning on our ability to predict outcomes is also dependent on our knowledge of the sensitivity in initial conditions and how quickly seemingly similar trajectories will diverge. Figure 7 shows sensitivity in initial conditions of initial population in the logistics equation. With only a difference of 0.0000001, the results initially overlap but later diverge. This phenomenon has been used to explain why flight paths of missile test data deviated from seemingly similar initial conditions.

Military Applications

Complexity / Chaos theory has universal applications. Vastly different systems can be reduced to a few universal forms and can contribute to the synthesis and consolidation of science in regards to a large number of complex and seemingly disparate physical phenomena. One of the most powerful consequences of chaos

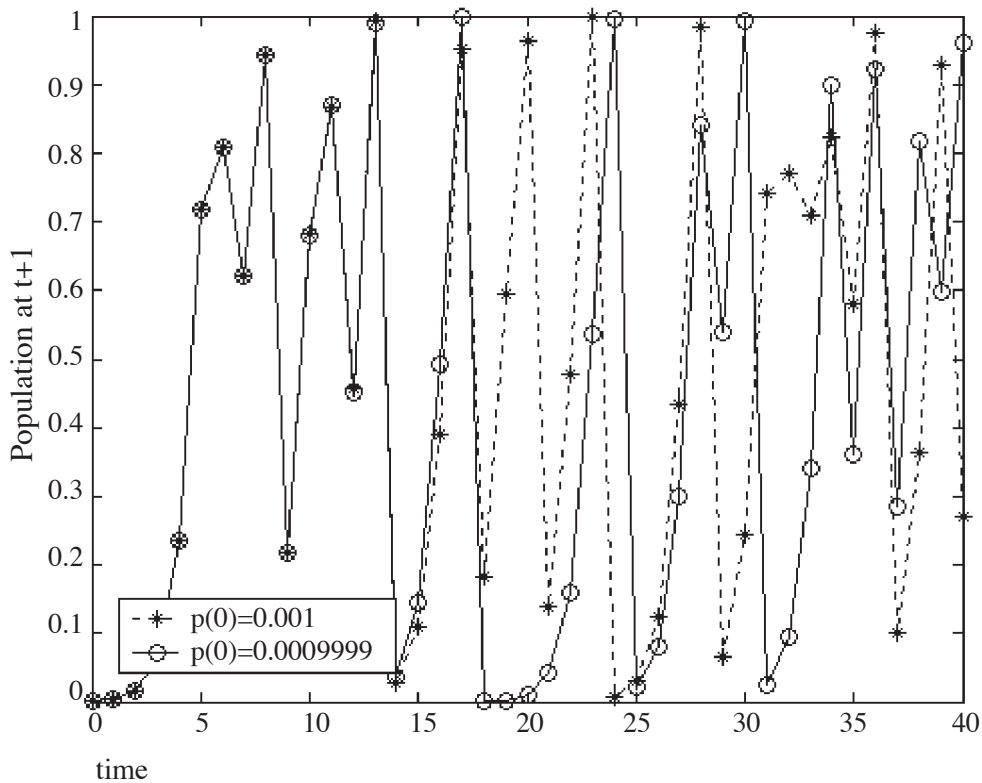

Figure 7. Sensititivity to Initial Conditions

theory is that a chaotic system can be influenced so that it becomes stable. Complexity/Chaos theory has also been applied to wide ranging subjects from economics, biology, medicine, geology, and the prediction of war. Researchers have also successfully controlled chaotic behaviour in a surprising number of physical systems. Some of these military applications are briefly described below.

Study of War

Several studies have been made to predict and model the outbreak of war using complexity/chaos theories. Geeraerts[15] studied into the relationship between non-linear dynamics and the prediction of war. Saperstein[16] compared the linear and non-linear models of war and uses chaos theory to model its outbreak. He found that some of the significant non-linear factors are interactions between animate entities, friction and chance. Tagarev[17] provided evidence of chaos in tactical, operational and strategic levels of military activity. Hachinski[18] showed that complexity theory represents a shift of emphasis from force-on-force attrition calculations to consideration of how high-level behaviours emerge naturally from low-level rules. It provides theories to understanding aggregate behaviour as non-linear and synergistic and a natural methodology for introducing qualitative characteristics of combat such as unit cohesion, effects of morale and leadership.

It is also possible to use genetic algorithms (a complexity method) to develop strategy and/or tactics.[19] Genetic-algorithm-based tactics or strategy "optimizers" would consist of an evolutionary search of a "strategy landscape" for high-pay-off strategies using whatever local information is made available to a combatant. Woodcock, Cobb and Dockery[20] uses cellular automata to model combat. Other works on combat models that uses complexity/chaos include those by Miller and Sulcoski,[21] Dockery and Woodcock[22] and Dewar, Gillogly and Juncosa.[23] The use of Lyapunov exponents can help to prioritize various strategic options according to the relative unpredictability of their outcomes.

In studying chaotic systems, calculations of attractors depict distributions of outcomes can help to provide probability information to decision-makers. For example, in his study of the war in Somalia, Bowden found bifurcation behaviour in the residents of Mogadishu during the operation to seize Aidid clan leaders.[24] Somali citizens, upon perturbation by US forces, bifurcated into those still going about daily living and those erecting barricades and lighting summoning fires. As the mission progressed, Somali citizens increasingly abandoned their daily living and thronged to the scene of action. As the US forces fired at the massed crowds comprising armed and unarmed citizens, the mobs responded with another bifurcation. During the fights, the Somalis amassed and dispersed (they were oscillating between two states – with scenes of action being one attractor and places of cover being another).

A fundamental property of non-linear systems is that they generally react most sensitively to a special class of aperiodic forces. An analogy between John Boyd's Observe-Orient-Decide-Act (OODA) loop and information processing at the edge-of-chaos in complex systems suggests ways of interfering with an enemy's OODA "timing" and thereby disrupting the enemy's ability to maintain coherence in a changing environment.[25] Non-linearity shows that general friction will persist more or less undiminished in future war regardless of technological developments.[26] Consequently, the existence of chaotic systems confirms some of Clausewitz's deepest insights on friction. Beyerchen[27] also demonstrated that Clausewitz perceived war as a non-linear phenomenon that manifests itself in ways consistent with current understanding of non-linear dynamics. Sensitive to initial conditions, chaos theory explains how such small differences or "chance" occurrences of "the kind you can never really foresee" can give rise to long-term unpredictability. Technical superiority is a concept appropriate only if both sides engage in a linear warfare. With asymmetric warfare, non-linear dynamics and consequently complexity and chaos will play an even more important role.

Information Warfare

The increasing availability of real-time information to decision-makers amplifies concerns about information overload. The common transitions of chaotic systems suggest that it may be possible to control the flood by studying the effects of incremental changes in key parameters such as volume of information, frequency of reports, number of sources involved in generating the data, and the time allotted for decision-making. Understanding the transitions from reasonable decisions making to ineffective performance may help to tailor intelligence fusion systems for the benefit of commanders. Intelligent software agents can be used for adaptive information filtering and integration and as tactical picture agents, scouring and putting order on the fluid flood of battlefield and intelligence data.

Chaos can be used to transmit information.[28] Chaotic dynamic systems, such as electrical oscillators with very simple structures, can produce complex waveforms. The symbolic dynamics of a chaotic oscillator can be made to follow a desired symbol sequence by using small perturbations, thus allowing us to encode a message in the waveform enabling secure communications.[29] Another useful application is code breaking.[30] Pseudo random numbers used in cryptography can never truly be random. By using chaos techniques, its nature can be revealed.

Another application is digital image compression. Simple equations that generate complicated distributions allow pictures to be expressed as compact sets of instructions for reproducing those pictures.[31] By transmitting the instructions instead of all of the individual pixel values, thousands of times more information can be sent through the same transmission channels in a given period of time. This technology is already making its way in military map making and transmission of real time video links to the battlefield.

Other Applications

Lasers, which are used in many military applications, can also make use of chaos theories since they are affected by non-linear fluctuations that are chaotic.[32] In a low power laser at the Georgia Institute of Technology, the chaotic output of a laser is controlled by manipulating the laser's power source.[33] Very slight but periodic modulations of the input power forced the laser into similar periodicity. While the laser output was not driven to any specific target behaviour, repeatable transitions were observed, from chaos to periodicity when a single control parameter was modulated. Other studies include optically bistable laser cavities by Ikeda[34] and Gibbs[35] and chaos in a continuous wave laser by Atmanspacher and Scheingraber.[36]

The presence of chaos limits the ability to predict and control vibrations using conventional active control systems; but by taking advantage of chaotic dynamics, one can find the limits of possible vibration reduction, determine the best control mode for the controlling system, and get vibrations under control. This can be applied to controlling signatures of helicopters and unintentional modulations of engines in aircraft, ships and vehicles. Results of several vibration control studies can be found in Abarbanel.[37]

In a research at the US Air Force Institute of Technology, James Straight automated the process of identifying military vehicles from a few measures of vehicle position and velocity using chaos theory.[38] He correctly distinguishes the motions of five kinds of military vehicles.

Limitations of Chaos

Although many systems exhibit chaos behaviour, in general, chaos will not appear in slow systems, i.e., where events are infrequent or where a great deal of friction dissipates energy and damps out disturbances. For instance, we would not expect chaos theory to help us to drive a jeep or shoot a single artillery piece. On the other hand, the theory may eventually guide our decisions about how to direct convoys of tanks or how to space the timing or position of many projectile firings. Similarly, chaos theory offers no advice on how to fire a pistol, though it may pertain to the design of rapid-fire weapons.

Theoretical chaos results are seriously constrained by the need for large amounts of preliminary data. To make any analysis of time series, for instance, we can make reasonable deductions based on as few as one hundred data points but the algorithms work best with a thousand or more.[39] Therefore, even if we are able to design reliable decisions tools for battlefield use, models that require hundreds of daily reports of enemy troop movements may be useless in a short war. While some hope remains for the prospects of increasing the speed and volume of simulated battlefield information, the mechanisms for using such simulations for real-time combat decisions remain to be developed.

Conclusions

Militaries need to move away from linear dynamics using the Newtonian paradigm to non-linear dynamics using the complexity / chaos paradigm. Warfare and military systems exhibit complex and chaotic dynamics. The

universal properties of complex/chaotic systems point to practical suggestions for applying their results to military strategic thinking and decision-making as well as countless military weapons and systems. Due to its importance, militaries may wish to be familiar with the fundamentals of complexity/chaos in order to expect, recognise and exploit their dynamics in war and military systems.

(Ed note: This essay was a Merit Award winner of the 2004 CDF Essay Competition)

Endnotes

1 James Gleick, *The Making of a New Science*, (Penguin USA, Dec 1988).

2 John F. Schmitt, "Chaos, Complexity & War: What the New Nonlinear Dynamical Sciences May Tell Us About Armed Conflict", Marine Corps Combat Development Command, 4 Sep 95, pp16-25.

3 For example, we can expand the non-linear system as a Taylor series, and keep only the constant and first-order (linear) terms. We then solve the linearised equations. This technique is frequently employed in the sciences and engineering.

4 More details of these three characteristics listed can be obtained from Schmitt, pp17-22.

5 Friction plays a big role in the success of a war. For more information, please refer to *On War* by Carl Von Clausewitz.

6 The air campaigns in World War II generally followed this philosophy. See, for example, "AWPD/1: Munitions Requirements of the Army Air Forces to Defeat Our Potential Enemies," USAF Historical Research Agency, 1941; and "AWPD/42: Requirements for Air Ascendancy," USAF Historical Research Agency, 1942

7 John F. Schmitt, "Chaos, Complexity & War: What the New Nonlinear Dynamical Sciences May Tell us About Armed Conflict", Marine Corps Combat Development Command, 2 Sep 95, pp16-25.

8 Lee A. Segel, "Grappling with Complexity", *Complexity*, Vol. 1, No. 2 (1995), pp18-25.

9 The couplings between agents may be tight or loose, branching or sequential, and may contain feedback and/or feedforward paths. See Steven M. Rinaldi, *Beyond the Industrial Web: Economic Synergies and Targeting Methodologies*, (Air University Press, Apr 1995), pp8-9.

10 Roger Lewin, *Complexity: Life at the Edge of Chaos*, (New York: Macmillan Publishing Company, 1992), pp12-13, 47.

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Harnessing Transformation: The Interwar Experiences of the German and British Armies

by LTA(NS) Toh Boon Ho

Introduction

At the end of 1918, the British and German armies stood on opposing sides of the largest conflict to date; one poised on victory; the other facing defeat and revolution at home. In the summer of 1940, the outcome was similar, with the absence of revolution at home, but with the roles reversed. Germany had, in the short span of ten months, destroyed two mortal enemies, Poland and France; kept one enemy, the Soviet Union, neutralised through a non-aggression pact; defeated Britain's small army in the field, and was poised to invade the British Isles.

This remarkable reversal in just twenty-odd years can be attributed to parallel efforts in both armies to harness the transformation brought about by new technologies which influenced doctrinal changes and hastened organizational changes during the interwar period between 1919-1939. But in the audit of war, German interwar efforts clearly succeeded where the British failed, culminating in the historic German victory of 1940.

The German victory in 1940 constituted a revolution in military affairs precisely because "a major change in the nature of warfare [was] brought about by the innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts, fundamentally alter[ed] the character and conduct of military operations".[1]

Trench Warfare in World War I

Based on the above definition by Andrew Marshall, this essay will examine the interwar record of the British and German armies in harnessing transformation. Specifically, the paper will examine the lessons learnt from World War I by both armies and how those lessons influenced their views toward future war. Closely correlated to the views

on future war is its fulfilment through the application of new technologies and the resultant interaction and impact on doctrine and organizational changes to realize its potential. The paper will therefore examine how both armies responded to the trinity of organizational, doctrinal and technological change in the interwar period. The audit of war in 1939-1940 is clearly needed to assess and validate the divergent paths undertaken by both armies in the interwar period. The German victories in 1939-1940 were by no means inevitable. Rather, it can be argued that it was impossible by contemporary standards of the day. Hence, when the German victories occurred, it was less the result of luck, but the culmination of calculated risk-taking and superior harnessing of transformation in the interwar period which delivered a 'strange victory' in 1940.[2]

Drawing the Lessons of War

In December 1919, as his first act, Hans von Seeckt, chief of the interwar German Army, the *Reichswehr* until 1926, issued a directive to form 57 committees and subcommittees to examine and draw lessons from the Great War.[3] The dramatic events of 1918 – 1919 created a crisis mentality that imparted a sense of urgency to the *Reichswehr's* bid to draw lessons from World War I.

In late 1918, despite the successes of Ludendorff's Spring Offensive and Germany's tactical superiority in the field, the imperial army was staring defeat in the coming months. The situation was further worsened by the harsh conditions imposed by the Versailles Treaty, which limited the post-war *Reichswehr* to just 100,000 men organized within seven infantry and three cavalry divisions, with no tanks, heavy artillery nor an Air Force. Less devastating was the abolishment of the much-cherished German General Staff Corps and the War Academy (*Kriegsakademie*), whose functions were succeeded by the Troops Office (*Truppenamt*). Though abolished in name, von Seeckt was determined in carrying out the functions and training of the General Staff Corps through the *Truppenamt*.[4]

More importantly, Germany's wartime tactical superiority did not translate into victory. The key lesson drawn was clear. Germany's wartime military leaders mistakenly waged a war of positions (*Stellungskrieg*), rather than a war of movement (*Bewegungskrieg*). Adopting such a strategy committed the German Army into a war of attrition, where even superior tactics could not overcome the huge Allied advantage in manpower and materiel, bleeding and exhausting the German Army before the Allied armies could succumb.[5] Hans von Seeckt's personal wartime experiences on the eastern front convinced him on the virtues of a war of movement, where small, but highly mobile and superbly trained and led troops could engage and defeat larger numbers of immobile, indifferently trained and poorly-led Russian and Romanian forces.[6]

The wartime development of stormtroop tactics on the western front marked a tactical superiority which the Allied armies either failed to match or copy. Though the stormtroopers showed promise and delivered devastating results during Ludendorff's 1918 Spring Offensive, the Offensive petered


Hans von Seeckt

out because neither supplies nor artillery could keep up with the assaulting troops. Similarly, contemporary technology, particularly mechanized transport, was still in its infancy and hardly reliable. The advance still depended on the pace of the infantryman, not on mechanized transport. The solution to the problem was mechanization through improved technologies and the provision of either mobile organic artillery to the assaulting troops or air-delivered weaponry to lend the weight of firepower to the ground offensive, thus maintaining its momentum and destabilizing the enemy defences.

The shortage and contempt for technically-minded, in contrast to respect for tactically-minded, General Staff officers was viewed as a contributing factor for the wartime Imperial army's failure to grasp the possibilities offered by technology. The introduction of the tank by the Western Allies was dismissed by the wartime German high command which devoted little attention to tank development. When it did, the tank was given low production priority. In this regard, the Western Allies gained the initiative in exploring and refining tank tactics, which combined with mass, could and did create the break-ins of the German defensive positions by 1918 as envisaged by early armour theorists.[7] In the interwar period, von Seeckt saw to it that officer education emphasized not only tactics, but also technological knowledge. He stressed the need to keep abreast of technological changes, both domestic and foreign, and its impact on the conduct of military operations.[8]

Unlike the Germans, the British army emerged victorious at the end of 1918. Yet, the Kirke Committee, the official commission to draw the lessons of the Great War was only formed in 1932, fourteen years after the end of the war in response to public controversies stirred up by the publication of the Official History of the Great War. But the British Army did not stay in stasis during the fourteen-year hiatus. It similarly embarked on soul-searching immediately after the war. The British General Staff concluded that the four-year bloodbath which culminated in victory in 1918 could not be repeated again in future war. Instead, emphasis should be laid on mechanization and superior firepower, not manpower, to restore mobility and decision to the battlefield. Contrary to popular perceptions, the British General Staff did not eschew combined arms cooperation. It recognized the importance of combined arms warfare, particularly the successful combination of artillery, infantry and armour in creating the break-in of German defensive positions as exemplified at Amiens in August 1918. It noted the minimal cost of lives such a strategy accorded for inordinate results gained.[9]

Although the British army recognized and drew appropriate lessons from its wartime experience, the parsimonious Treasury thwarted its efforts during the interwar period. Under the Ten-year Rule, which assessed that Britain will not confront a first-class continental threat in the next ten years, the defence budget was subjected to the Geddes Axe to reap economies for post-war economic programmes. This was entirely plausible since the *Reichswehr* had been effectively circumscribed.[10]

The end of the war marked the reversion of the British armed services to pre-war imperial policing of its empire. This placed the British army at a severe disadvantage on two counts. Peacetime imperial policing emphasized seapower and trade route protection, a role traditionally assumed by the Royal Navy (RN). In addition, the creation of the Royal Air Force (RAF) in 1918 as an independent service created competitive demands in a period of fiscal austerity. To justify its existence and ensure its share of the shrinking fiscal pie, the RAF successfully argued for a role in imperial policing. This involved the use of airpower to control large tracts of inhospitable territory in place of expensive troop garrisons.[11] The British army became the 'Cinderella service' and was relegated to the bottom of defence priorities and budgets in favour of the RN and the RAF.[12] In contrast, the *Reichswehr*, though circumscribed, was still the dominant service and given top priority by von Seeckt in its budgetary allocations.

British Infantry attack in World War II

Confronted with this situation, the British army had to make a choice. It could either spend its limited budget on the demands at hand, i.e., the tools of imperial policing, or on heavy firepower weapons which would allow it to wage a continental war against a first-rate enemy power. The British army chose imperial policing, although it did not give up entirely on the experimentation and development of tanks and mechanization in general.[13] However, sacrifices were made in the area of artillery development, where new technical developments were eschewed in favour of legacy systems from World War I, which were widely available in huge quantities but hardly suited for mobile warfare.

The training of British General Staff officers was similarly lacking. Unlike their German counterparts who took an active interest in foreign armies and conducted annual staff rides to survey future battle grounds, British General Staff officers were trained in grand strategy, rather than operational techniques.[14] Additionally, ignorance of foreign armies created a mindset that judged the quality of foreign armies according to how closely they resembled the British, leading to disastrous consequences during hostilities.[15]

Differing Philosophies of Combat

The Germans viewed combat as an inherently chaotic exercise, in which no war plan survives intact on the first contact with the enemy. Faced with this situation, the German army practised a form of command and control known as 'mission command' (*auftragstaktik*), which emphasized initiative at all levels to fulfil the commander's intent. The written operations order was discouraged. Commanders were trained

to convey their intent via simple verbal orders. Subordinate commanders were expected to exercise their initiative in executing the brief orders according to their commanders' intent.[16]

From the British viewpoint, because combat was inherently chaotic, it became necessary to impose order on it. Thus, their command and control emphasized restrictive control in which strict obedience to orders had to be carried out to the letter. Operations orders were expected to be long, written pieces setting out in full detail the tasks that subordinate commanders were expected to perform. Any deviation had to be channelled back up the chain of command before new, written orders are issued. The net result of such differing views on command and control had a significant impact on training and military operations.[17] Free from such cumbersome arrangements, the German commander was better placed than his British counterpart to exercise and seize the initiative in a fluid situation and increase the tempo of operations to the extent that his decision-making cycle would far exceed that of his British opponent in the field.

Doctrine

Both the German and British armies concluded that future war had to be fought on the basis of mobility and firepower. Unlike the Germans, the British army's wartime experience was largely obtained on the Western Front, where artillery and firepower dominated positional warfare. However, this experience did not detract from their assessment that mobility had to be restored to the battlefield, and the tank heralded the promise of restoring mobility to military operations. But to do that, it was essential to utilize overwhelming firepower to create the necessary breach for armoured forces to break through into the open.[18]

Under Hans von Seeckt, the *Reichswehr* drew similar conclusions. The experiences of the Western Front indicated the need for firepower to be allocated to the units that mattered most in the field – the division. In addition, stormtroop tactics reinforced the need for combined arms operations between artillery, assault engineers and infantry during the break-in battle. Thus, despite the Versailles limitations on the organization of *Reichswehr* infantry and cavalry divisions, von Seeckt organised his infantry division along ideal lines, with provisions for adequate firepower for every infantry regiment within the division, as well as its own organic regimental infantry guns.[19] This situation compares favourably against comparable British units, which were woefully firepower deficient at all sub-levels of the infantry division. This reality made a mockery of British doctrinal emphasis on firepower.[20] Although both armies suffered from a lack of modern artillery – one due to treaty limitations, the other through fiscal austerity – the German army ensured that organizationally, the infantry division would be organised along lines that emphasized organic firepower. The actual artillery would be provided as and when rearmament could commence.

In contrast, despite the existence of legacy artillery systems, the British army did not organize and provision its infantry formations with adequate artillery or radio sets to realize its

doctrine. The British infantry division in the 1930s did not possess adequate organic artillery assets, let alone regimental guns for its component infantry brigades. It was overly reliant on Corps artillery to provide its firepower. The situation arose from pursuing the principle of economy of force where weapons required occasionally by divisions were best left outside their establishment and concentrated as corps assets to be disbursed when needed.[21] It also failed to provide for adequate levels of communications equipment to facilitate communications between the infantry and artillery.[22] This decision was to have a severe impact on the tempo of military operations. German units, adequately armed with devastating firepower and wedded to directive control, could exercise their initiative and engage in mobile high intensity operations. In contrast, British units, lacking command initiative, wedded to rigid orders and lacking sufficient communications equipment, had to depend on detailed artillery fireplans in any assault. This robbed them of any initiative and compelled them to fight set-piece positional warfare, while leaving them vulnerable to mobile high intensity operations where swift application of firepower was crucial to both the offence and defence.

The Panzer Division vs the Mobile Division

The German Panzer division was only created in 1935, after Hitler's decision to rearm. But the precursor for the Panzer division was the creation of the motor transport troops in the early 1920s where one battalion of motor transport troops, was attached to each of the seven *Reichswehr* infantry divisions. These motor transport troops were essentially experimental motorized units, which experimented with tank tactics using dummy tank mock-ups fitted over the chassis of automobiles in lieu of the Versailles ban on tanks.[23]

Panzer I first saw combat in 1936

The Germans learnt from their experimentation that tanks constituted the new queen of the battlefield, a combat multiplier to the infantry. A tank's value lay with its shock value and mobility. When employed in mass of at least battalion strength, it constituted a formidable foe. But the problem lay with the issue of speed. Instead of coupling the tank to the infantry, it was decided to motorize the infantry, engineers and artillery to match the tanks' speed. This solution meshed with the German conviction on combined arms operations, in which all arms minimized their deficiencies and maximized their strengths by operating together in a single formation through the Panzer division.[24]

The British continued their pioneering work on tanks in the interwar period. Their experimentation drew foreign interest, particularly German interest, on the role of tanks in future warfare. On the question of speed, unlike the Germans, the British decided that the

tank was best utilized in specialized roles, in either the infantry support role or exploitation role. This required two types of tanks: the slow but heavily armoured infantry tank to support the infantry, and the thinly armoured but fast cruiser tank for exploiting and harassing the enemy's command and control functions and logistics in the rear. The cruiser tank was concentrated in the Mobile division, which became the Armoured division in 1939. Although a combined arms outfit, it was too tank-heavy with too little infantry or artillery support.[25] The substantial infantry component was provided by a separate Motor division consisting of motorized infantry and attached artillery elements.[26] Given the fiscal austerity and separate divisional framework, both divisions did not have sufficient opportunities to operate and train with each other until hostilities began. This was a major weakness compared to the German Panzer division which was a true combined arms team integrated in a common formation.

Training

Both armies devoted considerable care to training in the interwar period. But the German system proved superior to the British system primarily because it had a coherent doctrine working in its favour and a good pool of motivated talent to start with. Hans von Seeckt paid special attention to training, particularly battle drills which imposed a uniform training standard across all formations within the *Reichswehr*. He also devoted special attention to new technologies like radio, tank tactics and aircraft employment in his large-scale annual military exercises which were retained by his successors after 1926 even at the height of severe budgetary allocations during the Great Depression period. These exercises allowed the full employment of combined arms concepts at corps level which enabled commanders and line troops to familiarize themselves with the doctrine.[27]

The British army did not enjoy such a luxury. Imperial policing duties took away opportunities for large formation training. Even forces based in Britain had limited opportunities to engage in corps-level training due to the shortage of funds. In fact, only two corps-level training exercises took place in the entire interwar period, in 1925 and 1935 which lasted barely a few days. More detrimental was the decentralization of training to formation commanders. This decision, a carry-over from tradition, had a significant impact on wartime operations. In particular, formations experienced a wide range of training and operational readiness, depending on the forcefulness of the formation commander. More importantly, there was no common doctrine since the army allowed its commanders the flexibility and leeway to interpret doctrine as they deemed fit. The disdain for battle drills further compounded the problem. The lacklustre and uneven pre-war training showed up evidently during the Battle of France in 1940 when British units were often outmatched by their well-trained German counterparts.[28]

Differing Views on Airpower

Both armies drew diametrically opposed lessons from the air campaign in World War I. Although pioneers in strategic bombing, the post-war study of the German Army Air Service's (*Luftstreitkrafte*) strategic bombing campaign against Britain concluded

that the effort and cost expended was not worth the marginal results gained. The role of tactical air support and gaining air superiority proved more valuable and promising than strategic bombing. Experience drawn from the 1918 Ludendorff Spring Offensive indicated that tactical air support provided offensive firepower and shock effect in the absence of tanks on the ground.[29] German interwar air doctrine thus focused on the close air support and air superiority roles, as well as developing the platforms to perform these roles. Army exercises involved air force officers and usually factored in the role of airpower and its impact on ground operations. Von Seeckt in particular, overcame the Versailles ban against a German air force by retaining ex-Air Service officers in the *Truppenamt* and establishing civilian air establishments like glider flying clubs and the civilian airline Lufthansa to maintain flying skills.[30]

RAF's Spitfire

In contrast, the British drew the opposite conclusion. The RAF concluded from its World War I experience that close air support missions were too costly in men and materiel, despite the great effect it had on German troops. Furthermore, the RAF was guided by a strategic bombing advocate, Sir Hugh Trenchard, who ignored the dismal record of the RAF's strategic bombing campaign against Germany.[31] When Britain went to war in 1939, the RAF had no doctrine for close air support nor dedicated platforms for that purpose. All its energies were devoted to the elusive goal of obtaining victory via strategic bombing and developing fighters to meet the requirements of national air defence.[32]

Exploiting Technologies

Both armies recognized the importance of technologies in future war. As already noted, von Seeckt devoted particular attention to increase his officers' awareness of technological advances and their impact on warfighting. Both armies similarly carried out experimentation on signals and radio equipment, especially mobile sets that could operate on tanks. Experimentation was similarly carried out on major weapons platforms like tanks. But in the German case, experimentation was limited by Versailles Treaty limitations. This did not stop German weapons development. In fact, such development often took place clandestinely. Valuable assistance was also granted by the Soviet Union, which allowed the Germans to establish flight schools and tank proving grounds to test out experimental tanks and aircraft models. Once the kinks were ironed out, the design blueprints were set aside to be mass-produced when the decision for rearmament was taken. When rearmament commenced, the German army had streamlined its tank production models to just four basic all-purpose types compared to the numerous models the British had drawn up. This further eased production difficulties.[33]

The British army did not face such treaty constraints. However, it did face a real fiscal constraint. This constraint

placed a limit on weapons procurement. Rapid technological changes further rendered these weapons platforms obsolescent within a short time. But overall, the more serious constraint was posed by the demands for specialized equipment, as seen in the issue over tanks, in which a proliferation of different types sapped an already strained procurement budget. In this way, the army could only procure limited numbers of a large variety of tank types which were unsatisfactory in meeting operational requirements.[34] More seriously, the emphasis on mobility and a parsimonious defence budget created a shortfall in medium and heavy artillery. The British did develop an excellent field artillery piece in the 25-pounder gun/howitzer. But it had to rely on legacy systems of World War I vintage for its medium and heavy artillery requirements when it went to war in 1939.[35] In contrast, although forbidden to possess heavy artillery, von Seeckt had German defence industries develop new, modern medium and heavy artillery prototypes in the 1920s which proved excellent examples in the early part of World War II.[36] British experiments with signals equipment yielded mixed results. Technological changes and unreliable equipment coupled with austerity measures produced only enough radios for the armour and artillery formations, with little excess for the infantry formations, which continued to rely heavily on cable communications that could be disrupted by air and artillery bombardment.[37]

A 25-pdr gun howitzer used in World War II

The Audit of War

When the German army went to war in 1939, it went to war as the best-trained, though not necessarily the best-equipped army among the belligerents. Although the Panzer divisions had proven their worth in the annual exercises of the late 1930s, they remained unproven in combat. Poland proved to be the testing ground for the German army's twenty-year experimentation with technological, organizational and doctrinal changes. In this respect, the German army proved the effectiveness of its doctrine emphasizing firepower and shock delivered through its organic firepower weapons and the tactical airpower of the *Luftwaffe* in conjunction with the mobility and shock value contributed by the elite Panzer divisions. Even then, serious shortcomings were identified and duly addressed through intensive training cycles during the 'phoney war' period which incorporated the lessons learnt from the Polish campaign.[38]

In contrast, the British Expeditionary Force (BEF) comprising the best British army formations were under-equipped and indifferently trained for the tasks at hand. Its sole redeeming factor was its rapid mobility, the result of the pre-war decision to mechanize the army. The BEF lost the French campaign primarily because its doctrine and organization, particularly the C^3I system, could not keep pace with the intense and rapid operational tempo of their German counterparts.[39] The strategic boldness of the German plan, which fully exploited the strengths of the Panzer divisions was completed by the poor strategic positioning of the best British and French army formations far forward in the north.[40] When disaster struck, defeat

became complete as the allied C³I system collapsed under the strain of combat. As the French campaign indicated, the side with greater numbers and better equipment but locked into a cumbersome and slow-moving C³I system without a common and coherent doctrine could be defeated by a smaller, nimbler enemy which fully exploited its strengths while capitalizing on its enemies' weaknesses.[41] In this respect, the British army, the junior partner in the coalition proved unable to restore the status quo once its dominant partner, the French army fell into disarray. The audit of war clearly proved that the German army understood better and more effectively harnessed the interwar transformation wrought by organizational, technological and doctrinal changes. For the moment, the Germans prevailed.

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Endnotes

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[22] French, *Raising Churchill's Army*, pp165-166; Toh Boon Ho, "Book Review – Raising Churchill's Army", p143.

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[24] The Panzer division comprised a tank brigade of two tank regiments with a total of four tank battalions (equivalent to the British regiment) and a motorized infantry brigade consisting of two motorized infantry battalions and a motorcycle battalion. Supporting arms included a motorized artillery regiment, a motorized antitank battalion, a motorized reconnaissance battalion and a motorized pioneer company that was subsequently expanded to battalion-size. See Citino, *The Path to Blitzkrieg*, p231; Geyer, "German Strategy in the Age of Machine Warfare, 1914-1945", pp558-559.

[25] The Mobile division possessed two mechanized cavalry brigades of six cavalry light tank regiments, a tank brigade of three medium regiments, and only two motorized infantry battalions and two artillery regiments. See French, *Raising Churchill's Army*, p42.

[26] The Motor division was a second-line formation comprising two motorized infantry brigades and two artillery regiments but no tanks. See ibid., p41.

[27] See Corum, *The Roots of Blitzkrieg*, pp 68-96; Citino, *The Path to Blitzkrieg*, pp105-247; French, *Raising Churchill's Army*, pp20-21.

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System Study & Design of Broad-band U-Slot Microstrip Patch Antennas for Aperstructures and Opportunistic Arrays

by CPT Matthew Tong Chin Hong

Abstract

An opportunistic array is an integrated ship-wide digital phased-radar, where antenna elements are placed at available open areas over the entire ship's length. Such an array has the potential to fulfill many of the Navy's mission, including ballistic missile defence (BMD) where the radar mission encompasses exo-atmospheric surveillance, tracking and preliminary discrimination. Advantages of the opportunistic arrays include (1) enhanced stealth – since low profile antennas reduce the ship's Radar Cross-Section (RCS); (2) high angular resolution – as the entire ship's length forms the "aperture" and produces a narrow beamwidth; and (3) potentially lower costs – through the use of commercial-off-the-shelf (COTS) technology and a flexible digital antenna architecture that reduces the number of distinct radar systems required. These inherent advantages, especially their opportunistic nature, make them excellent candidates for a variety of Army and Air Force applications.

This research first investigated the opportunistic array concept of BMD. A system level tradeoff was performed to size the system and verify that detection ranges greater than 1000 km could be achieved. Next, research focused on designing a low-profile, broad-band U-slot microstrip patch antenna. Theoretical calculations and paramedic studies were performed to develop an antenna element that could operate in the upper VHF/lower UHF frequencies. A set of simple design procedures was proposed to provide approximate rules that result in a good "first-pass" design with prescribed characteristics that require minimal tuning.

Introduction

The Aperstructure and Opportunistic Array Concepts

The aperstructure concept aims to exploit the entire ship's structure as a radar aperture and employ individual antenna elements that are conformal and integrated into the ship's structure.

The opportunistic array concept aims to implement this with an integrated ship-wide digital phased array, where antenna elements are placed at available open areas over the entire length of the ship. Figure 1 illustrates a DD(X)-sized ship with 1200 elements randomly distributed on its top-side structures. A key aspect of such a system is modularity – every antenna element is a self-standing transmit/receive module that has no hardwire connections other than power. Instead, a digital radar architecture is used to wirelessly network all the modular antenna elements and perform digital beamforming.

This research investigated the aperstructure and opportunistic array concepts in the context of Ballistic Missile Defence (BMD) in the US Navy.

Forward-Deployed Ballistic Missile Defence

The US Navy's key and enduring role lies in its core capability of continuous forward deployment of sovereign US warships. The introduction of BMD into the fleet enables the US Navy to project defence ashore from the sea by detecting and tracking hostile missiles launched far inside an adversary's homeland. This brings about a forward-deployed BMD umbrella for expeditionary air and land forces as they move into theatre – an increasingly crucial requirement as decreased shore-based presence overseas results in more forces being deployed into theatre from the US in times of crisis. In addition, a forward-deployed sea-based BMD will take the fight against asymmetric threats (e.g., theatre ballistic missiles armed with chemical and biological warheads) to the adversary's shores – reassuring enduring and emerging allies that they are protected too.

Key Advantages of the Aperstructure and Opportunistic Array Concepts

The aperstructure and opportunistic array concepts offer several key advantages over conventional radar systems. These include:

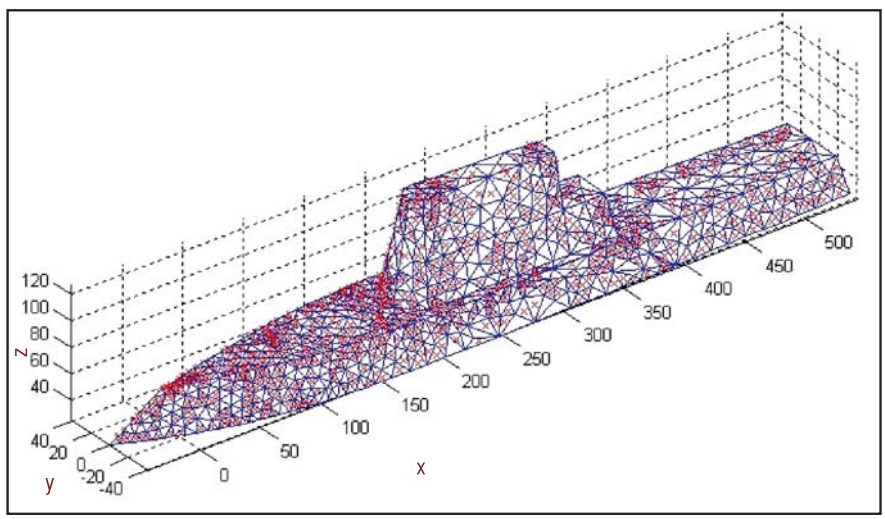

Figure 1. CAD Model of DD(X)-sized Ship with 1200 Randomly Distributed Antenna Elements (A red 'x' denotes an element location).

a. *High Angular Resolution*. The primary advantage of aperstructures and opportunistic arrays is the high angular resolution they can be achieved by utilizing the entire ship's structure as a radar aperture. High angular resolution is especially important in BMD applications when it is critical for the radar to detect the exact number of hostile missiles in flight and to track them precisely – at ranges beyond 1000 km. Angular resolution is proportional to beamwidth and the 3-dB beamwidth, θ_B, of an aperture can be estimated by $\theta_B \approx \frac{\lambda}{L}$ where λ is the wavelength and L is the length of the aperture. Using the length of the entire ship's structure as the aperture will minimize the beamwidth and achieve finer angular resolution.

b. *Enhanced Stealth*. Low profile patch antennas integrated into the ship's structure using hull appliqués hold the key to minimizing the ship's visual signature as well as radar cross section (RCS).

c. *Multifunction*. The digital architecture of the opportunistic array offers several advantages over conventional radar designs. Advanced signal processing techniques coupled with broad-band patch antenna designs offer the possibility of integrating radar, direction finding and satellite communications functions into the array. The result is a single aperstructure replacing the numerous antennas and masts populating the superstructures of present day ships.

d. *Increased Survivability and Operational Availability*. Opportunistic arrays are inherently more survivable and have increased operational availability vis-à-vis conventional radars. A radar architecture with hundreds of dispersed antenna elements ensures that operations will continue even if a number of elements are disabled due to enemy action or maintenance requirements. The modularity and accessibility of the antenna elements also means that damaged elements can be quickly replaced, even if the ship is in the high seas. In addition, the relationship between the performance of the radar and the number of functioning elements can be well-predicted, allowing any degradation in radar performance to be compensated by tactical means.

e. *Right Cost*. The digital radar architecture leverages on COTS technology to achieve high performance at the right costs. It also eliminates the need to maintain several distinct radar and communication systems by integrating their functions – resulting in overall cost savings.

Primary Research Objectives

This research addressed two primary research objectives in the development of the aperstructure and opportunistic array concepts, each with two research tasks:

a. *System Study of Aperstructure and Opportunistic Array Concepts.*

- Verify that a ship-based opportunistic array can achieve a detection range of at least 1000km.
- Characterize the radar performance vis-à-vis the number of antenna elements.

b. *Design of Low-Profile Broad-band Microstrip Patch Antenna.*

- Design a low-profile patch antenna with broad-band characteristics necessary for radar and communication functions.
- Develop a set of design procedures that result in a good "first-pass" design with prescribed characteristics that require minimal tuning.

Opportunistic Arrays – Random and Thinned Phased Arrays

Opportunistic arrays can be described as random and thinned phased arrays. Opportunistic arrays exploit the advantages of conventional phased array radars while overcoming the physical impracticalities of implementing a uniform, periodic array on the superstructure of a ship.

• Phased Array Radars

Phased array antennas are typically formed by multiple single-element antennas spatially distributed in two- or three-dimensions. The radiation pattern of a single-element is typically wide, with low values of directivity (or gain). The radiation pattern of a phased array, however, is the vector addition of the radiation patterns of individual elements and can achieve very directive characteristics. In an array of identical elements, there are *five* factors that can be used to shape the overall radiation pattern of the antenna[1]:

a. Geometrical configuration of the overall array.
b. Relative displacement between elements.
c. Excitation amplitude of the individual elements.
d. Excitation phase of the individual elements.
e. Relative pattern of the individual elements.

Arrays offer several advantages over aperture antennas. The main beam is electronically steered and hence the scan rate is limited primarily by the speed of the control electronics. As a result, arrays are able to track multiple targets quickly. Arrays can also be made up of conformal antenna elements that integrate into the structures of ships and aircraft, thus reducing their aerodynamic drag as well as visual signatures. These advantages of phased array radars are exploited by opportunistic arrays.

• Why Opportunistic Arrays?

Phased array radars are most commonly designed with periodic arrays. In developing the aperstructure concept, however, it was necessary to investigate if random and thinned phased arrays i.e., opportunistic arrays, were able to achieve comparable performance. This was because the superstructure on a ship made it physically unfeasible to implement a uniform, periodic array over the entire ship's structure. In addition, opportunistic arrays could potentially reduce costs and weight vis-à-vis large periodic arrays of closely spaced antenna elements.

System Study of Aperstructure and Opportunistic Array Concepts

A CAD model for a DD(X)-sized ship was built and various numbers of antenna elements were distributed randomly over the ship's structure. The programme MATLAB was used to plot the beam

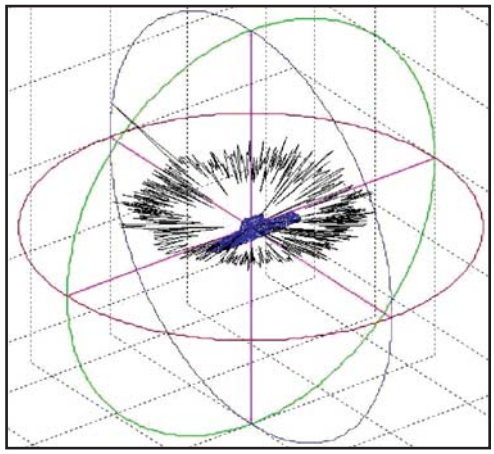

Figure 2. Polar Plot of the Radiation Pattern for a Broadside Scan Condition.

pattern and determine the gain and average sidelobe levels numerically for various element configurations. Figure 2 shows a polar plot of the radiation pattern for a broadside scan condition.

In order to create a realistic model, radar parameters from the AN/FPS-115 PAVE PAWS (Phased Array Warning System) were used. The AN/FPS-115 PAVE PAWS is an electronically steered phased array system developed by Raytheon and is the most similar system found in open literature[2] in terms of operational goals.

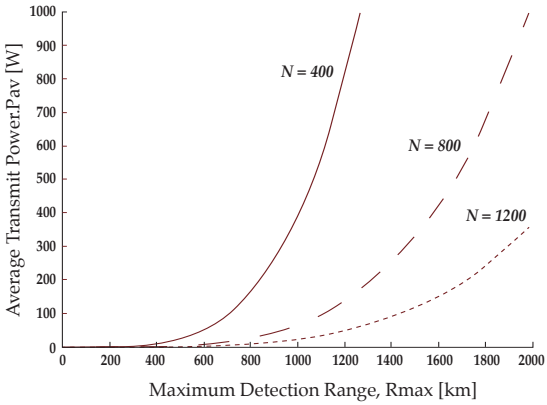

Figure 3. Relationship Between Radar Theoretical Maximum Range and Total Number of Antenna Elements for Broadside Scan Condition.

The radar average transmit power model was used together with the numerically determined values for gain as well as the parameters from the AN/FPS-115 PAVE PAWS to characterize the performance of the radar vis-à-vis the number of active antenna elements.

The simulation results indicated that only 400 antenna elements were required to achieve a theoretical maximum range of 1000km, assuming (as in the AN/FPS-115 PAVE PAWS) that each element delivers an average power of 500W. Figure 3 shows the simulation results for a broadside scan condition. In addition, it was shown that it was possible to predict the relative sidelobe level and main lobe gain, given the number of active antenna elements. Subsequently, the radar performance can be predicted if the total number of active antenna elements is known.

Commercial Development of Microstrip Patch Antennas

In recent years, the rapid evolution of high-speed wireless communications technology coupled with the exponentially increasing demand for high-performance mobile applications have spurred intensive research into broad-band, low-profile antennas. Microstrip patch antennas possess the physical characteristics that make them ideal for mobile phones, bluetooth personal networks and wireless local networks – simple topologies, compactness and conformality. Interestingly, these exact characteristics are also desirable for the aperstructure and opportunistic array concepts.

"Classical" rectangular microstrip patch antennas however have bandwidths of approximately 2% to 5% – too narrow for use in typical communication systems. Figure 4 shows the topology of a rectangular microstrip patch antenna. Its simplicity – a patch of metallization on a grounded substrate – allows simple analysis and has resulted in well-established theory and analytical models that accurately characterize its behaviour. As described later, the theory for the "classical" rectangular microstrip patch antenna can be leveraged to develop the design guidelines for the U-slot microstrip patch antenna.

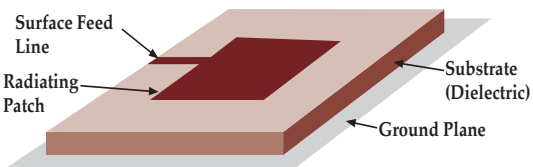

Figure 4. 'Classical' Rectangular Microstrip Patch Antenna[3].

Broad-banding of Microstrip Patch Antennas

Various techniques have been devised to increase the bandwidth of microstrip patch antennas. Two simple and common methods are to increase the patch height or decrease the substrate permittivity. Both, however, are typically inadequate as the former quickly nullifies the low-profile advantage of the patch while the latter is subject to material availability and suitability. More sophisticated techniques include the use of a stacked patch (a multilayer structure consisting of several parasitic radiating elements with slightly different sizes above the driven element) or a coplanar parasitic subarray (a planar patch antenna surrounded by closely spaced parasitic patches). Both methods, however, obviate the realization of a low-profile, compact antenna element. Another technique of achieving wider bandwidths involves aperture coupled excitations but this method complicates the fabrication process due to the need for complex feed element designs.

One technique exists to increase the bandwidth while maintaining a low-profile, compact and simple topology – modifying the basic element geometry. The major disadvantage of this method, however, is complex analysis as the relationships between the antenna geometries and its characteristics are typically too complex to represent analytically. Nonetheless, this was the technique selected.

Topology of the Rectangular, Probe-Fed, U-Slot Microstrip Patch Antenna on a Single-Layer Grounded Substrate

The U-slot antenna element design, when first presented[4], boasted an impedance bandwidth of 47%. This was a pioneering design because it achieved large bandwidths with a very simple topology – a simple coaxial feed, a simple U-slot patch design and a single layer foam substrate. Since then, many experimental and theoretical studies have been performed on the U-slot antenna design but no accurate analytical models have been developed. Two different parametric design approaches, however, were found subsequently [5 6]. This research evaluated

both design approaches and proposed a third approach – a hybrid approach that includes aspects from both.

Figure 5 shows the topology of the U-slot microstrip patch antenna investigated in this thesis. The aim of introducing the U-slot on the rectangular patch is to produce four resonance frequencies. Broad-band operation is achieved when the second and third resonance frequencies are sufficiently close. Experimentally, it has been shown that variations in parameters such as the width and length of the U-slot, height and size of the patch, probe size and location as well as substrate permittivity can dramatically change the antenna's behaviour. To date, however, no analytical method has been developed that accurately relate the complex relationships between the antenna dimensions and characteristics. Consequently, no analytical procedures can be offered to determine the dimensions depicted in Figure 5.

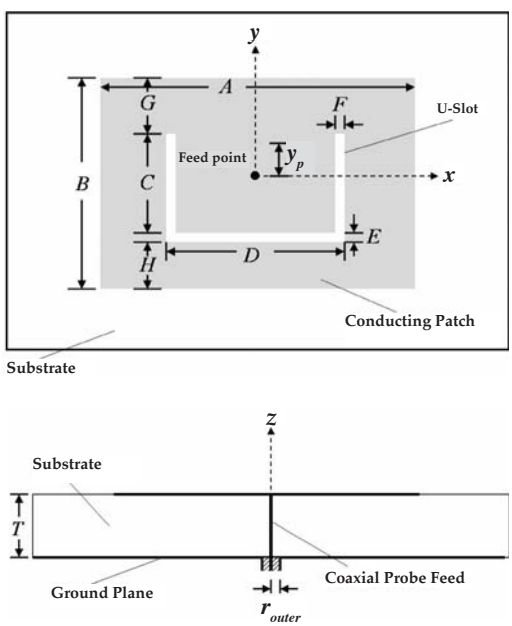

Figure 5. Topology of a Rectangular, Probe-Fed, U-Slot Microstrip Patch Antenna on a Single-Layer, Grounded Substrate.

Proposed Design Approach

The proposed design approach uses design equations established for the rectangular, not the U-slot, microstrip patch antenna, to achieve initial designs that are close to the desired operating frequency. Thereafter, to use the Smith Chart to identify trends in the tuning procedure and to systematically broaden the bandwidth. This tuning technique, however, requires an understanding of the relationship between the U-slot geometry and the impedance characteristics of the patch. In particular, parameters such as the probe location, probe radius, substrate thickness and slot width that exercise significant control on the impedance loop size and location were studied. Figure 6 shows generic impedance loci and the associated bandwidth characteristics.

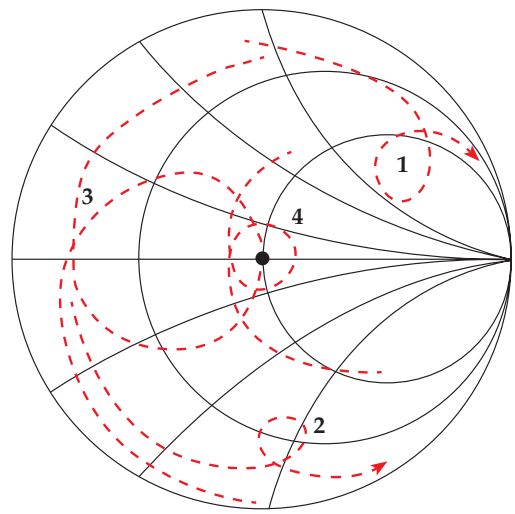

Figure 6: Generic Impedance Loci for U-Slot Microstrip Antenna.
[Locus 1 indicates that the design has too much inductance. Locus 2 indicates that the design has too much capacitance. Locus 3 indicates narrowband behaviour. Locus 4 indicates broad-band performance.]

Design of Low-Profile, Broad-band, Probe-fed, U-Slot Microstrip Patch Antenna

The simulation tool CST Microwave Studio was used to design the U-slot antenna element. CST Microwave Studio was first validated against published experimental and computed data for the U-slot geometry. It was determined that there was good agreement between the results from CST Microwave Studio and the published results[7]. Next, the type of substrate and coaxial feed were selected. The effects of variations in the U-slot dimensions on the impedance characteristics were then investigated using CST Microwave Studio.

- **Effect of Probe Location (y_p)**

Figure 7 shows the effects of varying the probe location along the y-axis on the impedance behaviour of the U-slot. The results indicate that as the probe is moved in the negative y-direction, the impedance loop becomes more capacitive and its size increases slightly.

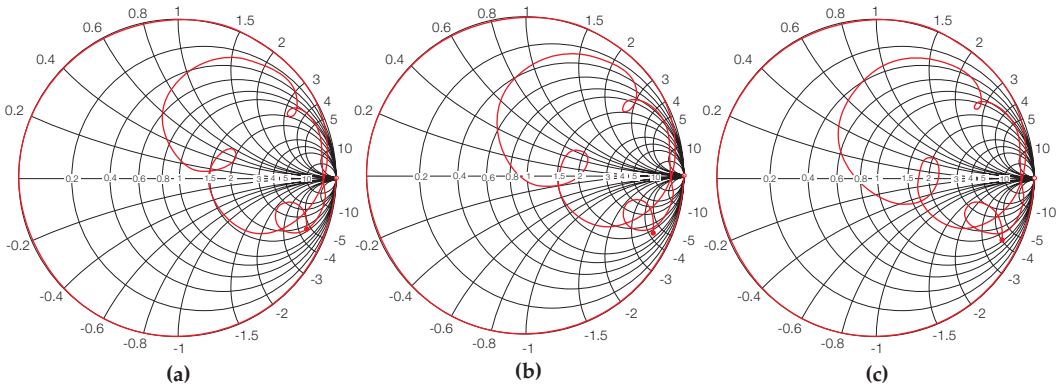

Figure 7. Effect of Probe Location on the Impedance Behaviour of the U-Slot. (a) y_p 0 mm, (b) y_p = -5 mm, (c) y_p = -10 mm.

- **Effect of Substrate Thickness (T)**

Figure 8 shows the effects of varying the substrate thickness on the impedance behaviour of the U-Slot. The results indicate that increasing the substrate thickness causes the impedance loop to decrease in size and also become more capacitive. However, Figure 8 also shows that there is a limit beyond which increasing the substrate thickness results in loss of the resonance condition.

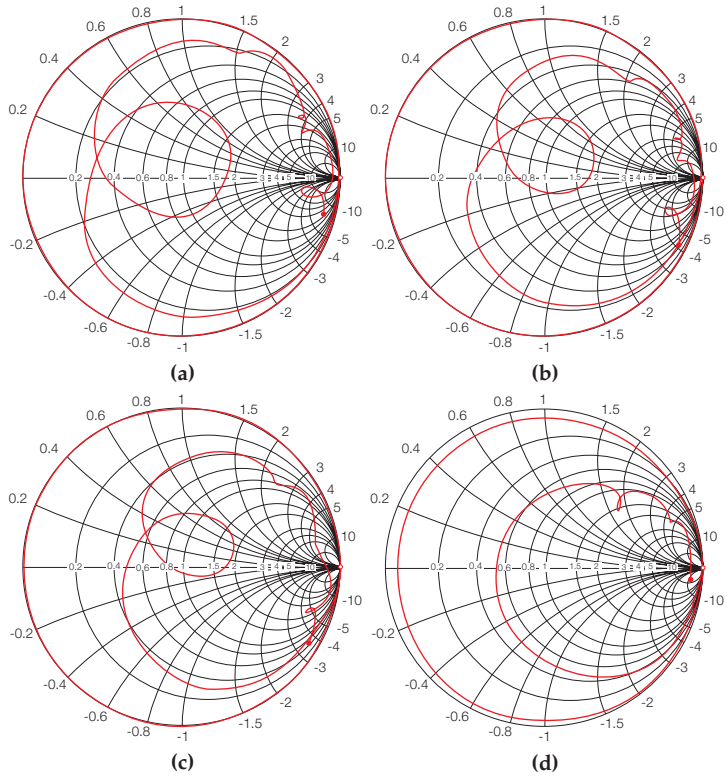

Figure 8. Effect of Substrate Thickness on the Impedance Behaviour of the U-Slot (a) $T = 40$ mm, (b) $T = 50$ mm, (c) $T = 55$ mm, (d) $T = 60$ mm.

- **Effect of Slot Width ($E = F$)**

Figure 9 shows the effects of varying the slot width on the impedance behaviour of the U-slot. The results indicate that as the slot width is increased, the impedance loop becomes more capacitive and its size increases slightly.

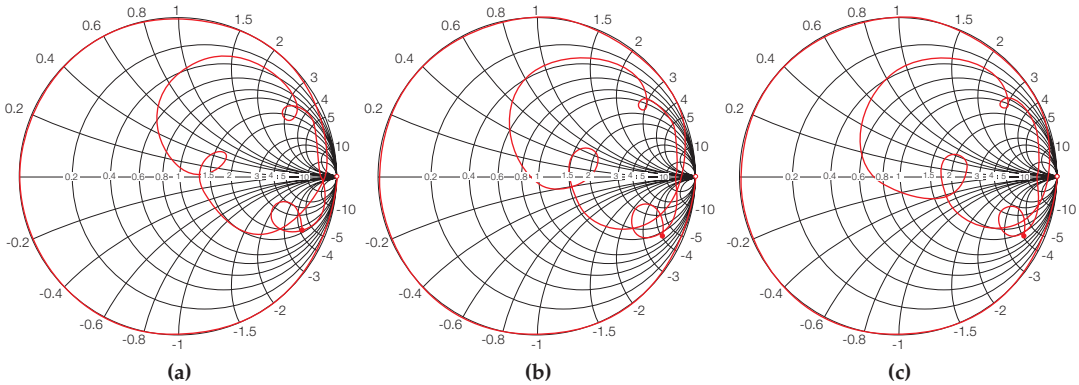

Figure 9. Effect of Slot Width on the Impedance Behaviour of the U-Slot (a) $E = F = 14$ mm, (b) $E = F = 15$ mm, (c) $E = F = 16$ mm.

- **Effect of $\frac{G}{H}$ Ratio**

Figure 10 shows the effects of varying the $\frac{G}{H}$ ratio on the impedance behaviour of the U-slot. The results indicate that as the $\frac{G}{H}$ ratio is decreased, the size of the impedance loop increases and becomes only slightly more capacitive.

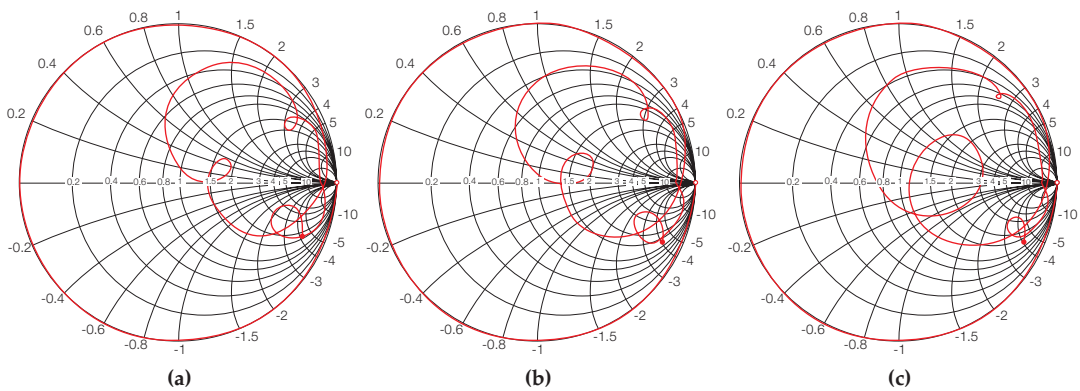

Figure 10. Effect of $\frac{G}{H}$ Ratio on the Impedance Behaviour of the U-Slot (a) $\frac{G}{H}$ =7, (b) $\frac{G}{H}$ =5, (c) $\frac{G}{H}$ =2.

Optimizing the Initial Design

An initial design with a center frequency of 300 MHz was created. Figure 11 shows the resulting Smith Chart. From Figure 11, it can be deduced that the design would likely exhibit narrow-band behaviour. This is confirmed in Figure 12, which shows the return loss for the initial design. From Figure 12, it is observed that the initial design has a center frequency of 346 MHz and a bandwidth of 24 MHz (7%).

The initial design was optimized using the proposed procedures and Figure 13 shows the resulting Smith Chart. From Figure 13, it can be deduced that the design would likely exhibit broad-band behaviour. This is confirmed in Figure 14, which shows the return loss for the optimized design. From Figure 14, it is observed that the optimized design has a center frequency of 316 MHz and a bandwidth of 63 MHz (20%).

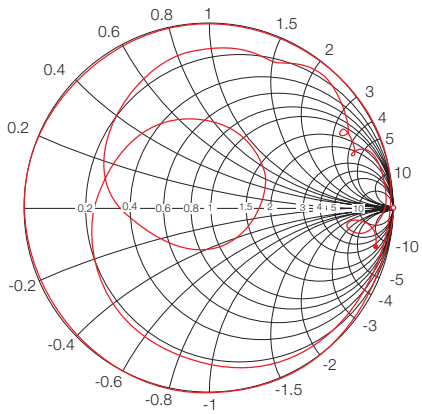

Figure 11. Impedance Locus for Initial Design of 300 MHz U-Slot Microstrip Patch Antenna Indicating Narrow-band Behaviour.

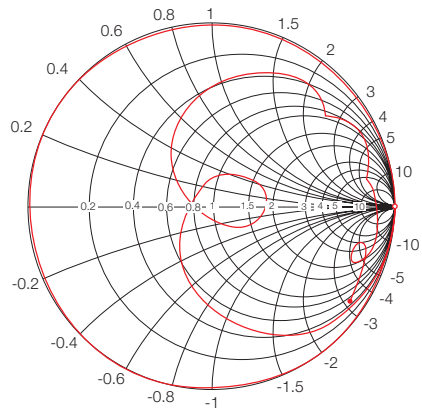

Figure 13. Impedance Locus for Optimized Design of 300 MHz U-Slot Microstrip Patch Antenna Indicating Broad-band Behaviour.

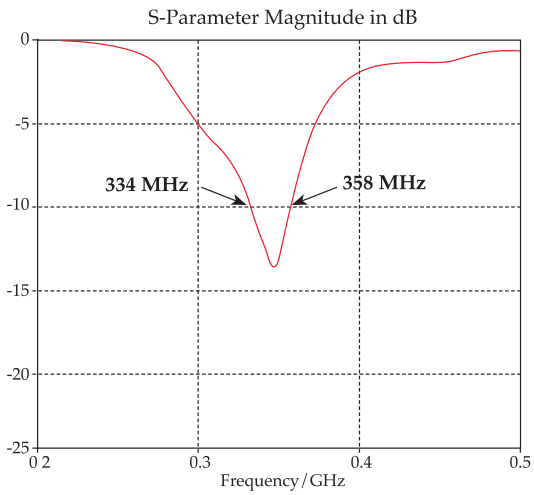

Figure 12. Return Loss for Initial Design of 300 MHz U-Slot Microstrip Patch Antenna Indicating a Center Frequency of 346 MHz and Bandwidth of 24 MHz (7%).

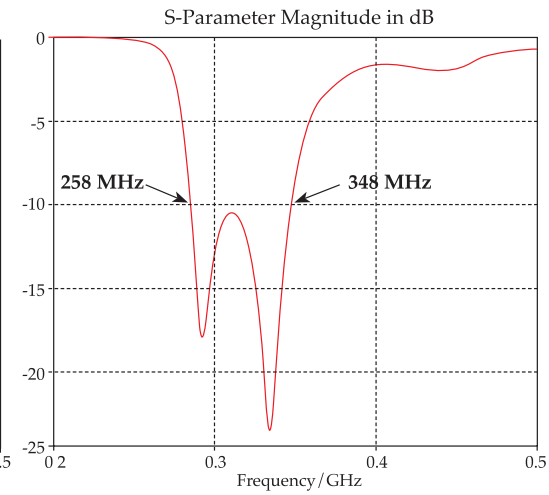

Figure 14. Return Loss for Optimized Design of 300 MHz U-Slot Microstrip Patch Antenna Indicating a Center Frequency of 346 MHz and Bandwidth of 63 MHz (20%).

Evaluation of Proposed Design Procedures

The design procedures outlined in this research created a functional initial design and provided a systematic method of fine-tuning the design to achieve broad-band operation. Nonetheless, it is important to understand the associated advantages and limitations.

- **Advantages of Proposed Design Procedures**

The advantages of the proposed design procedures include:

a. Initial design procedures are based on theory, albeit theory established for the rectangular microstrip patch antenna.

b. Initial designs typically achieve center frequencies that are close to the desired operating frequency.

c. Optimization procedures are systematic and intuitive.

- **Limitations of Proposed Design Procedures**

The limitations of the proposed design procedures include:

a. Physically unfeasible designs may be generated.

b. Does not insure that broad-band operation can be achieved for any given initial design.

c. Local optimum, instead of global optimum, may be achieved.

Possibilities of the Aperstructure and Opportunistic Array Concepts

The inherent advantages of opportunistic arrays, such as stealth, high angular resolution, multifunction, increased operational availability, low cost and, most importantly, their opportunistic nature, make them excellent candidates for a wide variety of applications, including:

- **Army and Air Force Applications**

The opportunistic and modular natures, stealth, multifunction capabilities and high survivability of these arrays can be exploited by the Army or Air Force to rapidly deploy networks of land-based radars within urban centres in crisis areas – quickly and covertly. Existing buildings can form the "aperstructures" and, with proper planning, the entire system could be set up under the cover of night. Such hastily formed radar networks can then be used for communications and/or to detect and track targets such as missiles, aircraft or artillery rounds. The fact that these arrays are dispersed, capable of operating under degraded conditions and quickly repaired make them highly resilient to attacks, even from anti-radiation missiles or artillery barrages.

- **Disaster Relief**

In the aftermath of the tsunami in 2004 as well as Hurricane Katrina in 2005, one of the biggest hurdles in bringing aid to the disaster areas was the lack of air traffic control facilities and communication links. Airports and airstrips existed in several of the affected areas but the lack of air traffic coordination hampered humanitarian

efforts and increased the risk faced by aircrafts and their crews. The absence of satellite communications links also resulted in many difficulties in the coordination of relief efforts. Opportunistic arrays offer a robust and flexible solution in such scenarios. Air traffic control and communication links can be quickly established by populating existing buildings with easily transportable modular antenna elements and using these buildings both as "aperstructures" as well as air traffic control and communication centers.

Conclusion

The first objective of this research was to perform a system study of the aperstructure and opportunistic array concepts. By combining statistical theory for thinned and random arrays with the results of the MATLAB simulations, it was determined that factors such as the number of active elements at specific scan angles, average sidelobe levels and main lobe gain could be predicted accurately. Using these results, the radar performance vis-à-vis the number of antenna elements was characterized. The study also verified that a theoretical maximum detection range of 1000 km could be achieved with approximately 400 antenna elements. In addition, the study indicated that 360° operation is possible, albeit requiring trade-offs in angular resolution and range.

The second objective of this research was to design a low-profile, broad-band microstrip patch antenna. CST Microwave Studio was shown to achieve results similar to the published experimental and computed data, hence validating its accuracy for the U-slot topology. The initial U-slot patch antenna design achieved a center frequency that was close to the desired operating frequency but had a bandwidth of only 7%. This design was optimized using a tuning technique that manipulates the location and size of the impedance locus on the Smith Chart. The optimized design achieved a bandwidth of approximately 20% while maintaining a low-profile, compactness and a simple topology. A set of simple design procedures that result in a good "first-pass" design with prescribed characteristics was also developed.

This research investigated the aperstructure and opportunistic array concepts in the context of BMD in the US Navy. However, the inherent advantages of such systems, such as high angular resolution, enhanced stealth and, most importantly, their opportunistic nature, make them excellent candidates for a variety of Army and Air Force applications.

Acknowledgements

The author would like to thank his thesis advisors, Professor David C. Jenn and Professor Donald L. Walters from the Naval Postgraduate School, for their excellent guidance and invaluable support in this research. Also, special thanks to LTC Yong Yoke Chuang (Republic of Singapore Air Force) and Mr Winston Ong (DSTA) who worked on the same project and were a source of great friendship, encouragement and support.

Endnotes

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VIEWPOINT

A More Realistic Experiment?

I want to compliment SCME, FSD and Dr Thunholm for the interesting experiment on Command and Control, detailed in "C2 Team Collaboration Experiment (TCX)", *POINTER*, Vol. 31 No. 3, pages 71-85. As an interested reader, I find myself wanting to raise several points of concern.

Firstly, **the positive correlation between experimental results and the expectation of the experimental team could possibly be put down entirely to the Hawthorne Effect**. This is especially so if the participants indeed "knew" of the expectations of the experiment beforehand. Professor Elton Mayo from the Harvard Business School discovered the Hawthorne Effect when he conducted a series of experiments at the Western Electric Company in Hawthorne in the late 1920s. He altered the physical surroundings and the work arrangements of the factory to understand what their effects on productivity would be. He was surprised to discover that productivity stayed higher, even when he reset everything to the original conditions. He concluded that productivity improvements that were observed under various circumstances, may not have been due to the changes in the physical surroundings or work arrangements, but merely to the **change in attention that the participants were receiving**. I agree with the observations by Mr Teo Chin Hock[1] that one way to isolate the Hawthorne effect was to have other HQs as control.

Secondly, I intuitively believe that **collaboration between HQs is far more powerful than within a single headquarters**. I believe that the experimental results looked largely at how it impacted on the Bn level rather than how collaboration can have the potential to reduce timings as **a system**. All field commanders know that the real key to speeding up battle procedure is not so much as reducing "coordination" within one HQ but **across several HQs vertically, i.e., Bn to Bde to Div, and horizontally, i.e.,** Bn to Bn, Bn to combat support units, etc. This is what really takes up time!

Thirdly, the experiment had two goals, which affected the ability to arrive at clear conclusive results. The first goal was to experiment with MissionMate to test its viability as a collaborative tool. This is a noble goal. If indeed this tool proves successful, principals need not be located together, but can be "distributed" across a wider area of the battlefield to reduce the Bn HQ's vulnerability to single attack, especially during its planning phase. To really test whether this collaborative tool works, one should stress the HQ to work under difficult conditions. The richest form of communication after all is face to face. Any other form of communication must feature some loss in richness. **We therefore need to learn what we lose by being physically separated and conversing over software.** Unfortunately, the experiment did not do this. The scenario was not complex. It was "realistic" and employed "a variation of one used for an earlier exercise" (lines 7 & 8 of pg. 75). In other words, the mission was familiar. I will be interested to know how the team would perform if presented with an unfamiliar scenario, and what the results would have been should the participants have been fatigued. Similarly, it would also be interesting to know how the experiment would have turned out if NSmen were involved. The second goal was to test the viability of Knowledge Battle Procedure (KBP), which is a variant of the SAF BP. A Recognition Primed Model of decision-making requires participants to be familiar with the scenarios. Otherwise, decision-making would not be recognition primed. So in the end, to prove the second, we needed things to be familiar. By testing the second, we limited the ability to learn about the first. The team should consider working on one thing at a time.

BG Bernard Tan
(Director, Joint Intelligence Directorate)

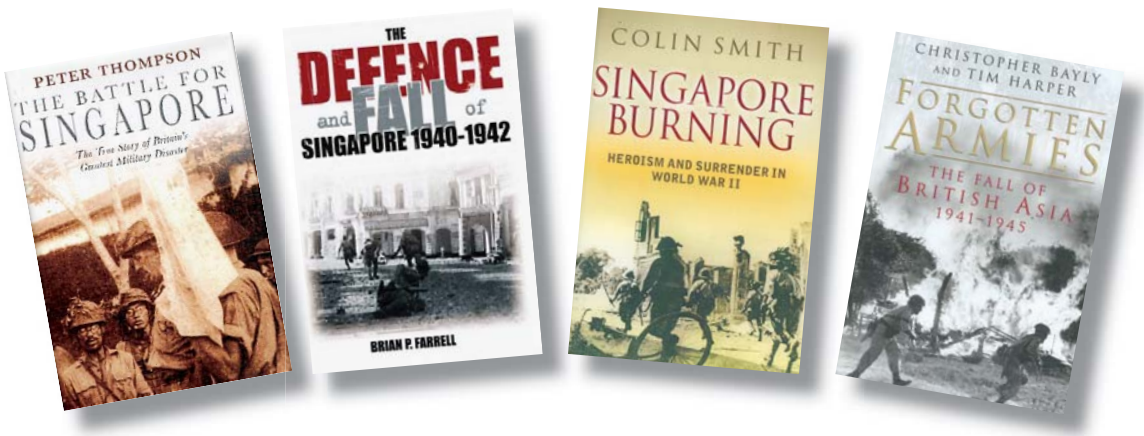
Endnotes

[1] In his written review of the "C2 Team Collaboration Experiment (TCX)", Mr Teo Chin Hock, Director (C4IT Services, DSTA) had suggested that the experiment would have been more rigorous if there was a "control team" subjected to the traditional regime of the SAF battle procedures for comparison.

BOOK REVIEW

Defeat into Disaster: The Defence and Fall of Singapore

by Mr Toh Boon Kwan



Brian P. Farrell, *The Defence and Fall of Singapore 1940-1942* (Stroud, Gloucestershire: Tempus, 2005).

Colin Smith, *Singapore Burning: Heroism and Surrender in World War II* (London: Viking, 2005).

Peter Thompson, *The Battle for Singapore: The True Story of the Greatest Catastrophe of World War II* (London: Portrait, 2005).

Christopher Bayly and Tim Harper, *Forgotten Armies: The Fall of British Asia, 1941-1945* (London: Allen Lane, 2004).

In *Did Singapore Have to Fall*, the historians Karl Hack and Kevin Blackburn classified the numerous writings on the Fall of Singapore into at least nine major schools of thought, ranging from grand strategic failures to poor military leadership to account for the Fall. They argued that the creative tension between the competing interpretations on the causes of the Fall offered a better understanding than a single explanation.[1] Not anymore.

In *The Defence and Fall of Singapore 1940-1942*, Brian Farrell, a Canadian military historian based at the National University of Singapore, has taken on the challenge of reconciling the different schools of thought on the Fall of Singapore and succeeded admirably

in providing a new explanation that synthesises past scholarship on this pivotal event in the history of the British Empire. Farrell offers the tantalizing thesis that it was the British military system that was responsible for the debacle in Singapore, transcending and subsuming his earlier arguments that poor command decisions at the grand strategy level and feeble leadership at the theatre level led to disastrous defeat in 1942.[2] Farrell argues that the military system tried to make the situation fit the plan and the battle fit the doctrine. This turned defeat into disaster.[3]

The imperial defence of the Far East was framed by the 'Singapore strategy' – a grand strategy that stipulated that any danger to the British Far East possessions, Australia and New Zealand would be swiftly met by a naval fleet sailing from the British Isles and operating from the Singapore naval base. The 'Singapore strategy', however, was never a realistic defence plan. It assumed that Britain would not be facing multiple threats simultaneously both in Europe and in the Far East. The modest capabilities of the Royal Navy meant that it could not adequately defend the British Empire against more than one major power at any one time. With Britain fighting for its life against Nazi Germany and Fascist Italy in 1941, it unsuccessfully resorted to bluff to deter Japan from taking advantage of its weakness in the Far East.[4]

Instead of rectifying the known weaknesses of British grand strategy, the men who ran the military system insisted on the retention of a flawed grand strategy, compromising theatre strategy and unhinged campaign strategy. This guaranteed defeat. The main fleet would not be able to arrive in time to make use of the Singapore naval base, yet theatre strategy was predicated on the defence of an empty naval base and forced the army to defend the whole of Malaya to keep enemy forces as far away from the naval base as possible. The army predilection for centrally directed set-piece battles based on holding static linear defences backed by firepower was ill-suited for the Malayan jungle. Instead, a battle doctrine of mobile defence that prizes initiative and battle drill, based on fighting for the road off the road, to inflict losses on the enemy rather than attempt to hold ground would have been a better response to Japanese infiltration tactics in the fight down the length of the Malay Peninsula. But this was anathema to British doctrine at that time and explains why the British army was consistently defeated from Norway to Malaya. The British military system was simply unable to cope with the high tempo imposed by the Japanese 'driving charge' at any time or any level. Defeat became disaster.[5]

Unlike the hard hitting and sobering analysis present in Farrell's work, the accounts by both Smith and Thompson make for light reading. Written in a journalistic style, both authors offer personal glimpses into the experiences of the fighting men and the civilians caught up in the maelstrom of war. The resentment welling up in Indian troops subjected to the racist attitudes prevalent in pre-war Malaya, the sense of bewilderment, chaos and panic experienced by civilians hurriedly evacuated before the rapid Japanese advance, and the frustrations of constant

retreats are splendidly captured by both books. The battles at Kota Bahru, Slim River and on Singapore Island, among others, and the sinking of the battleship *Prince of Wales* and battlecruiser *Repulse* are vividly described, chronicling the heroism, sacrifices, cowardice and desertion that are constant themes of life and death struggles at the sharp end.

Although atrocities committed by Japanese troops, for example, at Parit Sulong and Alexandra Hospital are now common knowledge, similar atrocities committed by Allied troops against Malayan civilians are only beginning to be acknowledged. Smith cited instances of innocent Malayans being placed at the tender mercies of their erstwhile British army protectors, summarily executed as suspected fifth columnists by panicky Commonwealth soldiers believing rumours that the native populations were aiding the enemy, for example, by pinpointing targets for air strikes. It did not help that many Commonwealth troops did not understand the language and customs of the local inhabitants they were supposed to defend.[6] Thompson noted that this sometimes proved deadly, for instance, in an encounter between Australian troops and Dalforce Chinese irregulars defending the same northwest sector of Singapore Island, at the expense of the Chinese irregulars.[7]

In his account of the Japanese initial assault on Singapore against 22nd Australian Brigade led by Brigadier Taylor, Thompson took pains to argue that the Australians did not cut and run in the face of the enemy's overwhelming numbers.[8] The Australians did not desert their posts. But Taylor disobeyed orders from his commanders for his brigade to hold their positions and await the counter-attack by Malaya Command's reserve. Having serious doubts that any counter-attack would be successful, he attempted to save his brigade by secretly authorising his units to fall back from their forward positions to a new stop line further back. But the fighting withdrawal scattered his troops as they floundered in the mangrove swamps and jungle in the darkness of night, intermixed with the advancing Japanese infantry. The path to disaster was paved with good intentions.[9]

In retrospect, Percival's responsibility for the disaster at Singapore has been exonerated by broader systemic explanations. As one individual in a flawed military system, he has shouldered the blame alone for far too long.[10] This assessment comes out clearly in the accounts by Farrell, Smith and Thompson.[11]

On the whole, however, all three accounts are largely chronicles of the Allied military experience and the tribulations of the European civilians. What is missing are the views of the Malayan civilians caught in the deadly struggle between two military systems. Fortunately, this gap is ably filled by the historians Christopher Bayly and Tim Harper. Their work covers the collapse of the British Far Eastern Empire, focusing on the fall of Malaya and Burma as well as the military mobilisation of British India to recover the lost possessions.

Telling the story from the local angle, Bayly and Harper narrates the dilemmas faced by the subject populations as a result of their conflicting loyalties, forced

to choose sides in the midst of the deadly conflict destroying their homes and livelihoods. Indians fought Indians as resurgent Indian Army troops faced off against their brethren serving in the Japanese sponsored Indian National Army in 1944.[12] Malay nationalists of the Kesatuan Melayu Muda pleaded in vain with their Japanese patrons to spare the lives of captured Malay Regiment soldiers who remained loyal to the British Crown.[13] The communist-dominated Malayan Peoples' Anti-Japanese Army fought hard against both the Japanese occupation army and criminal gangs affiliated with the Kuomintang, as well as inflaming ethnic tensions by assassinating Malay collaborators.[14] The war between Britain and Japan encompassed various civil wars involving an increasingly radicalised Asian population, armed and brutalised by both sides. As a result, "inter-community conflict became endemic in the wake of the fighting and would persist for at least a generation".[15]

Closer to home, the fall of a city to a callous enemy heralded the imposition of indignities on the civilian population. In spite of the best efforts of General Yamashita to impose discipline on his troops, Bayly and Harper reminds us of the orgy of rape that took place following the fall of Singapore as Japanese troops fanned out and took any woman they fancied. It was borne stoically and silently by the unfortunate woman folk in a society that treated rape as shameful. During the harrowing Occupation, more women would be coerced to become "comfort women" to serve the sexual needs of the Imperial Japanese Army. The men folk were not spared either. Bounded, blindfolded and massacred on Singapore's beaches as part of the Sook Ching operation. Similar atrocities were also taking place across the Causeway. More men – Chinese, Malays, Tamils – would die subsequently working on the infamous Thailand-Burma railway as slave labour.[16]

The end of war was greeted with relief by Malayans who were finally rid of the Japanese. But the returning British knew that they could not afford to overstay their welcome. Asian nationalism had been aroused and the end of the British Empire was discernible. The wars of decolonization would shortly follow.[17]

Let us not forget the immense suffering and sacrifices of our forefathers. And resolve to never, ever, take our defence for granted.

Endnotes

1 The nine major schools of thought are: Campaign School; Naval School; Diplomatic School; Grand Strategy School; Churchill thesis; Controversies School; Intelligence School; journalistic accounts and Japanese works. See Karl Hack and Kevin Blackburn, *Did Singapore Have to Fall? Churchill and the Impregnable Fortress* (London: RoutledgeCurzon, 2004), pp2-9 and author's book review of *Did Singapore Have to Fall*? in *POINTER*, 30, 4 (2005), p81.

2 See Farrell's earlier argument in Malcolm H. Murfett et al, *Between Two Oceans: A Military History of Singapore From First Settlement to Final British Withdrawal* (Singapore: Oxford University Press, 1999), pp175, 238, 360.

3 Farrell, *The Defence and Fall of Singapore*, pp8, 138.

4 Ibid., pp23, 28.

5 Ibid., pp119-120, 122, 179-180, 203-204, 397, 405.

6 Smith, *Singapore Burning*, pp160-161.

7 Thompson, *The Battle for Singapore*, p297.

8 Ibid., pp290-296.

9 See Farrell, *The Defence and Fall of Singapore*, pp343-344 and Smith, *Singapore Burning*, pp459, 466.

10 For an earlier exposition of this view, see Toh Boon Ho and Toh Boon Kwan, "Poor Military Leadership or Flawed Military Organisation? The British army and the Malayan Campaign", *POINTER*, 29, 1 (January – March 2003), pp44-67.

11 Farrell, *The Defence and Fall of Singapore*, pp. 400-401, 405; Smith, *Singapore Burning*, pp564-565; Thompson, *The Battle for Singapore*, p425.

12 Bayly and Harper, *Forgotten Armies*, p379.

13 Ibid., pp221-222.

14 Ibid., p449.

15 Ibid., p276.

16 Ibid., pp209-214, 405-411.

17 Farrell, *The Defence and Fall of Singapore*, pp390-394; Bayly and Harper, *Forgotten Armies*, pp462-464. Smith makes a weak attempt to argue otherwise. See Smith, *Singapore Burning*, p562.

Mr Toh Boon Kwan is currently pursuing his PhD in History at the National Institute of Education. He received a B.A. (2nd Class Upper Honours) in History from NUS in 1999 and is the winner of the Wong Lin Ken Memorial Medal and Book Prize 1998/1999. He was awarded the Singapore Technologies Engineering Ltd Scholarship to read the M.Sc. (Strategic Studies) at IDSS, NTU in 2003 and is winner of the Tay Seow Huah Book Prize 2003/2004. He is currently an NSman serving with SAFTI MI.

FEATURED AUTHOR

Christopher Alan Bayly

Christopher Alan Bayly is the Vere Harmsworth Professor of Imperial and Naval History at the University of Cambridge and a Fellow of St. Catharine's College. Previously, he has been Director of Studies in History, Smuts Reader in Commonwealth Studies, and read History at Oxford. His research and teaching interests include British imperial history, and Indian and Southeast Asian history. He won the Wolfson History Prize in 2004 for his "distinguished contribution to the writing of history".

Bayly's chief publications are *The Local Roots of Indian Politics: Allahabad 1880-1920* (1975); *Rulers, Townsmen and Bazaars: North Indian Society in the Age of British Expansion 1780-1870* (1983); *Indian Society and the Making of the British Empire* (1988); *Imperial Meridian: The British Empire and the World 1780-1830* (1989); *Empire and Information: Intelligence gathering and social communication in India 1780-1870* (1996); *The Origins of Nationality in South Asia* (1997); *The Birth of the Modern World: Global connections and comparisons 1780-1914* (2004); *Forgotten Armies: The Fall of British Asia 1941 -45* with Dr. Tim Harper (2004); and *Forgotten Armies: the Long March Back* with Dr Tim Harper (2005).

Bayly and Harper's "scholarly and panoramic" book *Forgotten Armies: The Fall of British Asia 1941-45* (as described by Benjamin Schwartz in his *New York Times* review) tells the story of Indian, Chinese, Malay and Burmese prisoners, slave labourers, refugees, nurses, doctors, coolies, and comfort women – "the forgotten armies" of ordinary men and women of the subject races of British Asia in its greatest crisis. Its broad scope of the British 'great crescent', which stretched from Calcutta to Singapore, weaves together the histories of South and Southeast Asia in a wartime narrative, filling a gap in Eurocentric narratives of the Asian theatre in World War Two, which tended to focus on the Allied military

experience. Brian P. Farrell from the National University of Singapore reviews the book in the *Journal of Military History,* lauds the authors for striking "the difficult balance between being useful to the specialist and engaging to the reader", and declares that we "can learn much from the authors' skill at placing the military story within the broader context" of the war. Yet he questions the authors' focus on the British Empire, that a 'cursory examination' of Thailand and the Dutch East Indies "distorts the wartime experience and all-important postwar repercussions in the region". A similar point is made by Jon Latimer in his review in the *Sunday Times*, that while "well researched", "fluid and erudite", the book's "narrative flow tends to be interrupted", with omissions like the "pivotal political debate between Britain and America over China that defined the course of the war in Burma". This sentiment is shared by Rose Milne in her review in the *South China Morning Post*, who also questions the suitability of the title to an Asian audience. On a more laudatory (and perhaps postcolonial) note, *Straits Times* columnist Asad Latif remarks that the book "answers back for those whose silence was an essential part of their servitude", "not to appease the greats but to remember people who were at the receiving end of history" – a point echoed by Toh Boon Kwan in his review of the book in this issue.

Another of Bayly's work spanning South and Southeast Asia is his editing of *Two Colonial Empires: Comparative essays on the history of India and Indonesia in the nineteenth century* (1986) with D.H.A Kolff, a comparison of the respective British and Dutch colonies and their histories. His own essay in the compilation, "Two colonial revolts: The Java war 1825-30 and the Indian 'Mutiny' of 1857-59" seeks to isolate some major similarities and contrasts between the societies of early colonial Java and India by reference to the two great anticolonial revolts of the period. He points to the vigour of millenarian and populist themes in the Java rising and to the relative weakness of these in North India, contrasting the strength of Hindu-Buddhist legitimacy as enjoyed by Dipanagara – the "just king" – with the ideological fragmentation of Indian kingship.

A similar topic is dealt with in Bayly's editing of Eric Stokes' posthumously-published *The Peasant Armed: The Indian rebellion of 1857* (1986), which represents a substantial part of what would have been his definitive statement on the social origins of the Indian Mutiny of 1857, a vigorous account which throws light on the reasons of the British victory and the failure of mutineers to consolidate their revolt. Bayly's reconstruction of the volume was no mean feat given the missing draft material for three chapters, the incomplete references, and the lack of conclusions.

We see this topic again in his work *Empire and Information: Intelligence gathering and social communication in India 1780-1870* (1996), where Bayly argues that successful intelligence-gathering was a critical feature of the British domination of India, and presents a penetrating account of the evolution of British intelligence

gathering in India between the wars of annexation in 1793-1818 and the aftermath of the Mutiny of 1857. In the book, he shows how networks of Indian running-spies and political secretaries were recruited by the British to secure military, political, and social information about their subjects. He also examines the social and intellectual origins of these "native informants", and considers how the colonial government interpreted (or more often misinterpreted) the information they were supplied with. He demonstrates that it was the colonial government's misunderstanding of the subtleties of Indian politics and values, which ultimately contributed to the failure of the British to anticipate the rebellion of 1857. He argues, however, that even before this, India's complex systems of debate and communication were challenging the political and intellectual dominance of the European rulers.

Perhaps more controversial was Bayly's major exhibition in 1990, "The Raj: India and the British 1600-1947", at the National Portrait Gallery in London, which discussed the complexities of presenting the myths and realities of British India. As he noted in *History Today*, aside from issues of "scholarly accuracy" and the "dangers of anachronism", political sensitivities aroused by the subject matter of the exhibition stirred up much controversy. Issues were taken with the very name of the exhibition, how representative it was of the history of the region, and its applicability to descriptions of the period of British occupation. Bayly identifies the central problem of any art-historical exhibition: "coherence over this large period and huge range of topics could only be maintained by structuring the exhibition around a historical narrative. A written historical narrative can always be nuanced and shaded; paintings and objects may be internally complex, but it is difficult to make them argue with each other". His exhibition sought to present the full context of history, in the evolutions of both its reality and popular mythology – "it proved impossible to avoid the colonial stereotype without distorting the historical record itself."

In a commemorative speech at his *alma mater* on Professor Ashin Das Gupta, Bayly recalled the influence the then-Research Fellow at St. Antony's College and the Oriental Institute had on his early academic interest in Indian historiography. He spoke of a man who "brought India alive for us" beyond the "restricted diet" of courses on the subject, as an "intellectual pioneer" of a "quiet revolution in the writing of Indian economic and social history." Perhaps we shall hear something similar in the future about Bayly himself in his own academic field, on works existing and those yet to come. We at *POINTER* look forward to reading them.

PERSONALITY PROFILE

Field Marshal Kodandera Madappa Cariappa

Kodandera Madappa Cariappa (1899-1993) was the first Indian Commander-in-Chief of the Army and Chief of Staff after India gained her independence from the British Empire in the aftermath of the Second World War. He was instrumental in overseeing the peaceful and orderly division of the Indian army into two separate national armies due to the partition of the Indian subcontinent in 1947. He also played important roles in the Indian army's ejection of the Japanese army from Burma during World War Two and the Indian success in the Kashmir conflict with the Pakistanis in 1947-8. While he was well-known as a Westernised Oriental Gentleman, his love for the Indian Soldier (Jawan) and his patriotism won him the respect and admiration of most Indians.

Cariappa was born on 28 January 1899 at Shanivarsanthe, Coorg (now renamed Kodavu), a small state on the western coast of South India. Cariappa was born into a family of prosperous farmers – his father was an official of the revenue department. Cariappa had his formal education in the Central High School at Madikeri, and Presidency College at Madras. He was heavily influenced by famous academics at the Presidency College, where he developed a passion for literature and theatre, was an active sportsman in hockey and tennis, and also grew to love music and sleight of hand tricks.

Cariappa had wanted to be a soldier since his childhood and when the opportunity presented itself in the late 1910s, he applied to become a cadet in the temporary School for Indian Cadets at Daly College, Indore. The selection criteria, comprising of a written test followed by an interview were very stringent. Cariappa was one of the privileged few selected to be the

first batch of Indian cadets. After a year and a half of rigorous training, Cariappa was placed seventh in the overall order of merit in his cohort of 42 newly commissioned officers in December 1919.

Cariappa was first posted to the 2nd battalion of the 88th Carnatic Infantry at Bombay. Shortly thereafter, he was transferred to the 2/125 Napier Rifles, which moved to Mesopotamia in May 1920. In June 1922, he returned to India and was posted to 7th Prince of Wales' own Dogra Regiment. The Battalion's main task was to maintain law and order and keep the rebellious Pathan tribesmen under check at Khirgi in Waziristan. It was here that Cariappa had his baptism of fire: Relatively soon after his posting to Waziristan, Pathan tribesmen ambushed his convoy of lorries. His command abilities and quick thinking were well demonstrated in this crisis and he kept the situation well under control before reinforcements arrived and the convoy suffered little damage.

As the 1920s progressed, the process of Indianisation of the Indian army was well under way and Indian Officers, like Cariappa, had more career advancement opportunities than their predecessors. In June 1923, Cariappa was transferred to the 1st battalion of the 7th Rajput Regiment (Queen Victoria's own Light Infantry), which became Cariappa's parent unit. His new unit had just moved to Waziristan and been assigned similar duties with that of his former unit. Life in the 7th Rajput regiment was interesting with regular attacks by the rebellious tribesmen in the northwest frontier in Waziristan, a good training ground for young officers. It was at Waziristan that young Cariappa learnt the fundamentals of his profession. He also understood the importance of good administration and situational awareness.

In 1925, he decided to embark on an extended overseas tour to further his knowledge and broaden his horizons. He had the support of the General Headquarters in Delhi, which helped arrange for stays with British units where possible. Cariappa visited Europe, America, China, Japan, among several other nations. This trip exposed him to people of many nationalities and showed him why India was still behind many of these countries. The trip was greatly beneficial and he returned a wiser and more informed person. Upon his return, he rejoined his battalion, which had moved to Fatehgarh, a small town with little entertainment activities. Cariappa thus spent his spare time reading books of a wide range of topics. He also started writing for military journals and newspapers. This pastime provided him with the satisfaction of seeing his name in print and some extra income at the same time. Cariappa's personality was one of frugality and moderation. He was always immaculate and fastidious about punctuality, etiquette and table manners.

In 1931, Cariappa was posted to HQ Peshawar District; it provided him with important experience about the functioning of administrative staff at the higher headquarters. In 1933, Cariappa passed the entrance examination to the Staff Course, and became the first Indian officer to attend the course at the Staff College in Quetta. After completing his course, he rejoined

his parent unit at Kohat for a third tour of regimental service on the northwest frontier in 1934.

In 1936, he was posted to Secunderabad as Staff Captain of the Deccan Area. In 1938, he was promoted to Major and appointed to a higher post in the same headquarters. At the start of the Second World War, he was posted as Brigade Major to the 20th Indian Brigade in Derajat.

In 1941, he was posted to 10th Indian Division under General Slim and the division spent the next year in Iraq, Iran, Syria and North Africa. In 1942, he was promoted to Lieutenant Colonel and became the first Indian Officer to be given command of a unit - 7 Rajput Machine Gun Battalion. Cariappa was a hard taskmaster and quickly managed to weld his men into a well-trained and effective fighting force. His unit was soon converted into an Infantry unit and moved to Secunderabad in Deccan. In 1943, Cariappa handed over command of his battalion and was posted to the HQ Eastern Command as Assistant Quartermaster. Therefore, although Cariappa had been given command of a battalion, he would miss the chance to lead it in battle against the Germans or the Japanese. Cariappa wanted to have battle experience and he volunteered to serve in an active formation when the South East Asia Command was formed the same year. However, he was again appointed as Assistant Quartermaster, this time of the 26th Indian Division based in Burma. Although it was still a staff job, at least it was on the battlefront. The division was in the thick of the fighting against the Japanese and was instrumental in pushing them out of Burma. Cariappa was awarded the Order of the British Empire, for his efforts.

In November 1944, he was promoted to Brigadier but was not given command of a brigade; instead he was assigned as a member of the Reorganisation Committee, studying the reorganisation of the Indian army after the war. This short stint provided Cariappa with the opportunity to observe the workings of the army headquarters as well as the Viceroy Secretariat, which would prove invaluable when he took over as Commander-in-Chief. In November 1945, Cariappa was finally handed command of a brigade, when he was appointed as the Commander of the Bannu Frontier Brigade.

After the end of the Second World War, Cariappa became the first Indian selected for training in the higher directions of war at Imperial Defence College, Camberly. There he was exposed to a larger worldview and to the major global geopolitical issues of that era. During this period, there was much talk about the impending partition of the Indian subcontinent and the consequent division of the Indian Army, which Cariappa opposed. He felt that an undivided army could help India and Pakistan overcome their teething problems, sound advice that went unheeded by his political masters. In July 1947, Cariappa returned to India with his course incomplete as he was recalled to supervise the reorganisation of the Indian army before Partition took place.

On 15 August 1947, India became independent and Cariappa was promoted

to Major General and appointed as the Deputy Chief of General Staff. He was also the Indian officer-in-charge of overseeing and managing the division of the Indian Army and the sharing of its assets between India and Pakistan in a just and orderly manner during the traumatic Partition period.

In November 1947, he was promoted to Lieutenant General and appointed as the Eastern Army Commander as war between India and Pakistan broke out over Kashmir. Within months, he became the General Officer Commanding-in-Chief, Western Command, directing major offensives in the Kashmir Conflict. Cariappa enjoyed some of his finest moments during the Kashmir operations. Operation Kipper, planned by and named after him managed to successfully wrestle back Naushera and Jhangar from the Pakistanis. Soon after, he directed operations for the recapture of Zojila, Dras, and Kargil, and the re-establishment of links with Leh. He achieved all these in spite of the numerous restrictions placed on him by Indian politicians due to larger geopolitical considerations.

On 15 January 1949, Cariappa was appointed as the first Commander-in-Chief of an independent Indian Army, and was instrumental in the integration of troops and the transformation from an imperial to a national army. He raised the Brigade of the Guards and the Parachute Regiments composed of all castes, and the National Cadet Corps and Territorial Army using Regular army troops. He once remarked, "I don't care a damn if a man is a Hindu, Muslim, Sikh, Parsi or Christian as long as he plays the game to serve our country well. This is all that matters to me."

Cariappa was a man of strategic insight. He once said, "In modern warfare, a large army is not sufficient, it needs industrial potential behind it. If the army is the first line of defence, the industry is the second." He was also a servant of the nation: "Army is there to serve the Government of the day, and we should make sure that it does not get mixed up with party politics. A soldier is above politics and should not believe in caste or creed." A key achievement of Cariappa's during his four year stint as Commander-in-Chief of the Indian army was keeping the Indian army apolitical and establishing good precedents for his successors to emulate. This was a lasting legacy and to this day, India did not witness political instability arising from military interference in politics.

After retiring from active service at an age of 53, he was appointed as Indian High Commissioner to Australia in July 1953. When Cariappa arrived at Canberra, the Governor-General, Field Marshal Slim, broke protocol and visited Cariappa at his residence before the newly arrived Commissioner had the opportunity to present the Governor-General with his credentials. This was perhaps an indication of the friendship between these two distinguished leaders and the high regard that Slim has for Cariappa.

In 1956, he returned to India and retired to his house, Roshanara at Madikeri, where he spent much of his spare time teaching and educating Indians about sanitation, the environment, among other issues. He continued to take a keen interest in matters affecting his beloved military. In 1962, when border clashes

broke out between the Chinese and Indians, he went to a local recruitment office and volunteered to enlist as a soldier. During the wars of 1962, 1965, and 1971, he visited the front lines to inspire the troops, once saying that "An officer is nothing without the soldiers", a statement which remains the guiding spirit for Indian officers even today.

In 1964, Cariappa founded the Indian Ex-Servicemen's League to look after the welfare of ex-servicemen. He made a brief unsuccessful foray into politics in the early 1970s. In 1986, he was conferred the title of Field Marshal by the Indian Government for exemplary service as well as the deep sense of respect in which Cariappa was held by all sections of Indian society. He lived and remained, as he said, "an Indian and to the last breath would remain an Indian. To me there are only two sthans – Hindusthan (India) and Foujisthan (the Army)." On 15 May 1993, Cariappa passed away in Bangalore at the age of 94, as a legendary hero of his country and an inspiration for the people of India.

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Payment enclosed Cheque No. and Bank _____

A. PAYMENT BY CHEQUE

Crossed cheque to be made out to *'Permanent Secretary, Ministry of Defence'*. Send this form and cheque to:

MINDEF Cashier,
D'eXecutive Services
5, Depot Road #15-01,
Defence Technology Tower B
SINGAPORE 109681

B. PAYMENT BY PAY DEDUCTION (ACTIVE SERVICEMEN ONLY):
Send back this form by fax to 6799-7758 or by post to:

EDITOR *POINTER*
SAFTI MI, Military History Branch
500 UPPER JURONG ROAD
SINGAPORE 638364

I authorise the deduction of $12.00 from my pay for the purpose of subscribing to *POINTER* for 12 issues.

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Signature / Date

* NSmen can opt to subscribe to *POINTER*. In-service military officers and DXOs (Grade 8 and above) are automatically subscribers of *POINTER* upon enlistment.

Please inform your AO or Chief Clerk within 14 days of any change in address for our database to be updated.

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