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Exclusive Interview with Brigadier Justin Kelly  
Director General, Future Land Warfare,  
and Commander, Land Warfare Development Centre,  
Australian Defence Force

Tsunami Mission: Disaster Assessment in  
Tsunami-struck Southern Thailand

*by COL(Dr) Teo Kwang Joo*

'Network-Centric Logistics' for the SAF:  
Ingredients and Challenges

*by LTC Lim Bock Aeng*

Maritime Security: Possibilities for Terrorism and  
Challenges for Improvement

*by MAJ Serene Chua Pui Hong*



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# EDITORIAL

Greetings! I am MAJ Andy Ang, the new Editor, *POINTER*. It is indeed a privilege to be part of the *POINTER* team, and I look forward to bringing you more quality articles and hearing your views. As we bid farewell to MAJ Sally Ho, we wish her all the best in her new posting at NEXUS.

**“Change is inevitable.  
Change is constant.”**

*Benjamin Disraeli (1804-1881)*

As the axiom goes, the only constant is CHANGE. People change, things change, circumstances change. Change can be big or small, pronounced or subtle. Change may be a choice we make, or it may be imposed upon us. It can be a breeze, but change can also be a painful process. Some people view change as a positive challenge, others fret and agonize over it. In Learning Organization, many of us will be familiar with the stories “Who moved my Cheese?”, “Outlearning the Wolves”, and “The Frog Experiment”. Closer to our hearts, a new job, getting married, and starting a family are examples of life changes we may experience.

In the military context, much has changed, especially since September 11, 2001. Faced with a rapidly changing battlefield, today’s armed forces must adapt to be relevant and effective. It is in this light that we are honoured to feature

the transcripts of an Exclusive Interview with Brigadier Justin Kelly, the Director General of Future Land Warfare, and Commander of the Australian Defence Force’s Land Warfare Development Centre, as he shares with us the transformation that is taking place in the Australian Defence Force (ADF), the key shifts in training and education of the 21<sup>st</sup> century soldier, and the challenges faced as he spearheads Army transformation for the ADF.

In this issue, we are also very privileged to publish an article “Tsunami Mission: Disaster Assessment in Tsunami-struck Southern Thailand” contributed by Chief Army Medical Officer, COL(Dr) Teo Kwang Joo. Having walked the ground of Southern Thailand in the aftermath of the Indian Ocean Tsunami, COL(Dr) Teo traces the time he led a United Nations Disaster Assessment and Coordination team, shares his poignant experience, and emphasizes the importance of a swift and accurate disaster assessment that will set priorities for action and save lives.

In the article “‘Network-Centric Logistics’ for the SAF: Ingredients and Challenges”, LTC Lim Bock Aeng illustrates the possible benefits that can be reaped if military logistics adopt the fundamental concept of Network-Centric Warfare (NCW). LTC Lim also highlights the importance of developing the parallel of NCW in its logistics

function so that a more co-ordinated, responsive, flexible and lean military logistics system can match up with the pace of operations of a 3G SAF.

MAJ Serene Chua then reminds us of the importance of maritime security in her essay, “Maritime Security: Possibilities for Terrorism and Challenges for Improvement”. Besides highlighting the attractiveness and vulnerabilities of the Malacca Straits to terrorist attacks, MAJ Chua also updates us on the measures taken and challenges faced, and posits that it is critical for the stakeholders to respond through a coordinated enforcement framework to the threat due to the strategic importance of the sea route to Singapore in specific, and the world in general.

In the article “The Human Perspective of Safety – A Flight Commander’s Reflection”, MAJ Tay Gek Peng emphasizes that leadership is a cornerstone to building and sustaining an effective safety culture. MAJ Tay also proposes three human level strategies to rejuvenate safety in the RSAF, and highlights the importance of maintaining a strong command emphasis on safety.

We are also honoured to feature the Personality Profile of Chinggis Khan written by Dr Gombyn Sukhee, Consul General of Mongolia to Singapore. The legendary Chinggis Khan (also widely known as Genghis Khan) was the definitive ruler and conqueror of his era, expanding the Mongolian empire from Korea to Hungary, to become the biggest and most powerful in the 13<sup>th</sup> century. Dr Sukhee traces the life of Chinggis Khan and brings to light some of the successful strategies and tactics employed by this dynamic leader.

Finally, back to change. Any change, even a small one, can invalidate a planned course of action. To drive home the need to know and respond to change, let me leave you with a quote from C.S. Lewis: *“It may be hard for an egg to turn into a bird: it would be a jolly sight harder for it to learn to fly while remaining an egg. We are like eggs at present. And you cannot go on indefinitely being just an ordinary, decent egg. We must be hatched or go bad.”*

Happy reading!

Editor, *POINTER*

# Exclusive Interview with Brigadier Justin Kelly, Director General, Future Land Warfare, and Commander, Land Warfare Development Centre, Australian Defence Force

## Background

Brigadier Justin Kelly is currently serving as the Director General of Future Land Warfare and Commander of Land Warfare Development Centre in the Australian Defence Force (ADF). He has had over 30 years of distinguished service with the ADF during which he has made momentous contributions in the area of Army force development. His previous postings in the Directorate of Operational Requirements, Directorate of Armour and as Director of Concepts and Capability Development have led him to accumulate a wealth of experience in the field of Army force structuring and development. In January 2000, Brigadier Kelly was made a Member of the Order of Australia for services to Army force development. He had also commanded the Peace Monitoring Group in Bougainville in 2000/2001 and was Deputy Force Commander of the Peacekeeping Force in East Timor in 2002/2003.

Brigadier Justin Kelly visited Singapore in February 2006 to attend the Land Defence Asia Conference 2006 as a



keynote speaker to share his ideas about force structuring and development. *POINTER* is privileged to conduct a filmed interview with Brigadier Kelly at the sidelines of the Conference. *POINTER* is pleased to publish an edited transcript of the filmed interview, conducted at the Marina Mandarin on 23 February 2006.



## Interview

**I'd like to start the interview by asking you to outline for our readers the key roles the Australian Defence Force's Land Warfare Development Centre (LWDC) plays and how these relate to your responsibilities as Director General of Future Land Warfare (FLW).**

I'll start from the other end first. Future Land Warfare Branch is one of the three branches of Army headquarters. It does the Army inputs to military strategy, it runs our international engagement program, and it has the Army's director of C4I SREW. It also has a combat development function. The purpose of FLW is to do a rolling analysis for the Army to identify the opportunities and the strategic threats, and try to find the best way forward for the Army to meet both strategic needs and to adapt to the contemporary operating environment.

FLW then turns those analyses into concepts, it gets those concepts agreed by the Chief of Army and the senior leaders, and at that stage, passes it to the Land Warfare Development Centre. At LWDC, we have brought together the Centre for Army Lessons, Army Simulation Wing, our Doctrine staff, and the Army Experimental Framework together with the Army's Force Development staff. LWDC is responsible for taking in concepts, adorning them with additional detail, testing them experimentally, testing them against current operational experience through the Centre for Army Lessons, and then generating concrete change initiatives either as doctrinal change, or in some other aspect of force development. Major equipment purchases, organizational

change; once that is done and agreed, it is passed out to other executive agencies for implementation.

**Would you elaborate on the process that the Land Warfare Development Centre goes through, to what extent you involve the Australian soldiers and commanders in your process, and how do you actually go about that?**

Within the doctrinal process, the wider army is engaged on a very intimate basis, in particular the training schools, and our actual doctrine writers are outposted to the arm and service schools. They are part of LWDC but living in the arm and service schools. At each, there are a number of doctrinal groups, steering groups, so there is a combat arms steering group, which is chaired by the Commander of the Combat Arms Training Centre, and so his school commanders and subject matter experts provide both the guidance to doctrine writers, and are responsible for approving as SMEs the doctrine which is written. Then they come to us to get the Army's approval and to endorse it.

So, it's a very close and engaging process, and our concern at the moment, is that we have a very large doctrinal edifice, over 300 paper pamphlets, and that means that the revisit time can be three to five years depending on how important the document is. That is inadequate for the contemporary world. We are now going through a process of shifting our doctrine into an electronic search-engine basis, so that each soldier can have a webpage which is tailored to his own needs, and as we learn lessons which are of interest to the individual, the website will make that apparent to him. Equally, as we modify doctrine which is pertinent to him



or her, the website will notify the soldier that there is new doctrine which is of interest. So we are trying to engage each individual in doctrinal and continuous institutional learning.

**And will you be pushing out these e-publications over the internet or through an intranet?**

We are limited to an intranet at the moment, but we would be pushing it through some kind of password – protected system in the midterm. Not so much e-publications, there will be e-publications in them, but similarly there will be Communities of Practice, there will be raw observations from operations, there will be analyzed observations in the nature of lessons, and there will be embedded simulations. What we are trying to do is meet the individual needs of each soldier, using all the web technology and processes they are familiar with.

**You mentioned that experimentation is a responsibility of your Centre. How extensive are the experiments being conducted now in the Australian Army?**

We've been experimenting now quite extensively since the mid-90s, and we're quite practiced at it. I'll make a few points about army experimentation. First off, the nature of all military experimentation is that you tend to argue from the specific to the general, and therefore army experimentation is logically flawed. It is illogical to go from the specific to the general so we need to treat it very carefully. Consequently, we have embraced a battle-lab process where we do iterations of model-test-model, so a good idea might be

tested in a seminar, and is therefore further refined. It might then be tested in some kind of simulated war game which adds to our confidence in it, and eventually it might be built up to much larger and more comprehensive experiments. The battle lab process gives us confidence that what we conclude from experiments is broadly applicable rather than being true for only a limited set of circumstances.

At one stage we had a brigade dedicated in the field for a year and a half to do some experimentation, and more usual experimentation is under the auspices of the Army Experimental Framework which has a five-year rolling plan. Typically there will be four limited experiments, with a major headline experiment each year. They are thematically grouped, the limited objective experiments are to study discrete aspects of a larger problem, and 'headline' tends to bring what we have learnt from the limited objective experiments into a more comprehensive large-scale exercise. As I said, we've been doing it for over a decade now and it has proven to be extraordinarily powerful in a number of ways.

We do it in close conjunction with the Defence Science and Technology Organization (DSTO), and it is very much a partnership. And I suppose it would be fair to say that the Army asks the questions, and provides some resources, and DSTO conducts the experiments. That means that we have an external stakeholder responsible for the rigor of the outcome. The reports that DSTO produces are subject to scientific peer review, and so the experimental methodology and the results are

matched against the question for both rigor and direct connections. That means that we can have real confidence that although the answer might not be right, it would be difficult to get a better answer at this time and is likely to be mostly right. This relationship with DSTO has meant Army has been forced to expose its ideas to the independent scientific examiner, and it has proven to be very useful.

For example, we had a concept in the mid-90s called the 'Army in the 21<sup>st</sup> century' which had a major restructuring proposal, which restructured essentially every company and platoon in the Army. We subjected that to very extensive trial over two years, and in the end disproved the underlying proposals. So, we were able to avoid moving off into what would have been a force structuring error. The independent view has prevented us from falling into group-think on occasion. Equally, as we go through experimentation, we engage the wider Army in a number of ways. We take the Army staff college students each year, and use them as experimental subjects in the headline experiment. In the limited objective experiments, we also try to bring in subject matter expertise from the working army as a matter of course. The result is that over the decade of Army experimentation, nearly all officers have been engaged and involved in experimentation, and have become aware of the rigor, and in fact the tedium, of experimentation, and as a result, the Army is increasingly trusting of experimental results. The strength of the Army Experimental Framework brand is such that now decision-makers, faced with an

experimental result which says that this is as close to right as we can get, will generally accept that without further discussion.

**Moving on to the next question, could you please share the Australian Army's perspective on Future Land Warfare? What have been the key factors in the Australian context that have given rise to this point of view?**

We believe that there is no revolution in military affairs. It is our basic proposition that there are a number of longstanding trends which have been shaping warfare for a very long time, and we think that in force development time frames will remain relatively stable.

Those trends are a steady increase in lethality of all sorts. Single-shot kill probabilities of nearly every weapon have made steady increases since the Stone Age. We have in the last ten to fifteen years seen a rapid improvement in the lethality of artillery and air-delivered weapons, and that is not new, they have always been lethal, but their sheer efficiency and utility have been growing steadily over the last ten to fifteen years. That has been driving the 'emptying' of the battle-space. In Napoleonic times, people manoeuvred shoulder to shoulder in very deep echelons, and by the time of the US civil war, the battle-space was starting to empty, with higher rates of fire, more lethal weapons, better communications enabled war to spread out. By World War Two, we had non-linear operations with deep penetrations and large elements of combat power just being thrown into depth. We believe that trend has continued until now. It

is more correct to say that the battle-space has become disaggregated, and in fact it is now a mission-space within which battle-spaces will erupt with little warning.

The problem we have then is a space-to-force ratio, which is becoming unmanageable. Our usual aggregations of combat power with which we are comfortable, and our combined arms processes based on battalions or brigades or divisions, may no longer be appropriate, simply because we can't cover the space that we need to. In fact, if we create these large aggregations, the very lethal weapons with which we're faced will destroy large numbers of our forces. So, they are the first two trends. And those two have begun to merge into the third trend, which is the retreat into complex terrain.

As the battle-space is emptied, operations in the open, like open rolling terrain, have become impractical, because of the power of standoff strike. Therefore all forces, both regular and irregular, will increasingly be required to take shelter in complex terrain. There are a number of types of complex terrain: complex physical terrain we are all familiar with. In complex physical terrain, we are able to hide from the enemy's ISTAR and the enemy is able to hide from our ISTAR, and that means that we tend to fight by touch rather than with foreknowledge.

Equally, many of our enemies might choose to shelter in complex human terrain, that is, by surrounding themselves with innocent populations that prevent us from applying the combat power that we possess, or by

looking like innocent populations, they create a problem of recognition, of target acquisition for us. So, the retreat into complex physical terrain is associated with the retreat into complex human terrain.

Associated with that again is the retreat into complex informational terrain, where a penetrating international media will tend to look at operations in their own way. They will tend not to be terribly analytical, but will look at the image of conflict, and all conflict is inherently ugly. Conflict in urban terrain, because it deals with familiar objects, is even uglier. In urban terrain with innocent populations it is uglier again. And so whatever the motivations, or the rights or wrongs of any particular conflict, the media will tend to deal with it in a very unsympathetic way and so many of our enemies benefit from withdrawing into this kind of complex informational terrain. What that means, of course, is that very junior soldiers will be faced with very important strategic decisions, and will need to have a depth of understanding that we haven't demanded before. We like to say that the strategic corporal is now a private.

**Given this perspective, could you highlight perhaps what have been some of the key shifts in the training and education of your commanders?**

I would just make the observation that we are at very early stages of this shift. In the middle of last year, we agreed on an Army capability requirement for the 21<sup>st</sup> century soldier, including the 21<sup>st</sup> century officer. Our Chief of Army has issued a directive

on the 1<sup>st</sup> of January this year, which tasked us in Future Land Warfare to develop a detailed plan for the delivery of that soldier, and we are now on the path to do that. We have always been very good at producing soldiers and officers who are technically proficient, who are able to do their roles in military appreciation processes, who are able to lead their troops, navigate, work their radios, work with vehicles, do tactics. We've always been able to do that to our satisfaction.

In this more complex environment into which we are sending our soldiers, there is now a need for a depth of understanding: cultural understanding, strategic understanding, media understanding, which we have tended to harvest from relatively smart troops in the past but have done very little to nurture. Because of the difficulties inherent in complex terrain and complex warfighting, we believe we need to move along the path of improving their understanding. As well as improving the teaching of languages, we believe that there probably is an advantage in teaching critical thinking skills, creative thinking skills, and giving them intellectual tools to read a culture better than they have at the moment. We also need to improve our strategic education.

We strongly believe that war will become more joint, so we need to improve joint interaction, while retaining single-service excellence and culture. If we go too joint too fast, we put pressure on single-service cultures, which means the basic mechanism that allows us to fight may be weakened and we wouldn't want that.

The third part of it of course is so we have technical proficiency, we have understanding, the third part of the

puzzle – we are calling 'exertion'. We need to encourage every soldier and junior leader to step up and take control of their immediate circumstances, to lead themselves, to lead their peers, and to lead their superiors on occasion. The complex physical terrain isolates small teams, and although we can provide some support through networking, many of the decisions and many of the actions will be taken at very junior levels.

It is hard to make a soldier the subject of a passive learning environment, and then put them into an operational environment and say 'Step up, fly, you're free'. We have to do the technical proficiency and the understanding in a way which constantly requires the individual to take charge of himself and to take action autonomously. So what we're saying is that there is a training part, an education part and a conditioning part. We're at early stages, there is strong support across the army for it, there is strong support from our leadership for it, and I think we shall see substantive changes, which will start over the next year. But the nature of these changes is generational, and this will take many years to fully deliver.

**Could I ask you to elaborate then on what you think the organizational challenges actually are in trying to bring about these shifts and these changes? You've alluded to some of them, but up front, what are you facing on a day-to-day basis to bring about these changes?**

Our Army like all armies is busy. We have people on operations in Iraq, and in Afghanistan. Any Army which has people on operations tends to focus on their needs and what they're doing today. As a result the challenge of balancing resources and attention between future

needs and current needs, generally favours on current needs, which I think is right. But if you're a future-needs person, it's a challenge. We are lucky at the moment that the resources which flow to us from government are substantial, and this is very much a time of great opportunity. I believe the rate of change that we are undertaking at the moment, is limited not by desire, or by resources, but simply by the physical ability to change. We have a flood of new equipment coming in, we have a large degree of restructuring in order to prepare ourselves for complex warfighting environments, we have geographical shifts, we have everything in motion and we have people on operations, so I suppose the biggest single thing that we face is – the Army is so busy changing that it's hard to do new change on top of that.

**You mentioned that there is a high degree of support in the general Army for these changes. I assume that in every organization there would always be pockets of detractors and resistance. What are the main lines of arguments of these detractors against what you're trying to do?**

If it's not broken, don't fix it. And our Army has had a record over the last decade of continuous operational success. And people say that it's all going well, what would we change, why would we try to make substantial changes to what's going well? And again it's that current needs vs. future needs. We would see that any Army in this rapidly changing strategic environment needs to be continuously evolving and adapting, taking on new things, discarding old things. But people who are in battalions

and regiments, who are doing good work, who are performing well, don't feel that hunger for change in the same way. But I have to say that our leadership is very strongly towards continuous change and evolution, and it's bearing strong results at the moment.

**Could I ask then whether your experimentation process has a secondary objective – the need to expose people down at the regiments to the new ideas, to make obvious the need for these changes?**

Absolutely. In fact, we called our largest experiment 'headline', with a view that we would not actually learn much during the headline experiment. We would do the learning in limited objective experiments, and then in the headline activity, we would get the largest community possible in and involve them in the experimentation, show them the process, show them what we've learned, and use it as much as a PR activity as an experiment. At times we have had 300-400 participants in a simulated wargame. So from the start that was our intention and it has proven to be extraordinarily useful.

**Moving on, could you please describe and elaborate the links and processes that you have between your agency and those of your sister services in the ADE, in developing joint capabilities.**

The army investment in experimentation, in concept writing and in force development, is much larger than the other services. We may say that is because the challenge of understanding and articulating the very



complex 'system of systems' that is the Army is much greater than problems faced by platform-based services. We are also part of a very joint staff structure, we have a standing joint operational commander, we have a standing joint chief of capability development who is responsible for developing the ADF as a whole, and we have joint strategy staff and strategic policy staff. So our interactions as a force development agency takes place within that much larger and very powerful joint construct. We have in the department a head of strategic policy, who has a director general of military strategy and concepts. The 3 services work very much hand-in-glove with that man, and the services co-operate in a range of ways. Last year in our headline experiment we were examining a thing called a 'Recon Fire Complex', which is an integrated joint team at a very small level. We did that in a single-service environment with Air Force observers. In April this year, the Air Force is conducting their own experiment, but they are using the same scenario, and they are looking specifically at the Air Force part of it. So co-operation means that, although there are single-service experiments, we are dealing with a joint problem jointly, and will participate in experiments fairly collaboratively. We had the same approach when we were doing amphibious experimentation early this decade. The army had a concept called manoeuvre operations in the littoral environment, and we were experimenting very much on how we got from the ship to the beach and what we did subsequently. The Navy then experimented on how they got the ship to the beach, and supported the offload, and as a result we ended up with a very strong joint view of how amphibious operations should be conducted now and into the future. In fact, we were able to articulate many

of the parameters that will contribute to confidence of a successful outcome.

**I'd like to end this interview by touching on the issue of success factors. Other than the organizational structures and processes that you have in place, what do you think are the key success factors that will allow the ADF to continue to optimize its resources and move along this developmental path?**

I think clear concepts and rigorous examination of those concepts in the most open way possible, builds great confidence across the organization. If the organization is confident that the directions which are being taken seem likely to work, then resistance to change is minimized. It will still be there but it is minimized. If you link that to a strong leadership group intent on constantly adapting the defence force, I think we're in relatively good shape.

**Thank you very much for your time this morning, for your openness and your willingness to share with our readers your perspectives. All the best for the journey that you have embarked on.**

I'd just like to say that I've been really quite excited and impressed by the approach to change that the Singaporean army has taken. I think it's an exciting time and the products I've seen to date have been very good. Good luck. 🍀

*This interview was conducted by COL Lim Teck Yin, Commandant, Singapore Command and Staff College and Chairman, POINTER Editorial Board.*

*The filmed interview is available at the POINTER internet website.*



# Tsunami Mission: Disaster Assessment in Tsunami-struck Southern Thailand

by COL(Dr) Teo Kwang Joo

## Introduction

An accurate disaster assessment is a key element of a successful disaster response. Disaster assessment is carried out to determine the effects of a disaster on the stricken community. The purpose is to provide information that can guide lifesaving activities and then continues as a means of monitoring the situation and forecasting future needs of the survivors.

A swift and accurate assessment will enable mission planners to proceed expeditiously with humanitarian relief. An assessment that is incomplete or inaccurate may lead to inappropriate relief efforts and costly delays.

## Thailand's tsunami experience

On 28 December 2004, in response to a Thai government's request for international assistance, the United Nation's Organisation for Co-ordination of Humanitarian Affairs (OCHA) dispatched a 4-man UN Disaster Assessment and Coordination (UNDAC) team to southern Thailand. Four other UNDAC teams were also deployed to the tsunami-hit region including 2 teams to Indonesia and 1 team each to the Maldives and Sri Lanka.

On arrival, the Thai UNDAC team led by the author met with Thai government

officials including ministers, military commanders, governors and the various NGOs and UN representatives in Thailand (Picture 1). Soon after, the team carried out rapid assessment in the six tsunami-affected provinces of Ranong, Phang Nga, Phuket, Krabi, Trang and Satun (Picture 2). We sought to determine the extent of the disaster effects, locations of critical need, such as search and rescue, operating status of water and sanitation systems and other critical facilities.



*Picture 1: UNDAC team arrived in Phuket, Thailand to coordinate international rescue and aids*

Despite our participation in previous disaster relief missions, the team was left awe-struck by the destruction. All along the coast of southern Thailand, the scene was the same. Nothing was left standing. Villages, buildings and holiday resorts were flattened like paper structures (Picture 3). Ports were damaged and boats were washed

several kilometres ashore and were left sitting in the streets (Picture 4). Human remains were piling up in temporary mortuaries set up in local temples. The death toll rose by the day.



Picture 2: **Flattened coast.** Tsunami left trails of destruction in Khao Lak, Phang Nga province

It was heartening to see the Thai government's swift response to the disaster. The Thai Prime Minister put his deputy in charge of the entire relief operation in southern Thailand. Reporting to him were the ministries of foreign affairs, interior, social affairs, health as well as the Thai military. The Thai Ministry of Foreign Affairs handled the diplomatic community while the Ministry of Interior co-ordinated the national relief efforts. The Ministry of Social Affairs focused on reconstruction.



Picture 3: **Broken homes.** Picking up the pieces in Phi Phi island

The Thai military deployed a significant amount of resources in aircraft, ships, engineer plants and troops to assist the civilian disaster relief efforts. As Thailand did not have a civil defence force, search and rescue came under the direct control of the military. The command and control by the military saw relief supplies reach the south quickly, reducing the need for foreign aid.



Picture 4: **High and dry.** Boat washed ashore by the giant waves

Due to the large number of foreigner fatalities, there was huge diplomatic presence in the Phuket City Hall where the command centre for tsunami relief effort was located. The regular update sessions by the Minister of Interior was attended by more than 25 ambassadors. Under pressure from their respective governments, they asked tough questions. Mainly, these were the management of foreigners with missing travel documents, missing loved ones, evacuation of injured foreigners to their home countries and the repatriation of remains.

In the early days, faced with the shortage of refrigerated containers, the UNDAC team advised the Thai Government to carry out temporary burial for the large number of unidentified remains after they were photographed and had their dental

and DNA records taken. As an interim measure, dry ice was also used to delay decomposition of the bodies collected at the field mortuaries. Later, with the help of INTERPOL and international forensic teams, the Thai government quickly got DVI (Disaster Victim Identification) underway. Soon, refrigerated containers from local contractors began to arrive in large numbers. It was no small feat for a system to be put in place within such a short period of time.

Within three days, the UNDAC team had completed rapid assessment of all the six provinces. At the same time, daily co-ordination meeting was held with Thai officials, NGOs and UN agencies dealing with the disaster. This was a mean feat, considering it was only a 4-man team. Two members were out for assessment; one to Ranong, Phang Nga, Phuket and the other to Krabi, Trang and Satun. The remaining members of the team co-ordinated meetings in Phuket and attended the daily DVI co-ordination meeting. Having a group of professional and experienced UNDAC team was important as each member can be relied upon to work independently and is able to conduct quick and accurate assessments.

## Lessons for the SAF

The UNDAC mission to Thailand had learned invaluable lessons on disaster assessment. The co-ordination with multiple ministries and international relief agencies amidst intense diplomatic pressure had taught the seasoned UNDAC team important lessons.

Many foreign disaster relief teams and agencies had brought in services and resources, which were not useful.

The World Food Programme was rushing in food when Thailand was an exporter of food and not facing food shortages in the disaster areas. Food aid sent also proved unsuitable for the locals whose diet was mostly rice, vegetables and occasional fish.



*Picture 5: Ground feel. First hand appreciation of the situation*

Urban search and rescue teams, trained and equipped for urban environments, were less effective in searching the murky coastal water for human remains. Besides being there *early*, being *useful* is also important if we want to respond to disasters effectively.

The recent years have seen the SAF conduct a wide spectrum of overseas relief operations. It is important that as part of this capability build up, we also establish a strong rapid assessment capability that can be deployed quickly into an Area of Operations to gather a wide range of information. This assessment team should be multi-disciplinary, comprising of medical personnel, engineers, logisticians and communications specialists. The team, trained specifically for the disaster assessment role, can be inserted into a disaster area to provide information about the situation and what the approximate needs might be.

One of the most common mistakes of disaster assessment is to insist on an immediate account of every deceased, the physically injured, and destroyed or damaged houses. No such actions are possible until a full assessment is completed. Assessments that try to quantify every detail of a disaster will be completed too late to be of any good. It is accepted that the collected data provide only the “best estimates” of the situation. Too often, valuable time was wasted on collecting detailed information when representative information would be just as sufficient.

The collected information must also be useful to mission planners. It is important to provide information in such a way that it can trigger immediate and appropriate action. To do this, it may be necessary to collect the data incrementally, that is, to collect information according to the order in which it will be needed for decision making. The information should be presented in such a way that its implications are clear to the reader. This often means that some form of

baseline information is necessary in order to be able to determine priority problems and trends.

## Conclusion

The importance of an accurate disaster assessment cannot be overstated. Disaster assessment saves lives, determine the victims’ needs and help set priorities for action. To assess a disaster effectively requires pre-planning and training. It is necessary to pre-identify information needs and prepare assessment plans as part of our continued preparedness for overseas relief missions.

Timing is a crucial element in disaster assessment. Situations and needs change dramatically from day to day and assessments must be timed to collect relevant information at a time when the information is both available and will have an impact on response planning. To this end, a Needs Assessment Team should spearhead all future SAF overseas relief missions. 🇸🇬



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# ‘Network-Centric Logistics’ for the SAF: Ingredients and Challenges

*by LTC Lim Bock Aeng*



“Network-Centric Warfare derives its power from the strong networking of a well-informed but geographically dispersed force. The enabling elements are a high-performance information grid, access to ... information sources, weapons reach and manoeuvre with precision and speed of response ... value-adding command-and-control (C2) processes to include high-speed automated assignment of resources to need ...”<sup>1</sup>

## THE NCL VISION

The concept of Network-Centric Warfare (NCW) has been well expounded in recent military transformation literature.<sup>2,3</sup> Essentially, it seeks to exploit state-of-the-art sensor and information network technology to provide a common situational awareness, and integrate widely dispersed warfighters and their weapon systems into a highly adaptive system

to achieve unprecedented pace and effectiveness in warfighting. If this same concept is adapted to military logistics, it will equally revolutionise how we support our warfighters in future.

Imagine the possibilities... Sensors on weapons and soldiers will automatically report readiness status and request for re-supply to maintain operational tempo. Supplies will always arrive in the right amount, on schedule, at the pre-designated point. No more long logistics tail in combat, no more massing of resources along supply lines. Support crews, ammunitions, fuel and spares will always be pre-positioned and ready to re-arm or repair an aircraft or ship the moment it returns to base. Operational commanders will always be equipped with the latest logistics status to incorporate into the next cycle of battle plans. Logistics commanders will always be furnished with relevant and timely assets availability and operations information to accurately anticipate and meet the warfighters' needs. Logistics support no longer needs to be constrained by rigid command chains – any agency can service a combat unit to achieve better responsiveness. This vision is achievable through “Network-Centric Logistics” (NCL) – the dual of NCW applied to logistics.

If implemented successfully, NCL offers the potential to achieve a significantly more co-ordinated, responsive, flexible and lean military logistics system, by enabling a “Proactive-Sensing, Rapid-Execution” logistics support approach. This will be a key capability for the SAF as it embarks on a transformation towards a network-centric, dynamic and

integrated warfighting concept. For one, NCL will fulfil the need for an agile and responsive logistics capability to match the pace of operations. It can shorten the logistics Observe-Orient-Decide-Act (OODA) cycle, reduce logistics footprint, and increase the mobility of fielded forces to greatly enhance the combat edge of the SAF. NCL should also enhance the SAF's flexibility in cross-utilising competencies and resources to achieve greater resource efficiency. This will allow the SAF to cope better with unexpected requirement changes in operations and expanding commitments in operations-other-than-war (OOTW).

## THE NCL STRATEGY

How is this possible? One only needs to realise that NCL and NCW are duals of each other in parallel realms. ‘Logistics resources’ in NCL is analogous to ‘firepower’ in NCW! By applying NCW ideas, such as pervasive battle space awareness (PBA), increased firepower from shorter OODA loop, co-operative engagement capabilities (CEC) and Theatre-Wide Precision Strike (TW-PS)<sup>4</sup> to NCL, similar breakthroughs in logistics support can be realised. A shift from traditional *reactive mass-based* (2‘G’) logistics to a *proactive speed-based* (3‘G’) approach becomes achievable.

### Faster Responsiveness through ‘Shorter OODA’

Intuitively, logistics responsiveness can be increased dramatically through a common information network providing up-to-date operations and logistics situational awareness to synthesise and expedite planning processes between



warfighters and logistics agencies. Not only can warfighters receive up-to-date resource availability picture instantaneously for mission planning; logistics agencies can also constantly monitor impending operational demands or changes, and prepare for them pre-emptively. In fact, operations and logistics planning cycles can occur almost concurrently instead of sequentially. Logistics Planners can also play a more active role in operations planning by proactively offering options or solutions to help the Operations Planners improve the feasibility and robustness of operation plans and the speed at which plans are generated. The NCL infrastructure can also help increase visibility and control over the logistics pipeline to optimally match demand with supply. Availability of current and projected demand-supply situation in real-time, coupled with ability to track, deploy or divert resources faster and more accurately will significantly improve the quality and speed of logistics decisions in both peacetime and wartime. This ultimately results in a higher pace of operations for the SAF.

## Better Flexibility through ‘Co-operative Engagement’

Other than speed, NCL will also enhance flexibility and robustness of logistics processes in at least two ways. This can be achieved by firstly enabling a network of expertise and resources to ‘co-operatively’ generate assets in operations support. The network can cut across Services and be extended to local defence industries or Original Equipment Manufacturer (OEM), enabling the SAF to move capabilities and resources more flexibly to the point of need or meet new operational demands. This network of capabilities can also be exploited to help the SAF reduce the need to duplicate commercially available resources or expertise for a wide-range of peacetime operational commitment. Secondly, NCL can also offer opportunities to channel logistics support more flexibly in the field. With a common mission and shared situational awareness, multiple agencies can exercise initiative based on availability of resources or proximity to support our warfighting units without being constrained by linear chains of command.

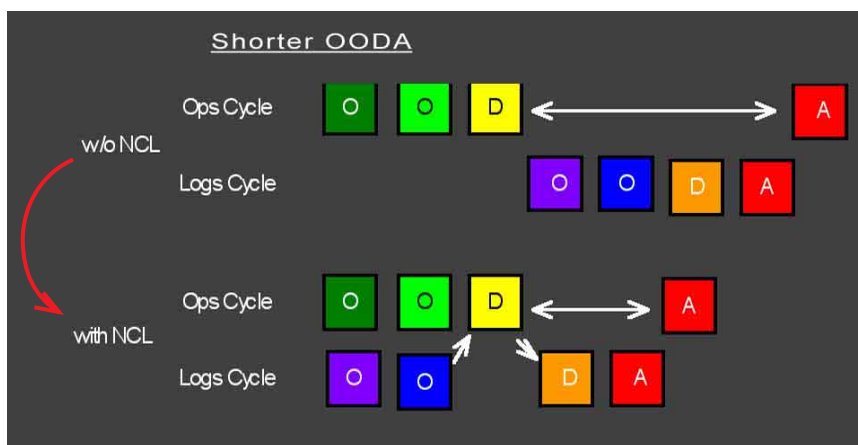


Figure 1. Shorter overall ‘Observe-Orient-Decide-Action’ in Operations Planning

## Leaner Footprint through ‘Precision Strike’

With better speed and asset awareness, NCL also supports a shift away from ‘mass-based’ logistics where spares and buffer stocks used to be kept in anticipation of needs towards a ‘speed-based’ logistics<sup>5</sup> where needs are met precisely and timely by exploiting situational awareness, asset visibility and swift distribution capabilities. The speed-based approach reduces the logistics footprint of fielded forces in operations by facilitating a “Just-In-Time, Just Enough” replenishment concept, allowing forces to be leaner and more mobile. Visibility of actions initiated in response to shortfall also reduces the tendency for users to raise multiple demands as ‘insurance’ in the hope that at least one will arrive. As a result, lesser inventory is necessary, and even lesser will sit ‘idle’ in the system. Every piece of asset can be utilised to its fullest potential.

## INGREDIENTS FOR NCL

### Technological Infrastructure

- **Information Networks**  
(‘Info-Grid’)

So, what are the building blocks to implement NCL? Obviously, one of the key components is an information grid to serve as an exchange of information for current and projected demands, and resource situational awareness. The network would have to incorporate the needs of the Logistics Planner, the Execution Agencies, and the Ops-User to support collaborative planning, decision-support and instructions



“Air mail”: performing an air drop

dissemination between planners and execution agents, while providing visibility on the latest availability (supply, delivery, repair) status to the end-user. The SAF’s Tri-Service Enterprise Resource Planning (ERP) System, which promises near-real time data updates and linkages to Operations and Procurement agencies, is an example of an information platform that can fulfil this role.

- **Automated Asset Tracking**  
(‘Sensor-Grid’)

The second technological infrastructure element is some form of automated asset tracking sensor. This element is important because the essence of the NCL lies in the availability of accurate, relevant, and timely logistics assets information and demands. Given the massive inventory and volume, accuracy and timeliness are best achieved through automated means where quantity and serviceability information of assets at all locations are updated instantaneously as they change. Technology in this area is maturing and its cost is dropping rapidly. In recent years, automatic identification technology (AIT) and

wireless networking technology has increasingly been adopted by many in the commercial sector, led by world-renowned courier service FedEx or DHL. The SAF would do well to start experimenting and adopting it for our key and limited assets.

## Distribution Capabilities (‘Shooter-Grid’ equivalent)

The third crucial building block is a rapid and reliable distribution capability. Without this, having the ability to “*see faster, understand faster, and decide better*” cannot possibly translate into tangible benefits. The set of distribution capabilities should be comprehensive and robust enough to implement ‘Just-In-Time’ logistics; precise and scalable enough to implement ‘Just Enough’ logistics. Additionally, the movement of every piece of asset should be easily ‘track-able’ by its users (similar to

FedEx and DHL) to generate high confidence and reliability for our warfighters when operating both in benign and hostile environments.

## ORGANISATIONAL COMPETENCIES

Unfortunately, technological infrastructure alone is not sufficient to fully harness the benefits of NCL. A carefully conceived synergy between the NCL Concept, skills of NCL practitioners and technology is critical. Our organisation structure, purpose and policies must also align with the strategy of NCL to cultivate the necessary competencies and processes to exploit each other’s strength. Our people must not only have the knowledge and skills to maximise the potential of the infrastructure, but we also need the commitment and mindset to effect the strategy (Figure 2). At least three organisational competencies are necessary.

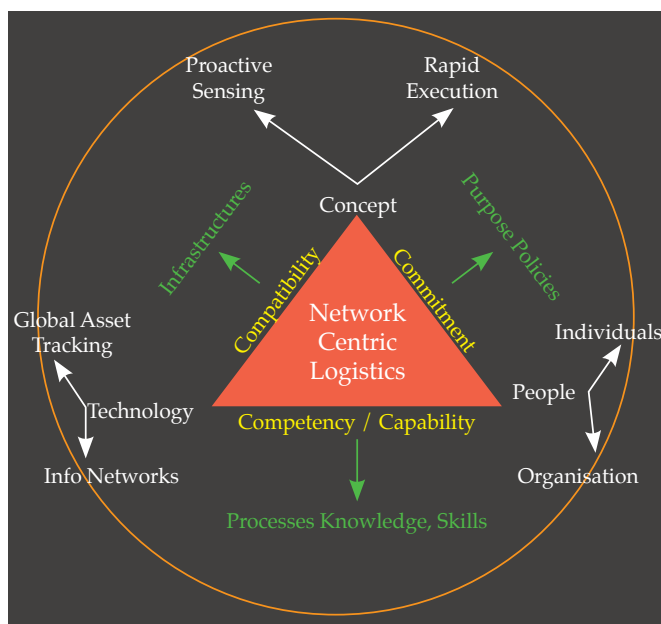


Figure 2. Synergising Concept-Technology-People in NCL

## Cross-functional Linkages

The first is cross-functional linkages. NCL is as much about networking people, skills and assets as networking information. Most modern militaries however, the SAF included, have adopted a functional based organisation structure. While such a set-up facilitates professional development, it can also limit flexibility, responsiveness and cross-functional exchanges. For greater integration and synergy, cross-functional lateral linkages will have to be built on top of hierarchical vertical linkages to create a 'network' of linkages rather than a strictly 'chain' structure.

Such cross-functional linkages are critical in NCL because it facilitates proactive-sensing by connecting people across functional and hierarchical boundaries. Vertically, it flattens the SAF Logistics organisation, and prevents filtering and reduction of information towards the bottom of a hierarchy. Laterally, it blurs organisational boundaries between Operations-Logistics and Logistics-Contractors, allowing information to be shared through direct communication and close working relationships. This results in multiple points of sensing change, understanding information better through clarification, and allowing empowerment at more levels to act in concert with each other.

Cross-functional linkages also facilitates faster decision and action through team collaborations instead of 'passing the buck' functional-biased processes. It promotes outcome driven work groups with stronger ownership of the final product/service even

if the members may originate from different functional commands. The greater body of expertise, broader perspectives, and deeper specialisation from cross-functional teams will also result in better mutual understanding of capabilities and limitations, better connectivity and inter operability to facilitate decision making and logistics support execution.

## Cooperative Competencies

Secondly, SAF Logistics Organisations should build stronger internal and external linkages to harness an expanded and complementing network of competencies and capabilities. These may be with other SAF agencies, contractors, local SMEs or non-government organisations, etc. Such collaborations are becoming more vital to the SAF as supply, maintenance and engineering demands become wider and more complex. Militaries can no longer afford to specialise and perform all these activities in-house. Organisationally, we must be able to integrate seamlessly with both internal and external agencies at the planning and execution levels of various functions, and tap resources from beyond the SAF where there is commonality of resources and competencies.

## Flexible Relationship

The third organisational competency is to move away from rigid command chain structures to provide flexible logistics support based on proximity, availability and time-to-arrive, where there is commonality of resources and objective, aided by NCL capabilities. Such an execution concept opens up new possibilities in supporting our warfighters arising from bottom-

up recommendations, decentralised networks and self-synchronisation of actions, injecting adaptability and robustness into our logistics system. HQ needs only to intervene by exception. To realise this attribute, SAF Logistics Organisations must first find the right level of details to specify in HQ's command intent, balance the 'what to achieve', 'who should achieve' and 'how to achieve' aspects in order to guide actions of lower echelon units without stifling their flexibility. This will have to be gradually developed, taking into consideration the organisation and people's culture and maturity.

## INDIVIDUAL COMPETENCIES

Aside from infrastructure and organization changes, NCL would not be complete without the knowledge, skills, and commitment of people to maximise these changes. Three individual competencies appear to be pre-requisite in NCL practitioners for the NCL concept to thrive.

### Active Sensing

The first set of individual competency pertains to the ability to sense proactively. It is predicated on having 'quality communication' and a 'warfighters mentality'. Open communications, aided by a less rigid organisational delineation with warfighters and commercial contractors, promotes sharing of information and understanding each other's limitations between warfighters and logisticians. It also helps in clarification of intent and exchange of ideas, resulting in an accurate sensing of demands, build-up of trust and a "quality relationship"

(in Learning Organisations lingo) between logisticians, commercial service providers and warfighters. A warfighter's mentality, on the other hand, will be crucial for NCL practitioners to make sense of discussions with warfighters, interpret operations, and anticipate future operational needs – as part of 'proactive sensing' to aid logistics decision-making and response in a synchronised manner.

### Team Excellence

The second set of individual competencies encompasses the willingness to contribute effort and share knowledge so that expertise can be exchanged or cross-shared in a NCL environment. To be successful, we will have to steer away from the 'What's in it for me?' and the 'My knowledge is my power' mindsets of resource and knowledge hoarding by building 'team excellence' culture in our organisations. This may be aided by introducing processes to build 4 'C's – *Commitment* (by involving people to share in the pursuit of something they value together). *Contribution* (by showing the link between individual contribution to a greater cause). *Collaboration* (by building relationship and interdependence through engaging, involving and mobilising people on a shared vision or mission), and *Conscience* (through principles and values which generates trust and mutual respect) amongst our people.<sup>6</sup>

### 'Restless' Mindset

The third competency critical to NCL practitioners is that of maintaining a flexible and adaptive mindset. The NCL



structure and organisation processes can only implement the concept and make asset tracking and demand sensing for logistics support more efficient and timely. Ultimately, it is the people that must exercise judgement to plan and execute the front-end logistics support to fielded forces, and the back-end maintenance-repair-overhaul-supply chain to the depots or OEM. Therefore, a continual 'restless' mindset is a pre-requisite for NCL practitioners to proactively scan for changes, constantly innovate in order to optimise resource and process efficiency; and constantly search for alternative and faster means to support the warfighters needs. It will serve as a valuable 'outer-loop' to review, renew and improve NCL processes, leading to adaptability and greater efficiencies in an uncertain and always changing environment.

## CHALLENGES

Despite a strong impetus, implementing NCL will not be without its challenges. Invariably, there will be conflicting demands during implementation and competing interests between agencies.

### Capability or Simplicity?

The first challenge is in implementing the network-centric information system. With the cost of information technology and storage capacity reducing at such a tremendous rate, the natural temptation is to simply transplant processes people are already familiar with – and more – straight into the network and further bolt on an intelligent decision support tool for automatic decision-making to achieve 'information superiority'.

Unfortunately, robustness, response time and stability of information systems degrade as the amount and resolution of data gets higher. This necessitates a trade-off between system capability with simplicity. The best approach may just be to use the NCL information network to present concise, easily understandable situational picture and planning parameters for human operators to make better decisions. The SAF will need to invest time and effort to continuously simplify, de-layer and streamline our processes and data capturing demands to avoid information overload.

### Security or Connectivity?

Another interesting challenge must be in the trade-off between security and connectivity for the NCL information network. How do we ensure that it is secure, reliable and seamless at all times? The implementation issues are not trivial. Do we partition information based on the type of users (e.g. SAF, MINDEF, commercial users) or locality (e.g. local or overseas) and restrict connectivity? Or do we extend information on the network to all users to derive maximum benefits from collaborative involvement? Admittedly, information systems have become vital to war capability generation and is susceptible to asymmetric 'strategic attacks'. Yet, NCL networks need the extensive connectivity for global asset visibility and for interoperability with operations. Both Ops and Logs users need to work with it constantly in daily operations to gain proficiency, and to derive maximum confidence in the system. Limiting access to various systems or partitioned information



to protect security, and linking them only just prior to wartime use would not work.

## Exclusive or Inclusive Relations?

The SAF will also need to rethink the traditional functional demarcation between Operations and Logistics within Services, resource-based and functional delineation between Armed Services; and the boundaries between the SAF and commercial service providers such as MINDEF Approved Companies and weapon system OEMs in preparation for NCL. Most will be a trade off between operational control, security and cost efficiency. For example, to fully harness the benefits of NCL from global asset visibility and to exploit external competencies in maintenance, repair, overhaul (MRO), and freighting services, the SAF will need to include these external agencies into our NCL information and competency network. However, this has to be traded off with a possible dilution or loss of competencies within SAF and risks not being able to support surge operations internally or when faced with an embargo. Hence, a careful selection of ‘internal’ or ‘commercially viable’ competencies, and cultivation of partnerships that can survive sanctions, is necessary as part of consideration to form a more ‘inclusive’ relation with external service providers.

## Centralised or Decentralised C2?

Yet another challenge will be in the structuring of our C2 processes to reap the benefits of NCL. If we want to benefit from speed and co-operative effects of decentralised actions, we will first need to change mindsets of our

people. Subordinates must learn to become comfortable with autonomy instead of ‘referring up’ everything for fear of mis-interpreting higher HQ’s intent. Conversely, higher echelon commanders need to be comfortable in managing lower echelon units without micro managing. We will also need to learn from lessons when lower echelons actions occasionally become ‘de-sync’ with higher HQ’s intent. Ultimately, the SAF Logistics Organisations will have to find a balance between decentralised and centralised C2 of logistics operations to balance the desire for fast, flexible, responsive logistics support, and the benefits of tighter C2, standardisation and cost efficiency. Fortunately, the beauty of the NCL technological infrastructure is that it offers the flexibility to implement both C2 approaches, depending on the preferred doctrine. Therefore, SAF Logistics Organisations may start by striving for faster speed of command and common situational awareness under a centralised C2 concept first. As the organisation and people matures, a progressively more decentralised control and execution doctrine can gradually be adopted.

## What’s in it for Me?

Finally, and perhaps one of the most crucial challenges, is about how to motivate organisations and their people to subscribe to and practice networking and sharing information, knowledge, expertise and resources. Why should people across functional boundaries be interested to ‘educate’ one another about their specialist functions and be subjected to the scrutiny of what they do by others? Why would a logistics

unit care to contribute its own resources and effort ahead of another to fulfil a higher HQ intention in a decentralised operating environment? And why would an external agency care to expedite services to boost the SAF operational readiness or maintain a particular competency in support of SAF if there is no certainty of lucrative profits to be made? In short, how do we motivate organisations and people to break out of stove-piped functional demarcation of responsibilities and mindsets to contribute in an NCL environment?

Obviously, simply achieving synergy of infrastructure, organisational and people competencies will not be enough. We will also need a set of shared

mission, shared benefits and shared values to bind the hearts and actions of every individual and every organisation in the NCL operating environment. We will need strong leadership, who is committed to the vision of NCL, to share that vision and translate it into specific missions and tangible benefits for the organisations and people involved in order to sufficiently motivate and build commitment. Involvement and buy-in from all agencies, including commercial partners, to achieve alignment of organisational attitudes and processes will be critical. Therefore, a re-think of policies to integrate and reinforce the NCL strategy by finding meaningful roles for all organisations and individuals will be crucial.

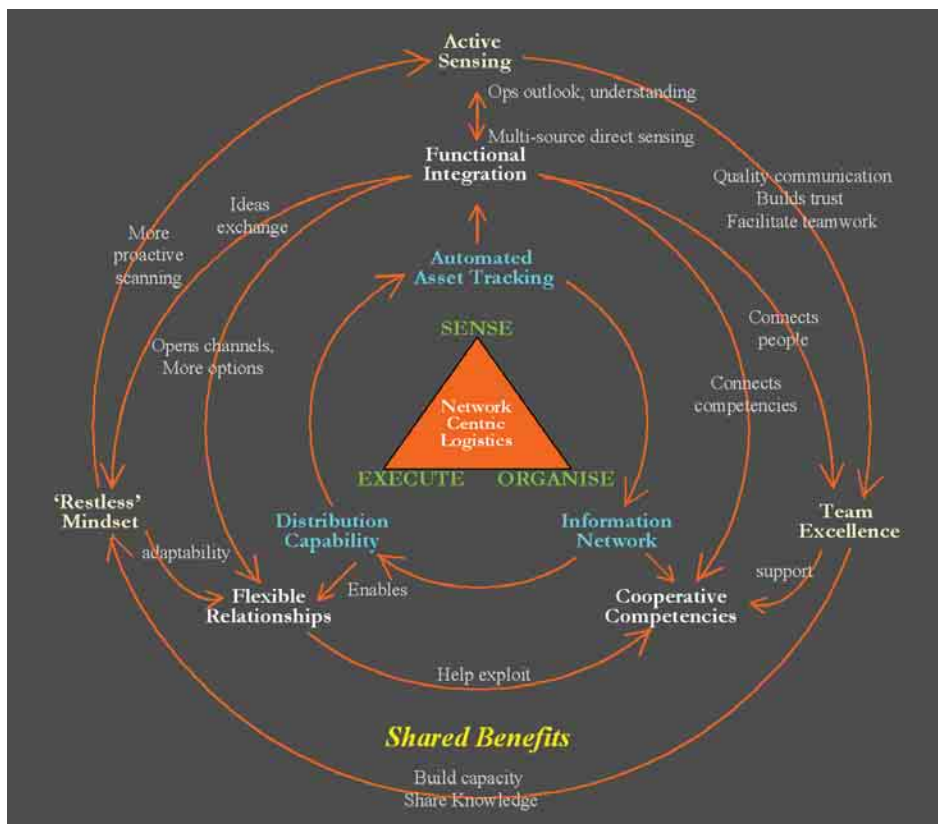


Figure 3. Shows the synergy of competencies elaborated in this essay and the need for alignment through shared mission, benefits and values

## CONCLUSION

In summary, as the SAF embarks on a transformation to prepare itself for Network-Centric warfighting concepts by exploiting modern sensor and information technology, it must also not overlook the importance of developing the parallel of NCW in its logistics function. The vision and benefits of such a ‘Network-Centric Logistics’ concept is compelling, and is key to achieving such a responsive, flexible and lean logistics system to match up with the pace of operations for a 3<sup>rd</sup> generation SAF. Despite the promise of automated asset tracking, information network, and rapid distribution infrastructures, full exploitation of the NCL concept can only result if organisation competencies and people competencies are aligned with the concept. Therefore, the organizational and people ingredients are critical, and this article suggests three competencies at each level for development. They are intended to reinforce each other as illustrated in Figure 3, but can at best serve as a structural foundation for

implementing NCL. Equally important in the ingredients for NCL is a set of shared mission, values, and benefits to align the hearts and minds of individuals and organisations around the NCL strategy for it to be successful.

As we pull together these ingredients, we must also tackle a few organisational dilemmas. We need to concurrently find a balance in the trade-off between security and connectivity of our information networks, an extent of decentralisation in our operations that our people are comfortable with, and build strategic partnerships with external agencies and foreign OEMs. At the same time, we need to review existing policies, cultivate the ‘soft’ competencies, streamline our organisation, processes, people, and mindsets to prepare for NCL. The best way to do this is to perhaps start experimenting, refining, and resolving these issues as we develop our NCL components, so that when the hardware and organisational competencies are in place, the SAF is ready to reap the envisioned benefits of NCL instantly. 🍀

## Endnotes

- <sup>1</sup> Arthur K. Cebrowski, John J. Garstka, "Network-Centric Warfare: Its Origin and Future", *United States Naval Institute Proceedings*, 124(1), (January 1998).
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# Maritime Security: Possibilities for Terrorism and Challenges for Improvement

*by MAJ Serene Chua Pui Hong*



**B**efore the tragic events of 9/11, seaborne threats generally took the more traditional form of piracy. 9/11 unleashed a brand of terrorism that is strategic in intent, devastating in impact, and global in reach. Unlike pirates and criminal syndicates that are driven by greed, terrorists are driven by a violent ideology that seeks to make grand political statements through destructive acts. According to Singapore-based terrorism expert Rohan Gunaratna, the global trade would be the next victim of

a terrorist attack on seaborne commerce.<sup>1</sup> As seaborne commerce is the lifeline of the international economy and a symbol of the globalized system, by hitting the maritime sector, which plays a major role in nearly every industry's supply chain, terrorist groups can disrupt and affect the entire world economy.<sup>2</sup>

As maritime security is of strategic importance to Singapore, the fear that pirates operating in the waters around Singapore might be linked to





*Map of the Malacca Straits*

terrorist organizations prompted our government to announce a review of its maritime security plans. “Piracy is entering a new phase, recent attacks have been conducted with almost military precision”<sup>3</sup> said Ex-Deputy Prime Minister Tony Tan, who was also the Coordinating Minister for Security and Defence in 2004.

### **The attractiveness and vulnerability of the Malacca Straits**

The Malacca Straits today are amongst the busiest sea-lanes in the world. More than 50,000 vessels transit the 621-mile long straits every year. More than a quarter of the world’s trade and half of its oil go on ships through the Malacca Straits, and shipping is vital to the economic health of countries such as Japan and China.<sup>4</sup> Linking the Indian and Pacific Oceans, the Malacca Straits is the shortest sea route between India, China, and Indonesia. The greater part of the Malacca Straits runs through the territorial waters of Indonesia, Malaysia and Thailand with the much shorter Singapore Strait joining it at the southern end. A total of six tempting chokepoints can be identified for

terrorists wanting to disrupt world trade. By using the Malacca Straits instead of the Indonesia’s Lombok Straits, super-large tankers ferrying crude oil from the Middle East to the Far East can save up to 1,600 km, roughly three days sailing time.<sup>5</sup>

### **The Evolution of Piracy to Maritime Terrorism**

Since 2003, the International Maritime Bureau (IMB) reported that pirate attacks have jumped 20 percent higher compared to each preceding year. It said the waters between Singapore, Malaysia and Indonesia rank as the world’s most pirate-infested. The report also showed some new trends: Hijackings of merchant vessels and their cargoes are found to be either military-style operations by militant groups to raise funds for their cause or attacks against soft targets such as tugs and barges.<sup>6</sup> London-based Aegis Defence Services’ intelligence supported and analyzed that militant groups may even be rehearsing for a terrorist strike at sea.<sup>7</sup>

Rohan said ‘The maritime domain is the least-policed environment and terrorist groups here have shown an interest,’ London-based maritime observer James Copinger-Symes also viewed that the attacks are getting more violent, frequent and organized. As oil and chemical tankers are increasingly being targeted, these incidents suggest ‘terrorist targeting and build-up’. For instance, a chemical tanker, the Dewi Madrim, was hijacked by machine gun-bearing pirates in speedboats off the coast of Sumatra in 2004. These weren’t ordinary pirates looking for booty but terrorists learning how to drive a



ship. There is also evidence showing terrorists learning diving so as to attack ships from below.<sup>8</sup>

Rohan has also espoused that Al-Qaeda has established concerted links with a myriad of Islamist terrorist groups in Asia, such as the Abu Sayyaf, the Moro Islamic Liberation Front (MILF) and the Kumpulan Militan Malaysia (KMM). As this region is home to these Islamic terrorist and militant organizations, including the Jemaah Islamiyah, Rohan pertinently observed, “The centre of gravity of terrorism has shifted from the Middle East to the Asia-Pacific.”<sup>9</sup>

## The beginning of Maritime Terrorism

Besides the inherent attractiveness of maritime targets for terrorists, they are generally softer targets compared to more traditional targets such as embassies that have been significantly hardened. From a maritime perspective, the watershed event occurred on 12 October 2000 when two Al Qaeda suicide bombers rammed an explosives-laden skiff into US Arleigh-Burke class Destroyer, USS Cole. Thereafter, maritime terrorist operations evolved rapidly through imitation, direct training, and sharing of resources and expertise. The USS Cole incident triggered two other terrorist groups within months. On 23 October 2000, four suicide stealth boats of the Liberation Tigers of Tamil Eelam (LTTE) of Sri Lanka breached the Trincomalee naval port, destroying one fast personnel carrier while damaging a second. Then on 7 November 2000, a Hamas suicide boat attempted to ram an Israeli naval craft but exploded prematurely.<sup>10</sup>

## The Nexus of Terrorist Capability, Intent, and Opportunity

The ability of terrorist organizations to operate comprises three distinct facets; capability, intent and opportunity. They need the capability to undertake terrorist activities and the intent to do so. By capability, it implies that the necessary funding, people, equipment and weapons so as to have the ability to execute physical actions. By intent, it means they possess the determination and resolve to execute those physical actions, whatever they may be. By opportunity, it implies that the terrorists are able to deploy and manifest an ordinary naval vessel into various terrorist threat scenarios.<sup>11</sup>

**Capability.** The USS Cole, LTTE and Hamas attacks within four weeks demonstrated the copycat effect, a phenomenon not uncommon among terrorist groups. These “low-cost high-impact” maritime operations from terrorist groups are possible with the advent of Al Qaeda and the transnational nature of modern terrorist networks today. These networks are, with increasing frequency and sophistication, aligning themselves with organized criminal elements and state actors to gain information, knowledge capabilities and resources. Many terrorist groups gained initial expertise in maritime tactics via state actors providing specialised training and resources, and thereafter, evolved in a cooperative global effect to disseminate terrorist tactics and techniques.<sup>12</sup>

**Intent.** A successful attack on a cruise ship or a port would result in many casualties and economic repercussions. Cruise liners are like floating World Trade Centres with as many as 4,000 people onboard. Ports are the hubs of the global trading network. According to Rohan, terrorists have been using explosive-laden ships as weapons to attack ports, strike warships in the Indian Ocean by crashing commercial airliners into them in early 2002, and plant explosives in cargo containers after 9/11. Closer to home, in January 2002, Singaporean intelligence discovered sophisticated reconnaissance information of US naval facilities and ships in the region gathered by Al Qaeda.<sup>13</sup> These evidence showed that the threats are real, imminent and close to home.

**Opportunity.** A vessel can manifest as a terrorist threat in the following scenarios:

- **Vessel as a means.** The nature of commercial shipping is multinational. A ship could be owned by a company in one country, flagged by a second, crewed by nationals of a third and be carrying the cargoes of a fourth through the territorial waters of a fifth, to the port of a sixth country. With such complex network, terrorist groups can adopt commonly used tactics to smuggle members, weapons, supplies, narcotics and contraband. Evidence has shown that the Palestinian Authority, Al Qaeda, LTTE, KLA, ASG and MILF have contracted or acquired ships that can navigate long distances.
- **Vessels as a weapon.** The LTTE attack showed that collisions involving large vessels that have long stopping distances can cause significant destruction. With the unusually high number of tugboats

being hijacked in 2003, terrorists could load them with explosives to ram into ships or ports.<sup>14</sup>

- **Vessels as a bomb.** Terrorists can pose as passengers and crew to gain access to ships to plant explosive devices, bomb or WMD clandestinely. For instance, the Abu Nidal organization exploded a bomb aboard a day-excursion ship in Greece, killing nine and injuring hundreds in 1988.
- **Vessel as a disruption tool.** Sinking vessels in key trade bottlenecks, port channels and key military installations creates significant economic and military disruptions, as well as overstressing the surrounding infrastructure like roads and rails.
- **Vessel as a target.** LTTE is known to be developing underwater capabilities and sophisticated technologies such as stealth mechanism and high powered multiple-engine craft that are capable of outrunning military vessels.<sup>15</sup>

## Are the three Littoral States ready?

“The primary responsibility for the safety and security of the Malacca Straits lies with three littoral states...Indonesia, Malaysia and Singapore have taken some measures... but not adequate to safeguard against maritime terrorism...No single state has the resources to deal effectively...The littoral states are not the only stakeholders...Other users have a strong economic, if not also strategic, interest in ensuring that the Malacca Straits is kept open and safe. All stakeholders should be prepared to play a part in the security efforts... we can make progress if we proceed on the basis of consultation and within the bounds of international law”<sup>16</sup>

Defence Minister Teo Chee Hean,  
26 April 2004

## 1. *Singapore*

Singapore's paramount concern is the freedom of passage. The right of international ships to free passage through the Malacca Straits is critical to our port, export-oriented economy and oil-refining hub. Hence, at the national level in 2003, Singapore has also stepped up maritime security measures with the establishment of inter-agency Navy-led Maritime and Port Security working group, which is made up of members of the Navy, Police Coast Guard and the Maritime and Port Authority (MPA).<sup>17</sup> The working group has developed and implemented regulatory measures to enhance security and control movement of shipping (in particular, Sensitive Vessels and small craft) within the Maritime Control Zone.

At the enforcement level, the MPA has institutionalized the need for "STRAITEP"<sup>18</sup> and the monitoring of vessels via the Vessel Traffic Information System (VTIS). In addition, MPA has also embarked on various new agreements with the US and International Maritime Organization (IMO), and they are<sup>19</sup>:

- IMO has amended SOLAS<sup>20</sup> to make way for ISPS Code<sup>21</sup> that forms a framework through which ships and port facilities can cooperate to detect and deter acts, which pose a threat to maritime security. Effective from 1 July 04, MPA has also embarked on electronic port clearance for ISPS vessels and Automatic Identification System (AIS)<sup>22</sup> for vessels using transponder.
- Signing of international treaty giving Singapore the right to detain and prosecute suspects

caught in its territorial waters but accused of piracy in other parts of the world.

- Since July 2003, MPA has required sensitive vessels such as vessels and tugs of 300 GT to submit Notification of Arrival at least twelve hours prior to arrival. Vessels carrying hazardous and noxious substances in bulk must submit the Notification at least 24 hours prior to arrival.
- Control of small craft movement within port water. Advisories to keep clear of sensitive key installations such as strategic island groups and approved passage route were also enforced and issued to them.
- Implementation of CSI since 20 September 02. In addition, MPA also compiles and issues Continuous Synopsis Record to the Singapore Registry of Ships. Advisories to all owners and operators to make available their anti-piracy plans<sup>23</sup> and to commence training for its company security officers and ship security officers immediately after 9/11.

## 2. *Indonesia*

Prior to 2005, Indonesia's response on the maritime security in Malacca Straits has been lukewarm as its paramount concern is territorial integrity. As an archipelagic state that spans 17,000 islands, Indonesia considers control over its territorial water to be crucial to the preservation of its national unity. Besides, its major ports are along the Sunda and Lombok Straits; trade conducted via the Malacca Straits is of little interest to them.<sup>24</sup>

Though there is existing bilateral cooperation against piracy such as the coordinated patrols between Singapore and Indonesia, as well as Malaysia and Indonesia, piracy and maritime terrorist attacks have failed to decline.<sup>25</sup> The reasons for piracy in Indonesia are largely caused by economic hardship, especially after the 1997 Asian financial crisis. Sam Bateman, a maritime policy expert from the University of Wollongong, states that there are two types of pirates. There is the opportunist pirate who may have military training and is doing it for his own gain and advantage. The other type of pirate employs more serious attacks against ships underway, even hijacking, which constitutes transnational crime.

With the political turbulence over the past few years, it has drained the resources and energy of the existing government.<sup>26</sup> For instance, at an observation outpost on Tollop Island, a few kilometres south of Singapore, the Indonesian military tries to monitor every ship that passes. However, the Indonesian Navy admits that these

outposts are poorly equipped and they often arrive too late to stop pirate attacks. RADM Moura Leeman said the Indonesian Navy needs communication equipment and better engines for their boats.

Indonesia has also resisted calls from countries, including Japan, for an international patrolling force. Japan has proposed to send vessels to Malacca Straits and other vital shipping lanes that lie along the coasts of Indonesia and the Philippines to boost maritime security after the disappearance of its chemical tanker shortly after departure from Malaysia.

### 3. *Malaysia*

Unlike Indonesia, Malaysia's paramount concern is its limited control over the straits will be further eroded. Since the endorsement of UNCLOS in 1992, Malaysia has been unhappy with single-handedly bearing the burden of problems caused by the increasing international traffic in the Malacca Straits.<sup>27</sup> In 2004, Malaysia even took



*Maritime security in the Malacca Straits is boosted by the launch of 'Eyes in the Sky' (EiS) initiative*

umbrage when Defence Minister Teo Chee Hean called for a multilateral cooperation on maritime security along the Malacca Straits. Her foreign Minister Syed Hamid Albar said “It is unfair for them to simply run down Malaysia, saying we don’t have the capability.” Malaysia also maintained that the security issues had been blown out of proportion as the vast majority of reported cases were small scale pirate attacks and no terrorist involvement has been found.

Similar to Indonesia, Malaysian Prime Minister Abdullah Ahmad Badawi reiterated that his country would never allow foreign military forces to help it patrol the Malacca Straits. Malaysia firmly believes in the principle of sovereignty and independence of a country, no matter how small the country is. On 21 July 2005, his keynote speech at the 56<sup>th</sup> General Assembly of the ruling United Malays National Organisation (UMNO) stated “Their presence (of foreign forces) without our permission is an encroachment which we consider as being disrespectful of our country’s sovereignty.”<sup>28</sup>

***Joint Air Patrol on Malacca Straits.*** Given such a glooming political outlook and guarded interests by various littoral countries for several years after 9/11, it has taken many vested parties by surprise that the joint patrol on Malacca Straits was announced on 13 September 2005. The so-called “Eye-in-Sky” air patrol is a joint effort by Indonesia, Malaysia, Singapore and Thailand. In fact, Malaysia was observed to be playing an active role by initiating the air patrol during the

meeting of the military commanders of the four countries in early August 2005 in Kuala Lumpur.<sup>29</sup>

IMB is also pleased to report that the actions taken by law enforcement agencies, notably in the Malacca Straits have made a major contribution to keeping the piracy down. There were no incidents reported in Malacca Straits in the first quarter of 2006. Cooperation between Indonesia, Malaysia and Singapore is now better than ever before and has played a key role.<sup>30</sup>

***What about the other strategic players such as the US and APEC?*** The US Coast Guard developed the concept of Maritime Domain Awareness programs as the total awareness of threats, targets and areas of interest on the water. It has expanded the Coast Guard’s ability to physically track craft operating in US waters. Details are as follows<sup>31</sup>:

- Inspecting containers at the point of packing and tracking their route and monitoring their integrity using “smart containers”. X-ray machines that examine entire containers at one sweep are also being used. These devices can detect large and small objects inside containers and packing crates, allowing non-intrusive inspection and cost and time saving.
- Ports and Waterways Safety System (PAWSS) to automatically collect, process, and disseminate information on the movement and location of ships in ports and on waterways through the use of a network of radars and onboard ship transponders.



- ShipLoc device that allows shipping companies to monitor the exact location of their vessels using a personal computer with Internet access.
- The Sea Marshal program, which escorts, boards and inspects arriving and departing vessels with 300 highly manoeuvrable craft and twelve Maritime Safety and Security Teams, consisting of 100 Coast Guard personnel.
- Container Security Regime to assure the in-transit integrity of containers and provides electronic information on a container's contents to customs, ports and shipping officials as early as possible in the supply chain.
- Implementation of ship and port security plans and AIS in July and December 2004 respectively under the ambit of STAR initiative, as actively pursued by MPA.

As APEC (Asia Pacific Economic Cooperation) aims to promote trade, expand business opportunities and create jobs in the Asia Pacific region, it has endorsed various programs such as APEC Counter-Terrorism Action Plan, APEC Counter-Terrorism Task Force and Secure Trade in the APEC Region (STAR). These programs are committed to fight not only maritime terrorism but also global terrorism as a whole.

Specific to maritime terrorism, APEC has endorsed and carried out the following programs and initiatives<sup>32</sup>:

- Customs-Trade Partnership against Terrorism (CTPAT)<sup>33</sup> in February 2003, after the successful implementation by US.
- Conducted a sea-lane disruption simulation exercise in April 2003. Thereafter, its Energy Working Group developed and implemented energy emergency preparedness plans to create a real time emergency information sharing network.

- Increased cooperation between APEC and organizations such as IMB's Piracy Reporting Centre.
- Intelligent Transportation Systems (ITS) to enhance the end-to-end supply chain security and increase the efficiency of trade using smart container technologies, similar to US' Coastguard.
- Implement common standards for an electronic customs reporting system developed by the World Customs Organisation (WCO), which will provide the data necessary to target high-risk shipments for inspection in 2005.

## Further Challenges for Maritime Security

Despite the diverging natures of the three littoral states, they have finally succeeded in agreeing with a common cooperative framework on the basis of consultation and within the bounds of international law. There are further challenges the three littoral states need to work upon, they are:

*UNCLOS*<sup>34</sup>. The status of the straits is a politically sensitive issue. Under international law, a major part of the straits is within the territorial sea of the three littoral states. Foreign vessels have the right to unimpeded transit through shipping lanes, but countries whose vessels use them have no right to patrol or arrest attackers unless they are authorized to do so by the coastal state in whose waters the incident occurred. This lack of common law enforcement framework on the doctrine of hot pursuit has hampered anti-pirate operations as the maritime police of one nation cannot pursue pirates into the territorial waters of another nation.<sup>35</sup>

Thus, it is crucial for the three littoral states to work on a common law enforcement framework so as to enable their maritime police to investigate, arrest and prosecute terrorists in their respective territorial waters. Only with the establishment of such framework and the willingness of the three littoral states to adopt a flexible approach can then move the joint effort to a higher level of cooperation for maritime security.

## Shared Intelligence

Intelligence is the ultimate deterrent weapon that individual states and the international community must possess. It needs to be relevant, accessible, actionable and delivered in a timely manner.<sup>36</sup> Hence, the insular, single-state, single-service response is no longer adequate. A wider response that encompasses

all the legal approaches that the state and the wider international community can muster is needed. To be truly effective, intelligence must be shared among various states. Within a single state, it is essential that all the intelligence-gathering agencies work together rather than against one another on a territorial basis. This requires some fundamental rethinking about traditional values and opinions, and a massive leap in faith and trust in others.

With the high traffic density along the crowded Malacca Straits and limited resources available, it is impossible to inspect all the ships traversing our waters. Hence, highest priority must be given to those carrying hazardous materials and those hailing from countries considered unfriendly or thought to have links with terrorist organizations. Thus, intelligence of sensitive vessels that are suspected of carrying out terrorist acts is critical before the arrival of these vessels so that necessary checks can be arranged in advance. These pre-emptive checks can only be made possible with the sharing of intelligence among states and international communities.

## Long Enduring Process

Though the majority of the shipping owners, flag states and the classification societies have remained committed and responsive to ensure the successful implementation of the ISPS code, gaining greater transparency about crews, passengers, cargo, operators, and owners, and turning the data over to intelligence

centres remains a great challenge. In more than any area, intelligence systems for maritime security have to link federal, state, local, and private sector systems to critical information.<sup>37</sup>


In addition, the ITS program initiated by APEC is costly as screening containers for dangerous materials is expensive; hence this may not be achievable by developing countries. In addition, various new programs introduced post 9/11 will take years to become effective, and only certain types of threats; such as the “bomb in a container” scenario are addressed. Meanwhile in the short to medium term, the spectre of maritime terrorism looms large.<sup>38</sup>

Lastly, of fundamental importance is the need to cut away the hardcore terrorist from his non-activist supporters and to interdict the funding that allows the weapons and other paraphernalia to be procured in the first place. Clearly, this poses a difficult challenge to individual state and even to the APEC Counter-Terrorism Task Force collectively. To eradicate terrorism, one needs to address its underlying social and political issues which may take decades to resolve.<sup>39</sup> In 2004, both Dr Tony Tan and Malaysian Deputy Prime Minister, Najib Tun Razak, have also appealed to the US to adopt a more “balanced approach” towards the Israeli-Palestinian issue so the rage which fuels radical terrorists acts can be quelled. Both leaders have commented that “Hard” approaches alone such as defending targets, arresting terrorist and

sharing intelligence were insufficient. “Soft” approaches to fighting terrorism, i.e. understanding motivations and winning hearts and minds are more critical.<sup>40</sup>

## Conclusion

To conclude, there are two areas on how the three states and strategic stakeholders can address the challenges of maritime security together. First, a firm and continuous commitment to closer international cooperation on maritime security issues among the littoral states is required. For a start, the littoral states should build on existing or emerging regional anti-piracy frameworks and identify methods and tactics on hot pursuit and other preventive measures.

Second, the littoral states can aim to establish an integrated multidimensional approach by working across traditional agency boundaries. Security agencies, enforcement agencies, port authorities and industry all have important roles to play. States do not have all the answers in the new security environment, so it is important to work closely with the shipping industry and relevant international organizations like the IMO.<sup>41</sup> 

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- 16 "Maritime Security in the Malacca Straits, *The Straits Times*, (26 April 2004).
- 17 "Policing The Sea Is A Job For Everyone", *The Straits Times*, (3 June 2003).
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- 19 Holland and Knights LLP, "Status of U.S. Ports", Maritime Developments, [www.holland&knightllp.html](http://www.holland&knightllp.html). (28 April 2004).
- 20 1974 Safety of Life at Sea Convention.
- 21 The ISPS Code enables detection and deterrence of security threats within an international framework; establishes roles and responsibilities; enables collection and exchange of security information; provides a methodology for assessing security; and ensures that adequate security measures are in place. The Code requires ship and port facility staff to gather and assess information; maintain communication protocols; restrict access and prevent the introduction of unauthorized weapons; provide the means to raise alarms; put in place vessel and port security plans; and ensure training and drills are conducted.
- 22 AIS aims to improve MPA ability to track and better manage shipping movements.
- 23 Anti-piracy plans covers the need for enhanced surveillance and use of lighting and detection equipment, crew responses and radio and alarm procedures.
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- <sup>33</sup> CTAP lists specific objectives and expected outputs by each economy to secure cargo, protect people in transit, secure ships engaged in international voyages, secure international aviation, halt the financing of terrorism, enhance cyber security, secure energy supplies and protect the health of the communities.
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# The Human Perspective of Safety – A Flight Commander’s Reflection

*by MAJ Tay Gek Peng*

## Introduction

It was by no accident that the RSAF was able to achieve an error-free record between workyears 95/96 and 00/01. The RSAF mindset of “zero accident” has become the bedrock of her safety culture, which was instrumental to the exceptional safety record during that period.

It was also by no pure coincidence that the first major accident that put an end to our proud safety record on 02 Oct 2001 (the S211 incident in Pearce), was followed by a series of other major and minor incidents, including the AS550 incident in SAFTI Live Firing Area on 7 Jan 2002 and the F16 incident in Arizona on 29 May 2002. A 2003 research report on organisational safety commissioned by the UK Health and Safety Executive highlighted that “good safety performance culminates in non-events which are not self-reinforcing”.<sup>1</sup> Such is the challenge of managing safety in which the ultimate goal is a non-event. This point also reminds us that the same strategies that had so successfully built the effective safety culture in the RSAF may not be ones that could continue to sustain it. They have to be reviewed and refined against the evolving social, economic, political and psychological environment that the RSAF operates in.

This essay proposes three strategies that could rejuvenate the safety culture in the RSAF. One common feature shared by these three strategies is the principle of Leadership being a cornerstone to building and sustaining an effective safety culture. Hence, the essay begins by highlighting the importance of maintaining a strong command emphasis on safety in the RSAF. This is followed by a discussion on each of the following three proposed strategies to rejuvenate the RSAF safety culture:

- Safety as a Human Value
- Alignment to Strategic Goals
- Balanced Reward System

Central to these three strategies is the hypothesis that a human perspective towards safety is necessary to complement the organisational perspective of safety. While systematic safety processes have been put in place and strengthened over the years, the author proposes that squeezing the last five percent towards perfecting our processes could be both costly and futile. Instead, strategies that engage safety at the human or individual level may reinforce our current safety management system and help rejuvenate the new generation of RSAF personnel with a refreshing perspective. This is especially so when most of the servicemen we are now

engaging had not experienced first hand the safety challenges the RSAF faced in the 1980s and early 1990s.

“Safety as a Human Value” is a strategy to strengthen in every RSAF personnel the will to embrace safety in his or her profession through a new dimension. “Alignment to Strategic Goals” proposes that clear strategic goals provide sustenance in an increasingly volatile operating environment, not unlike the compass needle in the rough sea. “Balanced Reward System” stresses the need for a balanced set of positive and negative indicators and rewards system in order to reinforce the will in the individual to embrace the safety culture.

## The Role of Leadership in Safety



*Chernobyl Nuclear Disaster*

In the past two decades, the issue of corporate governance for safety has come under much interest and scrutiny. This

has been caused by the inquiry outcomes into a number of major disasters such as Chernobyl<sup>2</sup>, TMI Nuclear Power Plant<sup>3</sup>, the Clapham Junction rail crash<sup>4</sup>, the sinking of the Herald of Free Enterprise<sup>5</sup>, Piper Alpha oil rig<sup>6</sup>, the Kings Cross fire<sup>7</sup> and the Esso Longford gas plant explosion<sup>8</sup>. One common conclusion from these reports is that failures at senior leadership levels were at least as important as technical defect and human error, in causing the accidents.

Lord Cullen, in the report of the Public Inquiry into the Piper Alpha oilrig disaster, which resulted in 167 deaths, stated, “I am convinced from the evidence...that the quality of safety management by operators is fundamental to offshore safety. No amount of detailed regulations for safety improvements could make up for deficiencies in the way that safety is managed by operators”<sup>9</sup>. Similarly, Mr Justice Sheen, who investigated the sinking of the Herald of Free Enterprise, concluded “that the underlying or cardinal faults lay higher up in the company... From top to bottom the body corporate was infected with the disease of sloppiness”<sup>10</sup>. Safety climate researches, like those conducted by M. Simard and A. Marchand, support these findings by emphasising the important role of leadership in the building and sustenance of safety climate and the reduction of accidents<sup>11</sup>.

The UK safety regulator, Health and Safety Executive, has adopted this position: “Senior management commitment is crucial to a positive health and safety culture. It is best indicated by the proportion of

### MISSION SUCCESS

Position the RSAF as a highly professional and premier organisation. It states our foremost commitment that every mission we undertake will be successful. It conveys a confident and competitive spirit and communicates success to encourage our people to excel.

### SAFETY ALWAYS

Signifies our unfailing safety commitment in tandem with the RSAF's continuous transformation to keep up with new challenges.

Safety must always be there, imbued in our people and we will succeed in all our missions.



#### *RSAF Safety Theme*

resources (time, money, people) and support allocated to health and safety management and by the status given to health and safety.”<sup>12</sup>

Within the RSAF, our experience has also convinced us that senior leadership commitment is crucial to an effective safety culture, amid from a much more positive perspective than the accident reports quoted above. It is in the author's opinion that leadership commitment is one cardinal preposition that should not change in the RSAF.

### Safety as a Value – A Human Value

In the RSAF, safety is a core value that is unique to the service. By aligning ourselves around our values, the RSAF from the highest level to the men on the ground can be bound together through a common foundation. This is one way great organisations withstand competitive pressures and volatile operating environment year after year, decade after decade.

In addition to that, the author would like to introduce the proposition that safety is also a tangible way the RSAF demonstrates that the service values the life of each and every individual service

personnel; that the RSAF does not accept anything other than zero accident because our senior leadership is committed to the operational safety of our airmen. Safety is one way in which our leaders can make human connections across this organization. Stamping out accidents and telling our soldiers that zero accident is the only legitimate goal is a way of showing care for our people. This is leadership.

This perspective could bind everyone in the organization together because it connects every service personnel both with their most basic need of survival, and their higher need of self-worth. It is a much more powerful message than the “safety pays” argument which many government safety regulatory bodies approach safety from<sup>13</sup>. The relevance of the economic argument at the organisational-level is questioned by a number of research bodies. For example, Cutler and James<sup>14</sup> criticized the UK Health and Safety Executive for painting an overly simplistic picture of the ‘safety pays’ argument. One criticism is that the ‘safety pays’ argument encourages the notion that leaders should prioritise the avoidance of accidents by reference to potential financial savings, or productivity improvement. This argument will lead the organization to a point where further investment in safety programme will not give a net return. In other words,

based on a purely financial or productivity argument, safety expenditure should be increased up to the point where the marginal cost of safety equals its marginal return, and no further<sup>15</sup>. While the moral reason of investment in safety is indisputable, the argument that safety pays is spurious.

Hence, in viewing safety, the RSAF would do well to set our focus beyond the number of sorties lost, man hours lost or financial resources wasted. Instead, safety, being one of the two unique RSAF core values that we so treasure, should already by itself be a value-able moral case for us to defend and to be held accountable for.

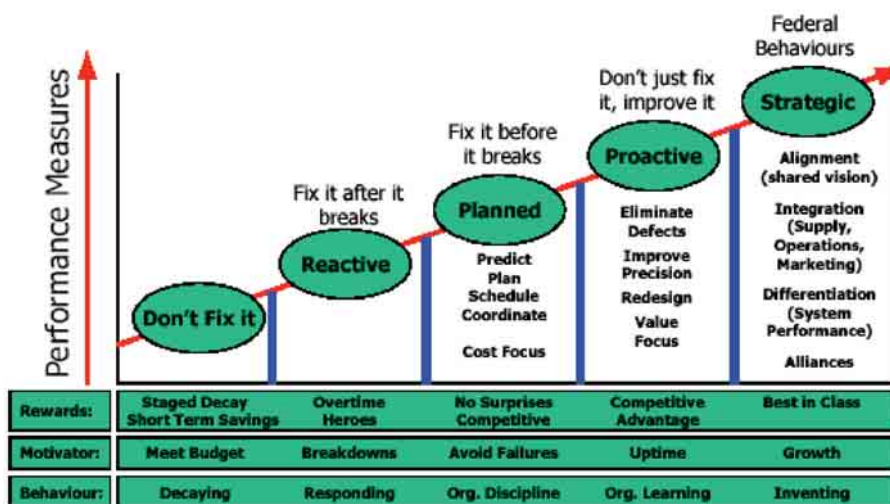
## Giving Meaning to Safety – Alignment to the RSAF Transformation

Building and sustaining any organisational culture is never a short-term activity. Because of the “Keep the SAF Young” policy, officers usually hold commands for two-to-three year spells. In such a system, it is not easy for any commanders to depend solely on their

leadership qualities to significantly rejuvenate the safety culture within their organisations.

Constancy in the alignment between safety and the RSAF mission, and her transformation journey is hence important because it transcends short-term fluctuations in our dynamic operational environment and changes in leadership. It requires that our sense of this linkage be communicated and internalised within all personnel in the RSAF.

Such alignment appeals to an airman’s higher psychological needs of self-fulfilment and actualisation as well.<sup>16</sup> It provides meaning to the job that every airman performs. Hence, it is from this perspective that the statement “Safety is a measure of the RSAF’s operational capability” provides an appealing meaning to every RSAF personnel. One of the SAF’s missions is deterrence, and the key is our operational capability. No matter whether one is performing the ‘tail’ or ‘teeth’ role, safety is a common denominator each can contribute towards this mission of deterrence. Emphasizing safety as a



*Journey from Repair-focused to Reliability-focused Safety Culture*



RSAF core value would also provide an anchor for our airmen as they face the seas of changes in the years ahead. This is especially so when the RSAF is embarking on a journey of transformation.

To sustain the appeal of this linkage between safety and the RSAF mission and vision, a critical role required of the RSAF senior leadership is to build a system of reward and recognition that befits the value we place on safety.

## Balanced Reward Systems for Safety

As the safety management system in the RSAF matures, it is important that our reward system for safety evolves in tandem as well. The model below by Liddel<sup>17</sup> is a close representation of the safety culture that has evolved in the RSAF. In the opinion of the author, the RSAF has progressed from a “reactive” safety culture to somewhere between a “planned” and “proactive” safety culture. In order to transit successfully into a proactive safety environment and beyond, our reward systems for safety must evolve accordingly.

Using the same model more specifically, if an airman operates in a reactive environment, there would be a number of personal rewards associated with working in this type of organisation, such as:

- The challenge and variety associated with never knowing what he will be working on next (not unlike a fireman’s job);
- The personal rewards associated with being the “hero” that can fix breakdowns and problem as quickly as possible;

- The satisfaction of being able to respond at short notice to the demands of last minute support missions.

Moving into the Planned environment, with its focus on systems, rules, procedures and discipline, all of these rewards have to be balanced with other rewards that encourage organisational discipline. In its place, from an individual’s viewpoint, are routine inspections, and minimal challenge. While there may be some people who relish the certainty that goes with this routine and discipline, it is unlikely to be the same type of person that thrives in the semi-chaos of a reactive environment. Hence, a balanced reward system would encourage our airmen to shift their focus along with the organisation’s focus.

Similarly, as the RSAF moves from the Planned into the Proactive environment and beyond, opportunities exist to provide other rewards associated with involvement in problem solving, the acquisition of additional skills associated with a focus on safety innovation, and organisational learning. Reward and recognition must stay relevant as the RSAF progresses towards safety.

## Conclusion

The critical role of leadership in rejuvenating the safety culture cannot be over-stated. The leaders must be able to show that we do it because it is right, to challenge our airmen to be at their best, and to care about the people they serve and the people they serve with.

The three proposed human level strategies to rejuvenate safety in the RSAF aim to complement the existing system level strategies. A healthy safety culture is



sustainable only when it seeps into the very bloodstream of the organization. In other words, until behaviours that support our desired safety culture are deeply rooted in our shared values, they are always subjected to degradation. Hence, the RSAF can ill afford to be insensitive to the human perspective of safety. 🇸🇬

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# Cooperative Autonomous Robots for Mobile Delay Operations

*by MAJ Yeoh Keat Hoe, Alan*

### ABSTRACT

The employment of cooperative autonomous robotic platforms [i.e. future Armed Robotic Vehicle (ARV)] in a mobile delay military operation was conceptualised and analyzed in this thesis in an attempt to investigate and narrow the research and development (R&D) gap, while drawing close reference to practical operational considerations. A non-dimensional delay effectiveness factor was derived and quantified as a measure of performance. Drawing upon biological inspirations, a simple, distributed behavioural-based robotic system with a modified subsumption architecture was designed into 10 homogenous robotic platforms. There was also an attempt to inject robot-learning behaviours into the platforms, in view of the constantly changing and dynamic operating environment. Individual and combined robotic behaviours were then tested and evaluated successfully, using both simulation and hardware demonstration.

The results showed that, on the whole, despite hardware and software limitations, satisfactory results in terms of the delay effectiveness factor were achievable at this exploratory stage. The adaptive behaviour of obstacle

avoidance using reinforcement learning had proven to be useful in reducing robot collisions, and thereby indirectly improving the robots' area swarming time. General good agreements between the simulation and experimental results were achieved. The employment of cooperative autonomous robotic platforms in a mobile delay operational setting could therefore conclude to be conceptually feasible. However, much R&D work was needed to bridge the gap towards being operationally feasible. Several critical aspects were identified and highlighted. These critical areas of focus included the Robotic Architecture, Relative Combat Power, Robot Density, Engagement Range, Communications, and Robotic Intelligence.

### INTRODUCTION

Cooperative autonomous robotic behaviours is an important R&D area for future 3<sup>rd</sup> generation (3G) war-fighting concepts. With the rapid technological advancement and progress in robotics field, the option to employ autonomous robots in tomorrow's battlefield to undertake dangerous and distasteful tasks in place of humans has grown increasingly feasible and attractive. Coupled with the growing complexity and demands in the mission tasks, multiple cooperative autonomous

robots will be needed at times. This in turn introduces a myriad of challenges due to the complex relationships between individual robot actions and group behaviours.

The Singapore Armed Forces (SAF) transformation roadmap towards a 3G network-centric knowledge-based force has heralded robotic platforms to be the vital and indispensable future force multipliers, with potential dividends of scalability and robustness in its employment. Technological advances in unmanned robotic systems have been identified to be one of the key R&D thrusts for the 3G SAF<sup>1</sup>.

There has been a substantial rise of research interest and activities in the fields of robotic technology for military applications in recent years. The FY2005 US Joint Robotic Program Master Plan<sup>2</sup>

had declared robotic platforms as the key to their US Army Future Combat Systems (FCS) and joint war-fighting efforts. An evolution roadmap was charted out as shown in Figure 1, with full robot autonomy targeted by 2020. Coupled with the rapid advances of artificial intelligence and robotic technologies, the prospect of robotic technology growth therefore looks promising.

Whilst a significant amount of R&D activities and efforts have notably been channelled towards individual unmanned systems<sup>3,4,5</sup>, groups of similar robots performing coordinated actions towards achieving a common task autonomously is also increasingly attracting interests. The biological inspiration of nature in robotics, in particular ants and bees<sup>6,7,8,9</sup>, has been one of the main driving themes. Each

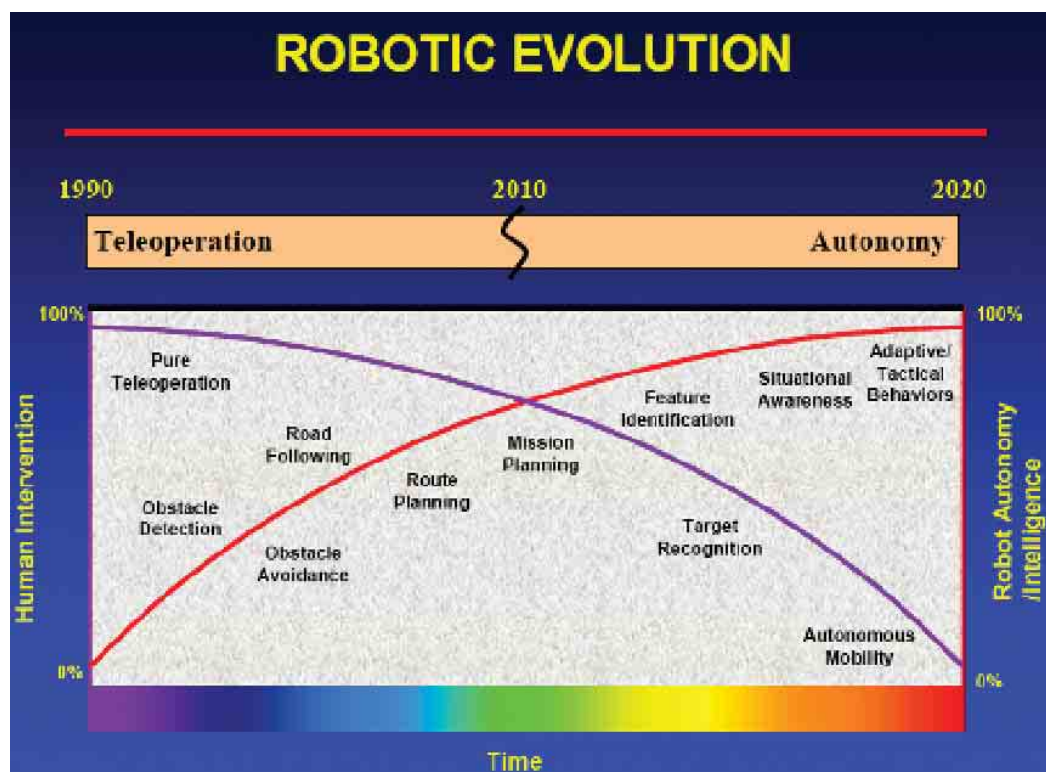


Figure 1. US FY2005 Joint Robotics Program Master Plan<sup>1</sup> - Robotics Evolution Projection

individual biological creature within its group can exhibit seemingly complex yet simple behaviour that would amount to an emergent *self-synchronous* cooperative behaviour when viewed as an entity. With the ever-changing environment, robots need to be adaptive in its behaviours.

This research investigated the science of cooperative autonomous robotic systems in the context of a conceptualised mobile delay operational scenario framework, with the key intent of providing a glimpse of the feasibility of employing groups of unmanned ARVs for operations.

## KEY RESEARCH OBJECTIVES

The key objectives that guided the study were as follows:

- a. To design & develop a scaled environment of low-costs cooperative autonomous robotic systems to conceptually emulate and evaluate the military mobile delay operation through both *software simulation* and *hardware concept demonstration*.
- b. To derive and evaluate an appropriate Measure of Performance (MOP) for the robotic systems.
- c. To inject and display robotic intelligence and evaluate its usefulness with its self-adaptive behaviours, and the robotic architecture employed.

## BRIEF LITERATURE SURVEY

Braitenberg<sup>9</sup> in his work created a variety of vehicles displaying a range of behaviours using relatively simple

sensor-motor coupling arrangements. This opened up a new realm of robotic intelligence, whereby seemingly complex robotic behaviours could be achieved using only simple analytical means.

## Behaviour Based Robotics

Arkin<sup>8</sup> in his book articulated a reactive robotic control system that coupled perceptions and actions together to generate timely response to a dynamic and unstructured world. The two most common reactive behavioural-based robotic architecture are the Motor Schema-Based systems and Subsumption Architecture<sup>8</sup>. The former are a software-oriented dynamic reactive architecture with a non-layered and cooperative coordination nature using vector summation. The latter, in contrast, comprises of a layered architecture for tasks-achieving behaviours that used hierarchical priority based arbitration to inhibit and suppress as its primary coordination mechanism, via rule-based encodings.

## Biological Inspiration

Living things can be considered as the prototypes of autonomous systems<sup>8,13</sup>. Many bio-robotic systems had already been developed from such motivations, and of greater interest to the author was the emulation of ant behaviours into robotic systems. Ants being small in size and relatively simple minded creatures can accomplish complex tasks via their social behaviour as a community, with no direct central control. Communications between ants are predominantly chemical in nature, using a volatile trail pheromone to mark out visited trails. Many mathematical pheromone models had already been

studied and developed for different species of ants<sup>9,14</sup>. Implementation of ants behaviours into hardware had also been carried out<sup>15</sup>.

## Multiple Cooperative Robots Concept

- **Robotic Architecture**

Multiple robotic systems offer the clear advantage of accomplishing tasks which a single robot will find it difficult to achieve on its own due to its spatial limitation. Besides allowing redundancies, it also permits the construction of several simpler robots that are easier to construct, cheaper, robust, flexible and more fault tolerant than a single powerful one.

Bekey<sup>13</sup> advocated 3 basic types of control strategies to achieve emergence behaviour between multiple robots, namely the centralised and hierarchical control, the decentralised (distributed) and local control (i.e. insect societies), and the hybrid of both.

Distributed control with minimal sensing and communication is plausible using simple finite state automata for coordination of robots to converge to an optimal behaviour<sup>16,17</sup>. This will be beneficial in a complex and dynamic environment where sensing and communication are constrained and limited.

- **Inter-Robot Communications**

Several forms of communications between multiple robots exist<sup>18,19</sup>. For instance, point-to-point communications, broadcast methods or via implicit form of communications such as trail marker laying. Complex

communications strategies are sometimes not much better than low level inter-robot communications.

## Robotic Intelligence

Robot learning is an essential component of intelligent robotic behaviour. Artificial intelligence research has already led to a wide range of robotic learning systems<sup>8</sup>, namely reinforcement learning, neural networks, evolutionary learning, experiential learning etc. Of these, reinforcement learning is most widely used in adaptive robotic control system. It uses a form of rewards and punishment system on the control system to exhibit learning. This adaptive learning ability would be investigated in this study.

## CONCEPTUAL SCENARIO

### Delay Operation

Military delay operations have traditionally been used as a retrograde operation, using either passive or active security measures, to protect the main body of a unit or to delay or impede the adversary advances. It is often employed in the context of trading up space for time, typically in face of a larger sized enemy. Several other influential parameters include relative mobility, reserves, communications, firepower, security of units, troop proficiency and morale, relative situation awareness etc.

In lieu of its high dividends of operator survivability and force multiplier effects, the concept of deploying cooperative autonomous armed robotic systems in the future to



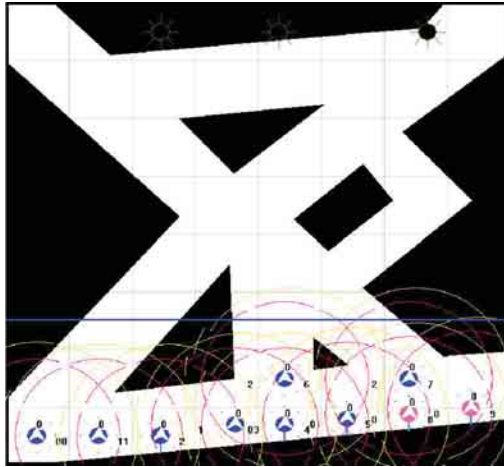


Figure 2. Simulated Conceptual Operating Ground Layout



Figure 3. Laboratory Conceptual Operating Ground Layout



Figure 4. Satellite Map of Actual Operating Ground with Track System Demarcated (Courtesy of Google Earth)

replace or complement conventional units in such military delay operation remains a potential possibility.

## Conceptual Framework

A hypothetical delay battle scenario was formulated that involved RED units advancing across a patch of no-man land in an attempt to reach the Forward Edge of Battle Area (FEBA) line of BLUE force. BLUE force in response would deploy its ARVs as a screen forward of its FEBA line to delay the RED aggressor.

For practical relevancy and complexity, a cross country terrain with a track network based on a fixed 1.7km by 1.7km map square extracted from a Singapore Topological Map in Lim Chu Kang was assumed. Its main cross-terrain tracks network would be broadly emulated, and the operating area would be scaled subsequently to fit into the demonstration area. Figure 2, 3 and 4 below illustrated the 2-D layout (160in by 160in) of the conceptual and actual operating ground.

### • Main Key Assumptions

#### a. Rules of Engagement (ROE).

The set of ROE, based on the concept of Relative Combat Power (RCP), would simplistically determine the reactions of each individual unit and the outcome of their engagements. The advancing RED units would either advance or retreat by a bound at a constant speed based on the RCP upon contact, with assumptions of no casualties, damages or breakdowns. The RCP was defined as the ratio of BLUE ARVs to RED units. Each of the BLUE ARV platforms

represented a single fighting vehicle, while a RED unit represented a Company-size unit.

**b. Engagement Distances.**

The engagement distance of every ARVs was assumed to be a fixed constant predetermined range for every battle, including the shorter fixed engagement standoff. This maximum engagement distance was also assumed to be its target detection range.

*Measure of Performance (MOP)*

One of the key considerations in a delay battle was time. A non-dimensional delay effectiveness (DE) ratio was derived as a MOP as such:

$$\text{Delay Effectiveness Ratio, DE} = \frac{t_{DB}}{t_A}$$

$t_{DB}$  : time of delay battle for RED force to reach FEBA line

$t_A$  : fastest time of advance in the event of no delay battle

*Key Factors Affecting MOP*

Six key factors affecting the DE (see Figure 5) were identified.

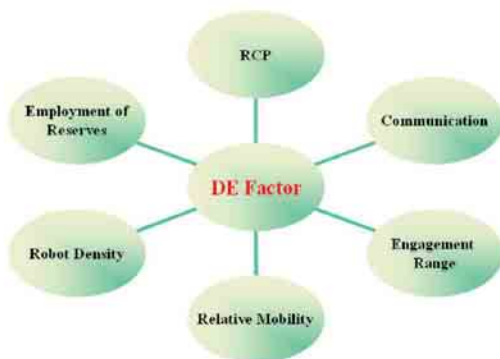


Figure 5. Key Factors Affecting Delay Effectiveness Factor

## SYSTEM ARCHITECTURE DESIGN

### Proposed Modified Subsumption Architecture

Subsumption architecture, as compared to motor schema, has the advantage of simplicity and robustness. Each behavioural layer is run independently and asynchronously, and new behavioural layer can be easily inserted.

However, by denying the use of some representational knowledge of the operational setting such as a grid-based spatial memory map, a pure subsumption architecture can potentially degrade the intelligence and performance of the robotic system in navigation. Having an adaptive learning capabilities will thus be desirable to improve the ability to avoid obstacles in a more intelligent and adaptive manner. A modified subsumption architecture for the BLUE ARV was thus proposed, as illustrated in Figure 6.

### Robot Configurations

Figure 7 illustrated the physical robot configurations. This was designed by drawing close reference to how a human is gifted with his basic senses of sight, hearing, touch, and speech (less of taste), while in cognisance of the principles for simplicity of design and low costs.

### Robot Behavioural Descriptions

Using the robot configurations defined, the following key basic behaviours were identified and defined as shown in Figure 6 on the next page.

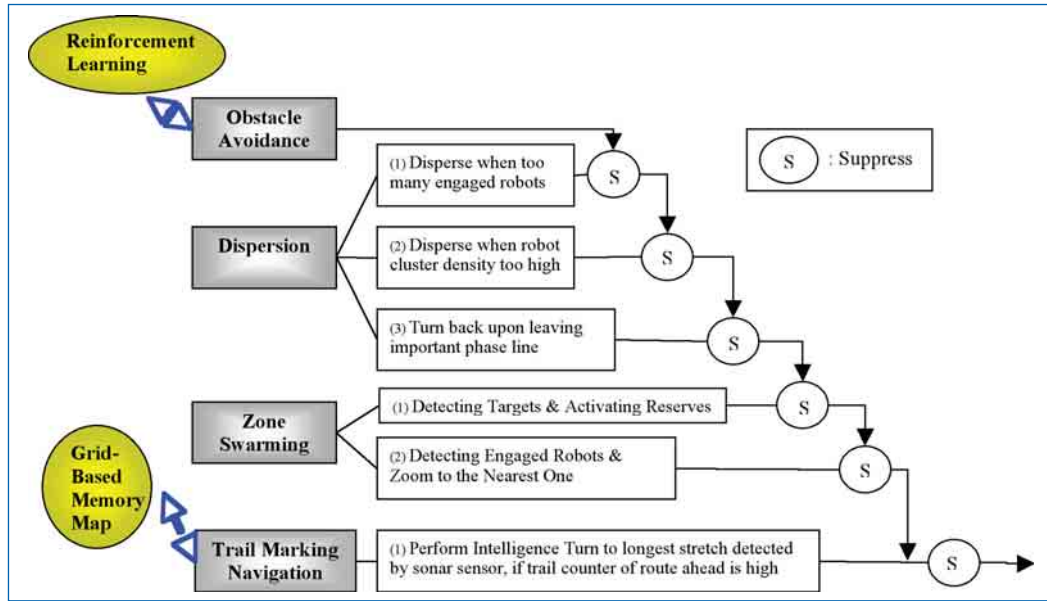


Figure 6. Modified Subsumption Architecture of Robotic System

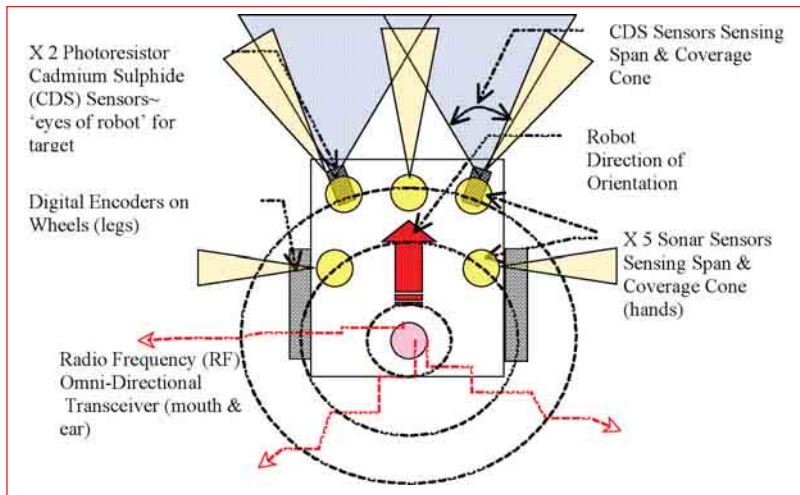


Figure 7. Robot Configurations Schematic Diagram

#### a. Obstacle Avoidance.

Adaptive capability using reinforcement learning (RL) concept was implemented. This model used a performance (behaviour) evaluation control policy whereby 'punishment' was enforced for running into any obstacle (wall or

other robots), while a 'reward' was awarded for not colliding at all after a fixed pre-determined time. The sonar sensor inputs were mapped onto appropriate output actions via a network model as shown in Figure 8 below, based on a neural network for modelling primate visual systems.

The basic idea was to allow an active sonar sensor unit to activate a corresponding unit in the feature detector layer. These feature layer units would then form a pattern amongst themselves via a competition using the winner-takes-all approach. The winner of this feature detector layer would then vote for one of the eight possible directional movement actions in the action layer. Note that although not fully shown, every sonar sensor input was connected to each and every feature detector layer, which in turn was linked to every action units. Each link had a synthetic weighting attached to it. It was with the modification of these weightings that brought into realism the learning effect observable on the robots.

**b. Dispersion.**

Dispersion behaviour was needed to prevent the robots from over clustering and to swarm the area adequately. Every individual robot has a fixed pre-determined RF zone in a concentric ring with a 'free zone' as shown below in Figure 9. Updates of individual robot's position and target detection status would be broadcasted. Any

robots that fell within the RF zone of that particular robot would be 'seen' by it. The number and status of other robots seen by this robot would then determine its appropriate reaction in accordance to fixed pre-determined thresholds. A total of three sub-behaviours were categorised:

**(1) Dispersion from Engaging Robots.**

A rule-based action of turning  $180^\circ$  to the rear was encoded, upon encountering a high engaged robot density.

**(2) Dispersion from Robot Clustering.**

Similarly, the robot that saw a high robot clustering density in its vicinity would attempt to turn  $180^\circ$  to the rear.

**(3) Holding on Critical Phase Line.**

In the event if there were no other robots detected within its RF zone, the ARV would not cross over the phase line. This would assure some robots are present to secure the last phase line, which are often fought fiercely in a delay battle.

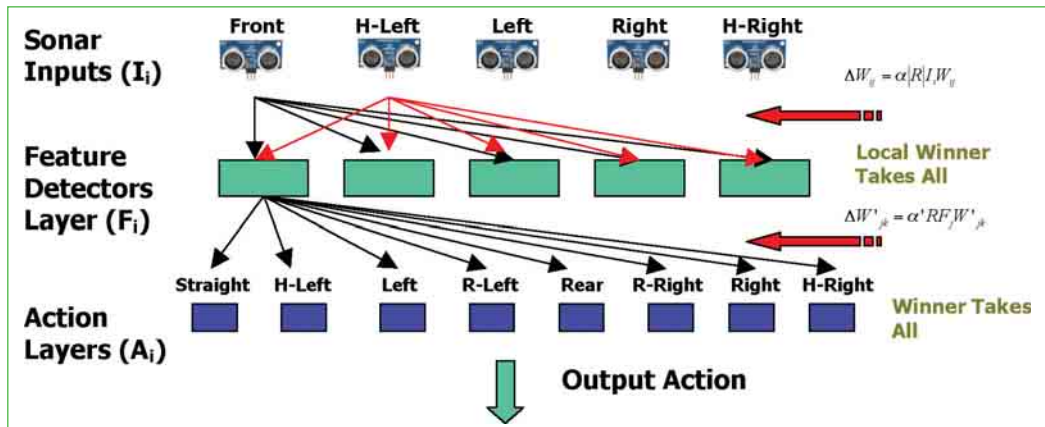


Figure 8. Reinforcement Learning Network Model for Obstacle Avoidance



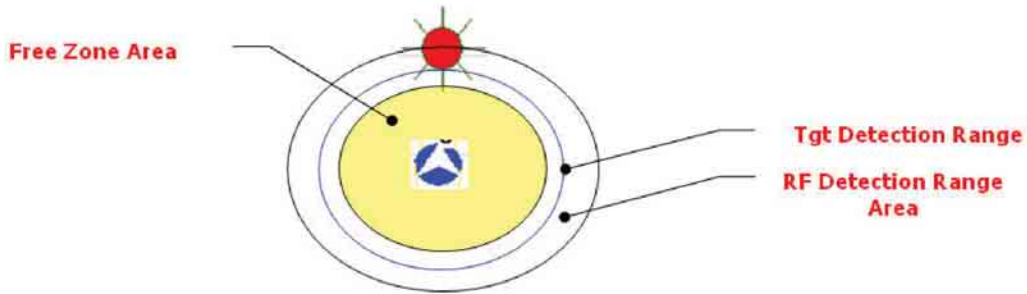


Figure 9. Schematic of Robot's RF & Target Detection Zone

**c. Zone Swarming.**

In order to achieve the desired RCP, the robots had to swarm onto the detected target. Pre-determined reserve robotic units could also be activated, upon an engagement below the critical phase line. Due to the need to prevent over clustering, this swarming action had to be localised. While the use of gradient message propagation<sup>18</sup> could be applicable, it would however require a large RF transmission packet, which the microcontroller had limitations in its RAM size to support. A zone swarming methodology was henceforth designed and proposed by the author as an alternative.

See Figure 10. A robot upon detection of an engaging neighbouring robot within its RF detection zone would steer and zoom towards the engaging robot, as shown in Figure 10(a). Upon entering the free zone, this zooming robot would be 'free' to sense the closest target in the vicinity. This free zone also served to minimise robots from getting too close to one another risking collisions. Once within the free zone, if the robot was to attempt to leave, it would detect the engaging robot again and would steer itself

back. Figure 10(b) illustrated this. Such behaviour had an important emergent effect of swarming around the target: as more and more robots got 'entrapped' within the free zone, it would increase the probability of having a high RCP against the target.

**d. Trail Marker Navigation.**

An embedded representation knowledge in the form of grid-based spatial memory was designed that would assist the robots to swarm through the area more effectively. Similar to pheromone laying by biological ants, each robot with its digital encoding sensors would monitor its own position and update the regular grid square (trail marker) that it had passed in its own memory, while broadcasting its status. In an ideal state, every robot would have the updated picture of all the movements within the grid square in its memory. An intelligent turn behaviour was designed whereby every robot, upon reaching a grid square that had a high trail marker value, would sense for the longest opening (main axis) with its sonar sensors, and steer towards that direction and proceed till the next grid square was encountered.



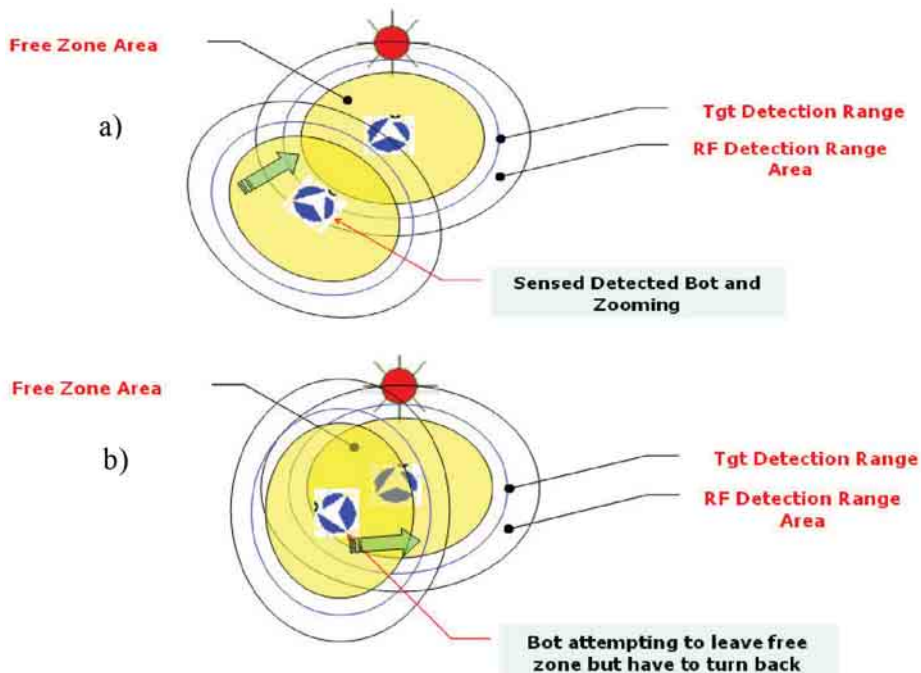


Figure 10. Schematic of Zone Swarming Methodology

## MODELLING AND SIMULATION

An existing Visual C++ robotic simulation model<sup>10,11</sup> by courtesy of the National University of Singapore (NUS) Cooperative Systems Laboratory (COSY Lab) was adapted to incorporate the modified subsumption robotic architecture with its four main behavioural actions. Object oriented Microsoft Visual C++ Programming Language Version 6.0 was used in the coding using incremental user-defined time-step simulations, with a simple window Graphical User Interface (GUI). Figure 11 shows the broad guidance logic built.

## HARDWARE IMPLEMENTATION

For the hardware demonstration, Parallax Inc. Boe-Bot was selected as the basic robotic platform to build the BLUE ARV, primarily for its low costs, simplicity, modularity in its hardware setup, and for the array of compatible

software and hardware support readily available from Parallax Inc. McGraw Hill's TAB Electronics Sumo Bot was chosen to represent the RED adversary unit primarily for its remote control function that the user could operate from afar during the experimental runs. Both robotic systems used light as the medium for target detection.

## BLUE ARV Robotic Systems

Figure 12 and 13 showed the pictures of a BLUE ARV robotic system built. A total of ten such similar robots were built, taking close reference to the conceptual design (Figure 7). Table 1 summarised the range of accessories parts and components used. The program codes to control and execute the individual behaviours of the robotic systems were programmed into the microcontroller, in accordance to the guidance logic described in Figure 11. Detailed sensors calibration and evaluation tests were subsequently carried out.

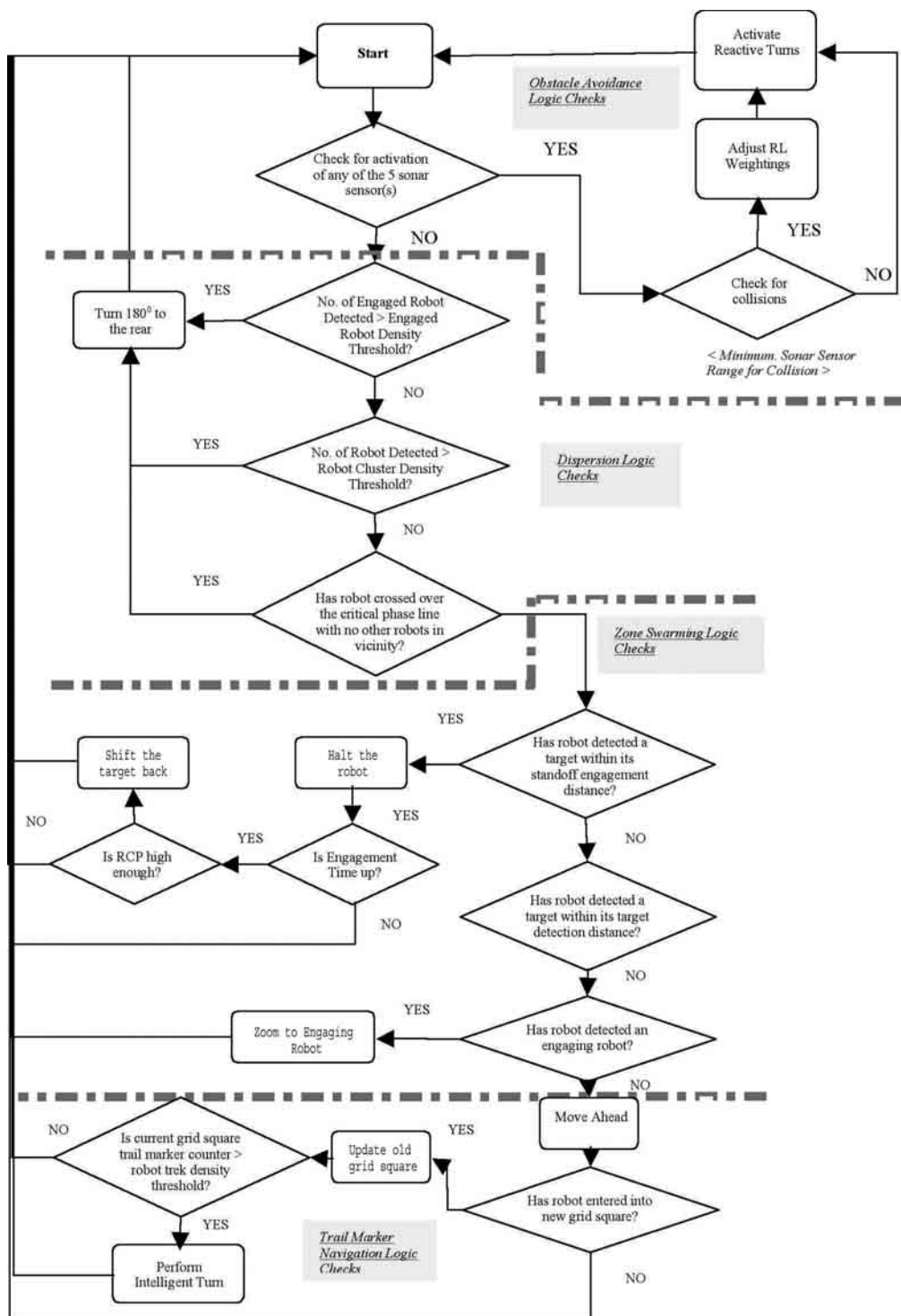


Figure 11. Robot Guidance Control Logic Flow Chart

## RED Target Sumo-Bot Robotic System

Figure 14 showed a picture of the RED Target robotic system built. A total of three similar RED Target Sumo-Bots were constructed. The platform's movement and behaviour was fully controlled by human using a remote control via IR link.

## Hardware Limitations

The main limitations encountered were the supportability of only

integer programming in the Basic Stamp microcontroller (i.e. loss of computational accuracy), limitation in the Random Access Memory (RAM) space for programming, the large dead spaces between the sonar sensors causing inter-robot collisions at times, the RF packet collisions during communications, the power degradation of the batteries, the drifting errors of the digital encoders, and the limited span and sensitivity of the light sensors.

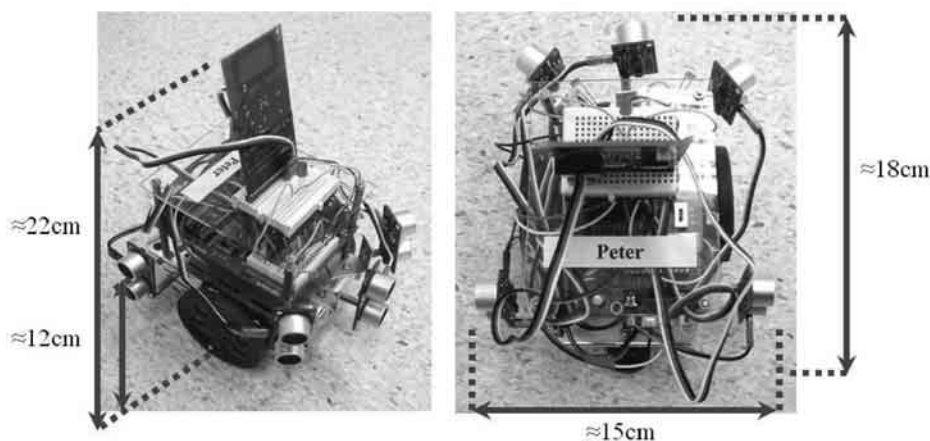


Figure 12. BLUE ARV Robot Physical Configurations

Main Components	Characteristics	Quantity
Body Chassis	Boe Bot Aluminium Frame, reinforced with acrylic board and breadboard	01
Controller	Basic Stamp 2E Microcontroller (Ubicom SX28AC)	01
Sensors	PING)))™ Ultrasonic Range Finder	05
	433.92 MHz Radio Frequency (RF) Transceiver	01
	Photo-resistor Light Sensor	02
	Digital Encoder Kit	01
Locomotion	Parallax Continuous Rotation Servo (Wheeled)	02
Power	AA Sized 1.2V / 1.5V Batteries	04

Table 1. Main Components of BLUE ARV Robotic Systems

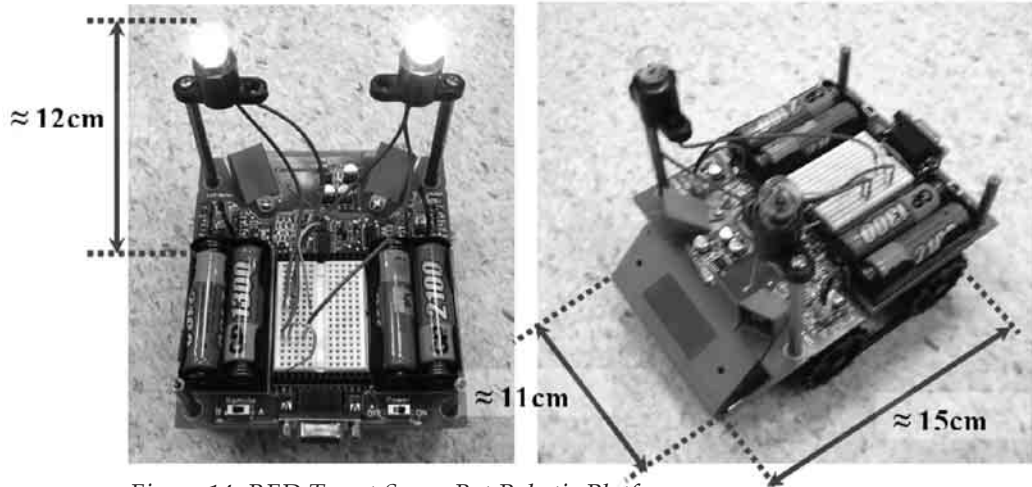


Figure 14. RED Target Sumo-Bot Robotic Platform

## EVALUATIONS AND ANALYSIS

The study covered the simulation and hardware iterative evaluations of *critical* individual robotic behaviours, followed by the systemic evaluations of the robotic systems as a whole while functioning in a delay operations environment setting.

### Behavioural Evaluations

- Obstacle Avoidance.

- a. *Sonar Sensing Distances.*

With considerations of the physical dimensions of the robot, the track

size and the entire operational area, the sonar sensing distances were iteratively sized using simulation and hardware validations as shown in Figure 15. The slight difference in the sensors threshold values was necessary so as to prevent the robot from over-reacting when it turned.

- b. *Reinforcement Learning (RL).*

The adaptive reinforcement learning was employed. The learning weightings for one robot moving around in the operating environment was optimised using simulations with an initial heuristic weightings

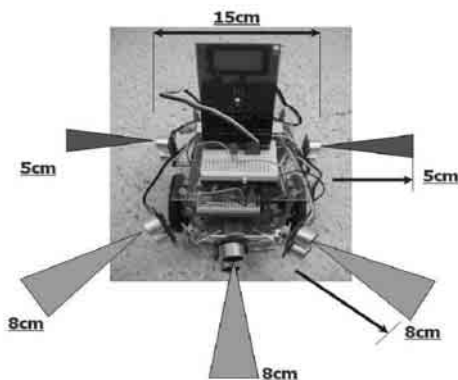


Figure 15. Sensing Cones of Sonar Sensors on the ARV

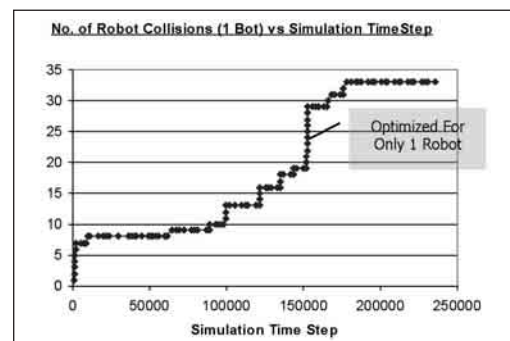


Figure 16. Temporal Accumulation of Simulated Collisions for a Single Robot

assumption, and were subsequently implemented for the rest of the robots. Figure 16. illustrated clearly the self-learning ability of the single robot in avoiding obstacles, with the rate of collisions settling notably to a nought as time passed.

While Figure 17 clearly showed the good agreements between the simulation and experimental results whereby more robots equated a lower swarming time needed, it was also evident in Figure 18 that RL

became more useful in reducing the area swarming time needed when the number of robots got higher, that is greater than 4-5 robots. This was attributed to the reduction of collisions rates thanks to the reinforcement learning ability (see Figure 19) that would otherwise have disrupted the swarming effort.

- Dispersion.

The dispersion of the robot when in face of high robot cluster and/or high engaged robot cluster was

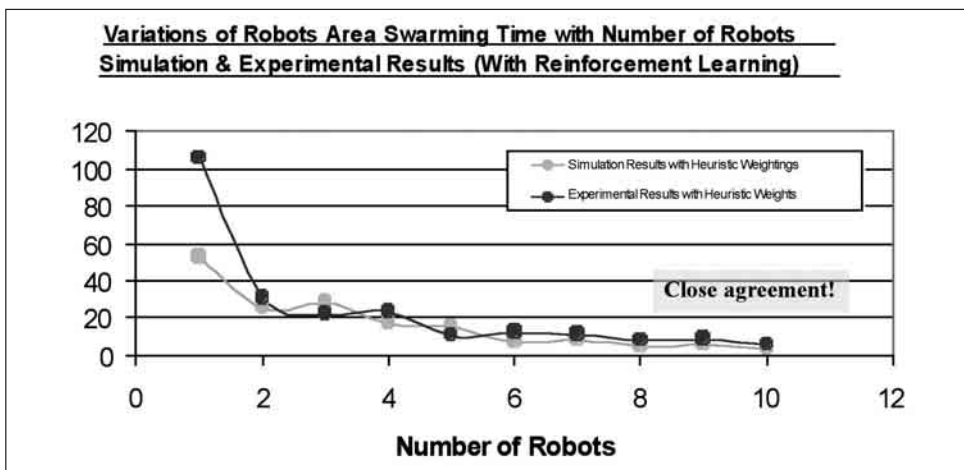


Figure 17. Comparisons of Robots Area Swarming Ability (Experimental & Simulation)

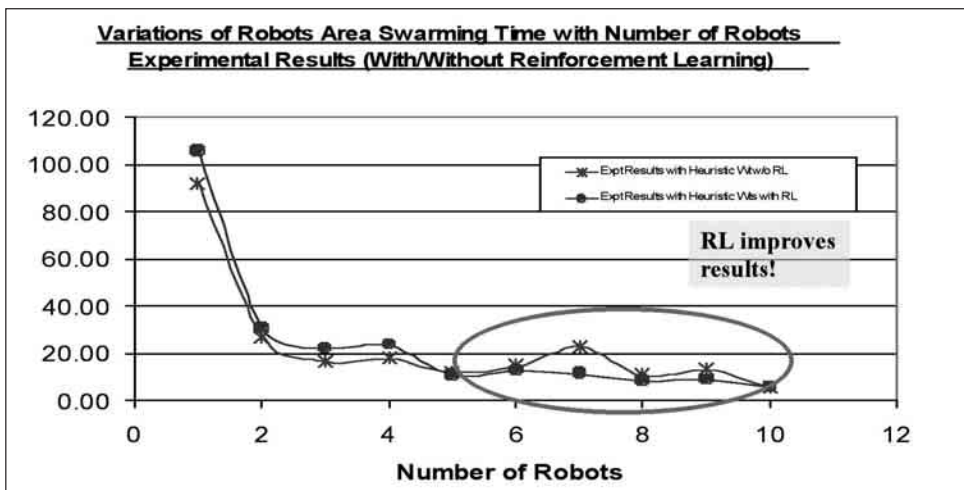


Figure 18. Variations of Robots Experimental Area Swarming Time with Number of Robots



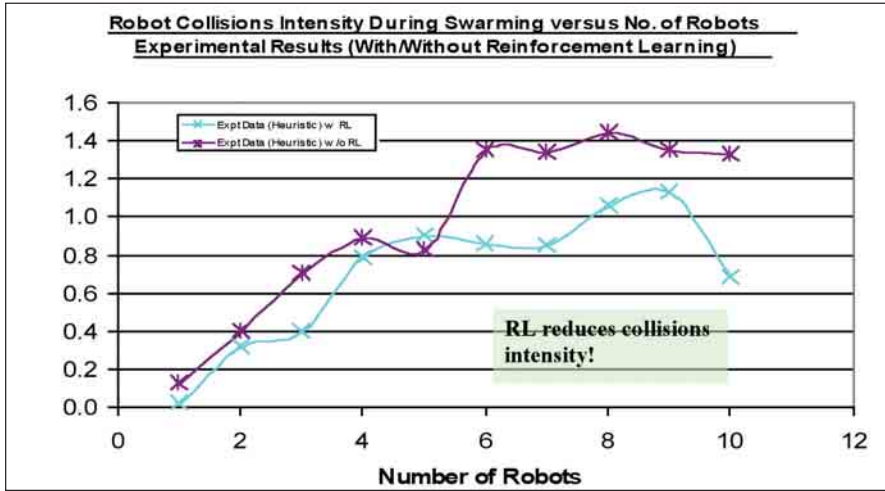


Figure 19. Robot Collisions Intensity with Number of Robots (Experimental) w/ & w/o RL

evaluated and verified via a simple test setup. This test included two robots engaging a target and an approaching robot dispersing away from it, while assuming a robot cluster threshold and an engaged robot threshold of two. The approaching robot was observed to rotate  $180^\circ$  away from the robot cluster. The series of simulated and experimental shots in Figure 20 illustrated this.

The next tests involved the evaluation of the individual robot in retaining itself back behind the critical phase

line in the event of no neighbouring robots. This was verified as shown in Figure 21.

#### •. Zone Swarming.

The behaviours of the robots using the zone swarming methodology described earlier were verified using both simulation and experimental tests. Figure 22 below illustrated the observations obtained. The experimental tests had displayed reasonable zone swarming behaviour, though certainly not as ideal as in the simulations. The success of the behaviour was heavily hinged on

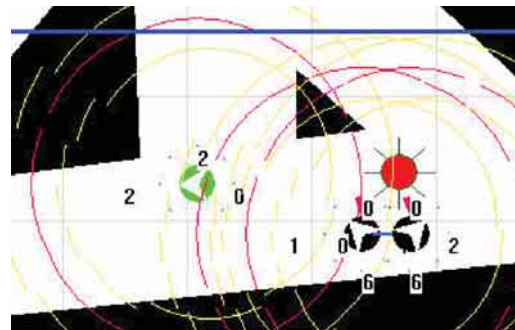
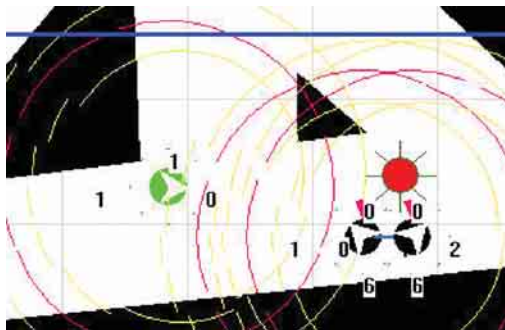


Figure 20a. Simulated Robot Dispersion from High Density Cluster

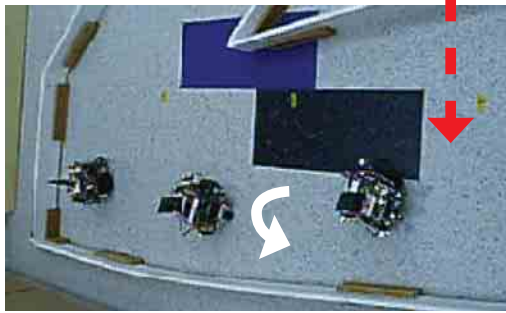
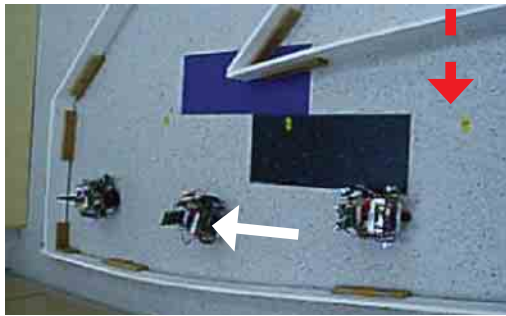
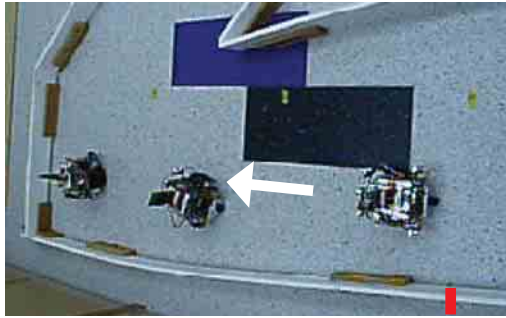


Figure 20b. Experimental Robot Dispersion from High Density Cluster

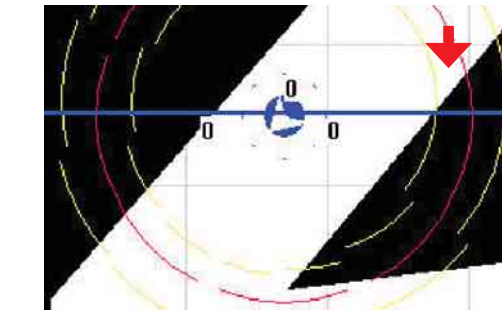
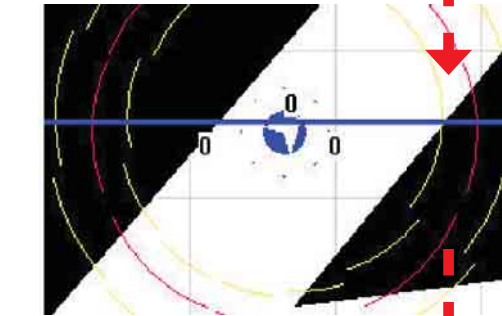
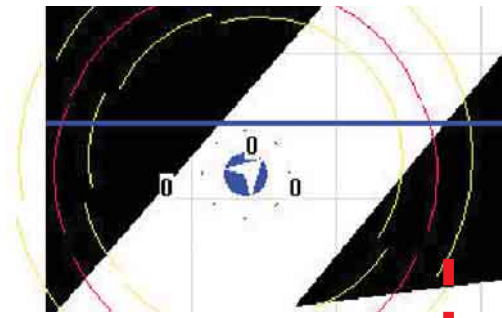


Figure 21a. Simulated Robot Holding Back Behind Critical Phase Line

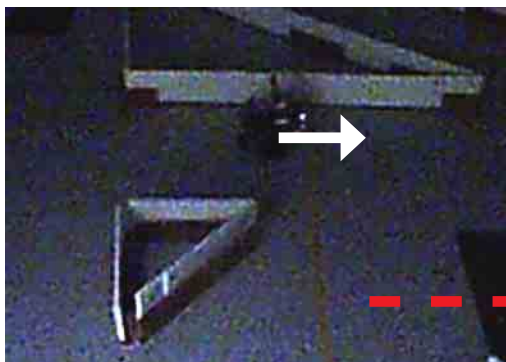


Figure 21b. Experimental Robot Holding Back Behind Critical Phase Line

the success of the communications throughout (see later). As noted in Figure 22b, the robot encircled in white was initially heading towards the engaging robot on the right. However, due to the close presence of the walls and the engaging robot itself, its collision avoidance behaviour took precedence and the robot attempted to leave the vicinity. It was led back again, however, when its RF sensor received the engaged signal again. Eventually, more robots became entrapped, causing clustering to emerge.

The next slice of this behaviour involved the activation of reserve forces in the event of an adversary target approaching near to the critical phase line and was engaged upon. Figure 23 below showed the behaviours verified in the simulation and experimental tests.

- **Trail Marker Navigation.**

The ability to effectively swarm hinged heavily on the intelligent turn behaviour. Its activation was largely dependent on the accuracy

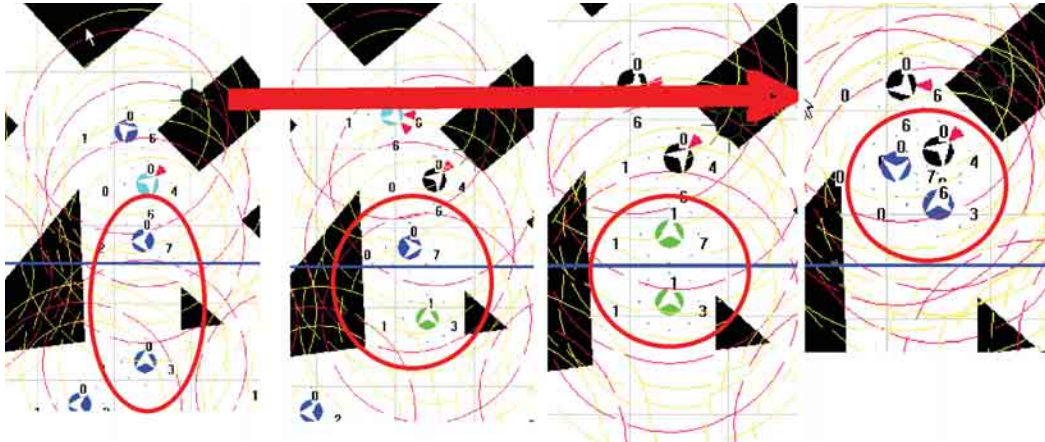


Figure 22a. Simulated Robot Zone Swarming Behaviour

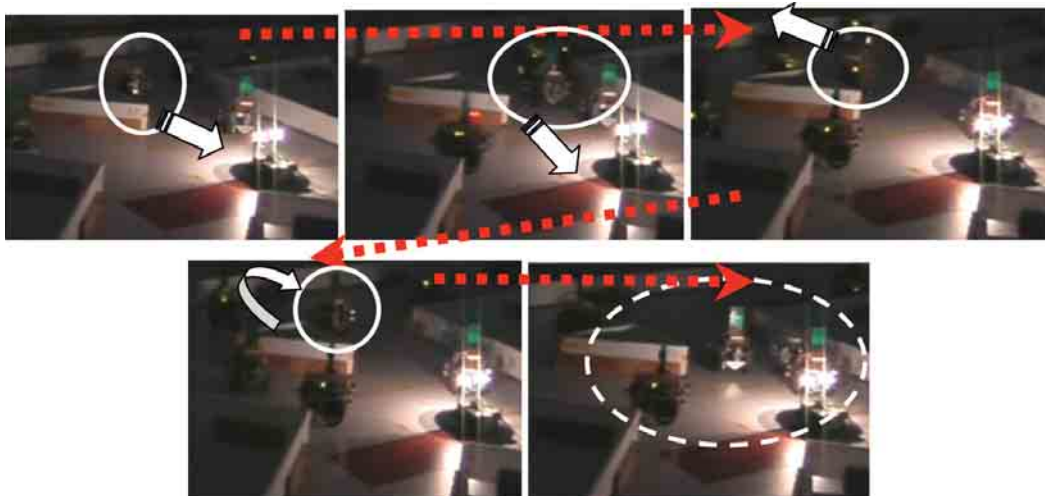


Figure 22b. Experimental Zone Swarming Behaviour



of the digital encoder sensing of its positional and orientation data, and the sonar sensors picking out the longest clearing. Even if the digital encoder accuracy was way off and had

been updating the wrong trail marker grid squares, upon activation of the intelligent turn, it would still select the longest opening route available. (See Figure 24)

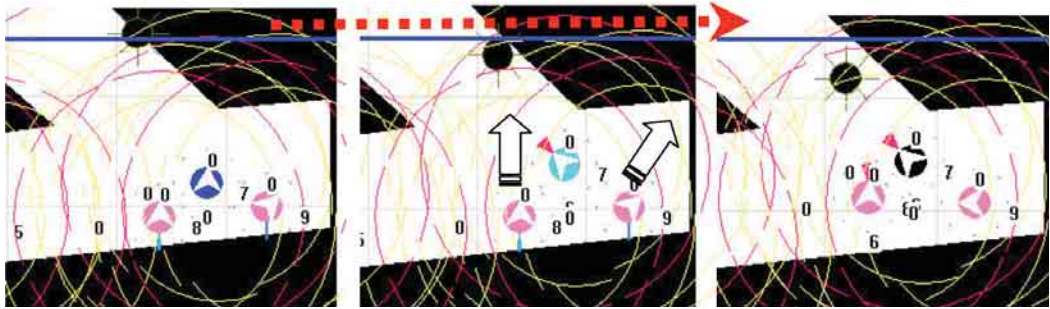


Figure 23a Simulated Robots Reserve Activation Behaviour



Figure 23b. Experimental Robots Reserve Activation Behaviour

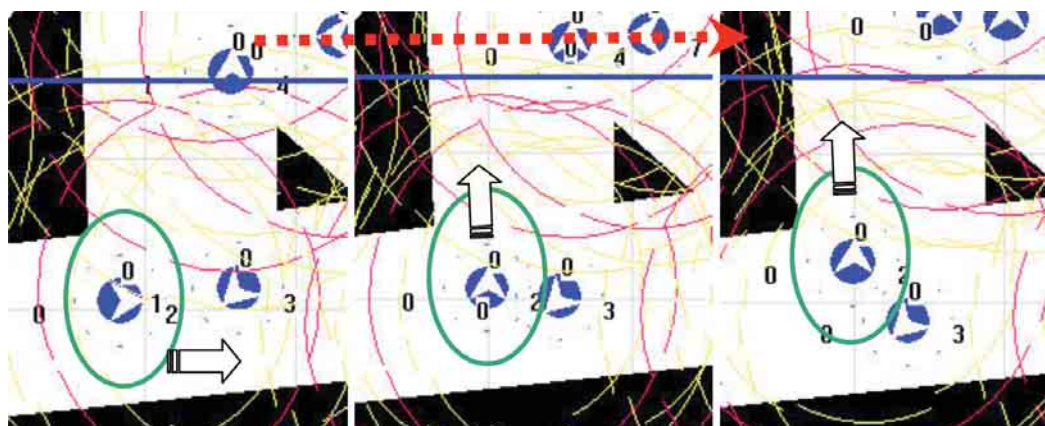


Figure 24a. Simulated Robot Trail Marker Navigation Intelligent Turning Behaviour

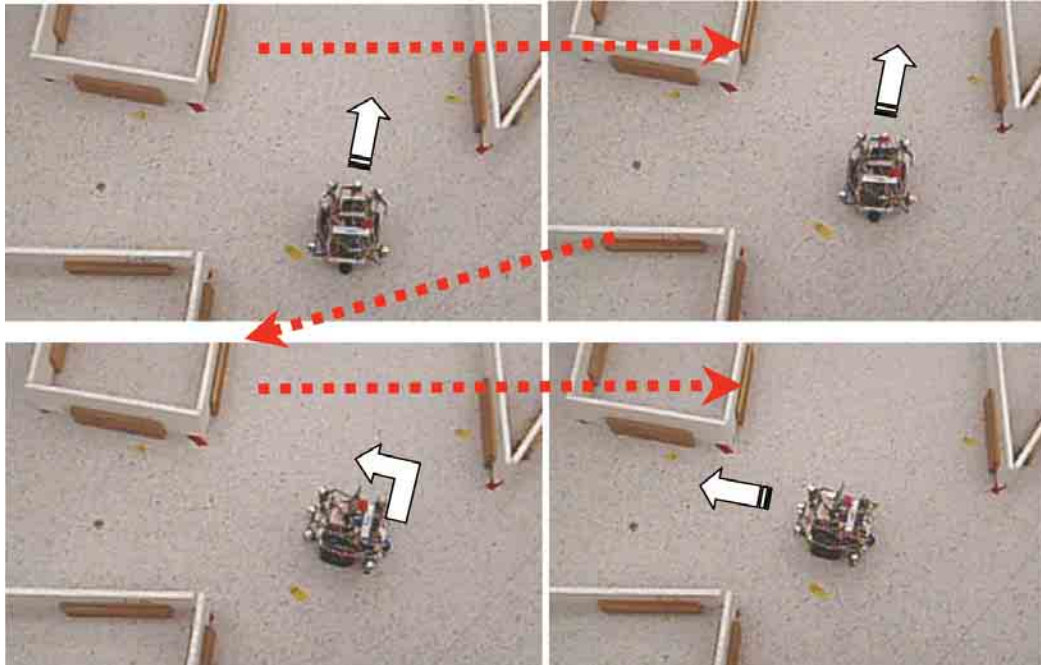


Figure 24b. Experimental Robot Trail Marker Navigation Intelligent Turning Behaviour

## Systemic Evaluations

The systemic evaluations combined the effects of all the robotic behaviours as one system while performing sensitivity analysis of the six key factors identified earlier in Figure 5, using both simulation and experimental runs<sup>20</sup>.

### *Factor 1: Relative Combat Power (RCP)*

A reasonable RCP to hold off or delay a bigger size force in a conventional delay battle would be of the order of three (in the opinion of the author) based on SAF conventional delay planning norms [i.e. three ARVs (platoon) to reasonably hold off a RED Sumo-Bot (company)].

Various evaluation runs were carried out for one Target and ten ARVs to assess the effect of RCP on the DE factor. See Figure 25. A 60cm target engagement range ( $\approx 250\text{m}$ ) was assumed

conservatively, analogous to close combat encounters. The results showed that the DE factor dropped significantly with the increase of RCP, while exhibiting a relatively close agreement between the simulation and experimental results at higher RCP. The set of parameters for a RCP of 3 was selected to act as the baseline for comparisons.

### *Factor 2 & 3: Employment of Reserves & Robot Density*

The use of reserves had always been a popular military strategy to employ in order to maintain initiative and flexibility during battle. It was therefore of interest to investigate the science behind employing robotic platforms to act as reserves.

Figure 26 illustrated the results of maintaining two robots to act as reserves, while comparing with one



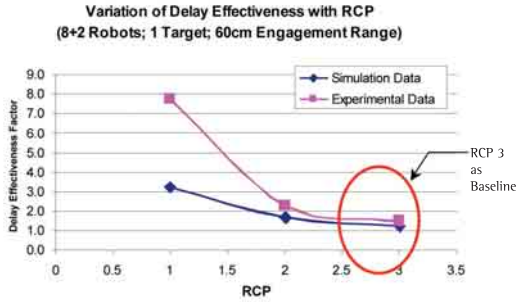


Figure 25. Graphical Results of DE Factor versus RCP (1 Target/10 Bots)

that used none. It was clear that the higher the robot density, the higher would be the DE Factor. Also, a low robot density would generally not justify the use of reserves contextually, based on the context of the scenario assumed (i.e. RCP of 3).

There was however no higher level of representation knowledge or intelligence imparted to the reserve units. The reserve units would be more effective if the exact positions of the engaging units could be communicated.

#### Factor 4: Relative Mobility

Simulation and experimental runs were carried out for the ten ARVs, with the relative speed ratio of RED units to

BLUE units varied. See Figure 27. The plots indicatively exhibited the presence of a maxima or optimal point at speed ratio (SR) of 1:1 (i.e. RED versus BLUE). This phenomenon could be tied closely to how fast the robotic platforms could detect, converge and spread out. Having a high SR would mean that the adversary unit could move much faster than the BLUE unit could react, while having a low speed ratio would however mean that the BLUE units would often be too spread out for them to be able to effectively converge onto a detected target.

#### Factor 5: Engagement Range.

Increasing the engagement range would effectively increase the area coverage by two fold since the area of a circle is a linear function of the square of its radius. Simulation and experimental runs carried out for various engagement ranges revealed that the increase in DE would be significant when we increased the engagement range. See Figure 28.

#### Factor 6: Communication

The ARV platforms in this study were a set of mobile nodes sharing a common wireless media (433.92 MHz) with no

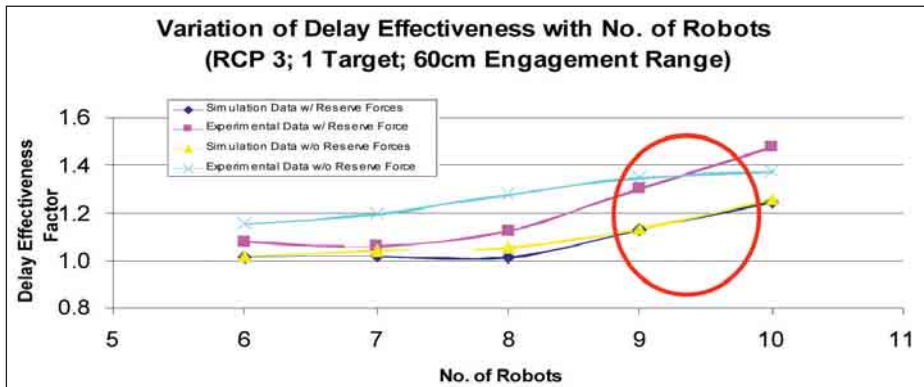


Figure 26. Graphical Results of DE Factor versus Number of Robots

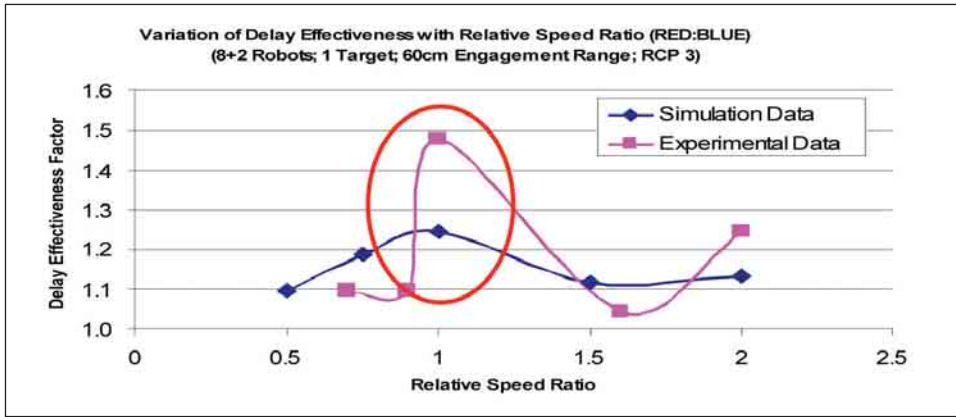


Figure 27. Graphical Results of DE with Relative SR (10 Bots; 1 Target; RCP 3)

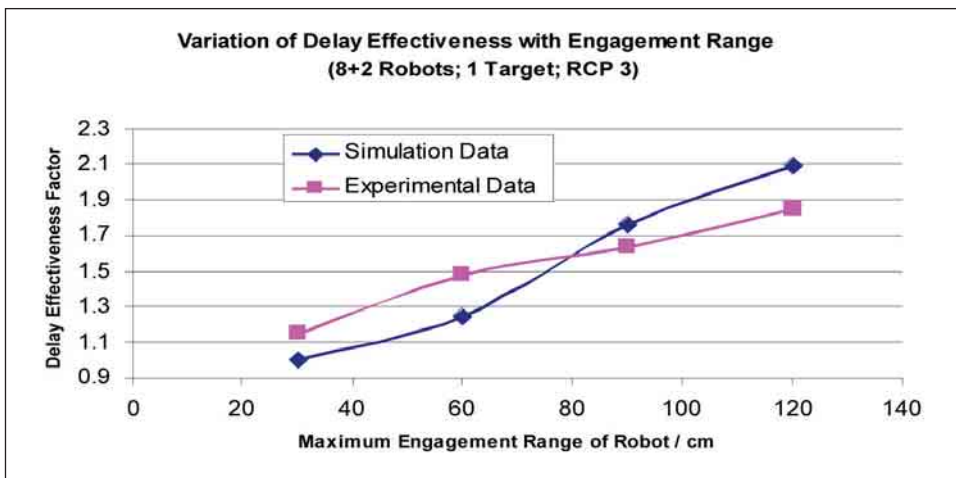


Figure 28. Graphical Results of DE versus Engagement Range (10 Bots; 1 Target; RCP 3)

fixed rigid topologies and low data rate. All nodes would constantly seek to broadcast updates to each other, resulting in high utilisation of the media.

Of interest to the author were the media access control (MAC) protocols. MAC protocols could be either exercised centrally or distributed, and asynchronously or synchronously. It was ascertained that asynchronous distributed MAC protocols would be more suited to the operational scenario by virtue of its scalability, and because the needs of each robots would be too varied and unpredictable at times to

call for a synchronous protocol. Two types of distributed asynchronous MAC protocols were considered, namely the contention-type pure Aloha protocol and the round-robin “token-ring” concept:

*a. Pure Aloha Protocol.* Every node would transmit whenever it wished to do so, regardless of the channel state.

*b. Token Ring.* Every node would take turn to transmit in a pre-fixed sequence (i.e. A to B, then to C). It would break its silence if there was no receipt of the ‘token’ to speak after waiting for a pre-defined period.

The data transmitted by the robots was of a fixed RF transmission packet size of 11-bytes, with cyclic redundancy checks (CRC) for data integrity. Figure 29 showed the comparison of results of five and ten robots for both protocols. Due to the sharing of the common transmission media by many robots at irregular periods, timing of utilisation was a critical factor. Although the Aloha Protocol could give a high efficiency of throughput of 36.6% for four robots, it was verified that the token ring protocol was able to perform significantly better when the number of robots was high (27.2% for 10 ARVs). See Figure 30. The strong influence of the communication efficiency (Token Ring) on the DE factor was evident of the importance of robot cooperativeness.

## FINDINGS AND RECOMMENDATIONS

### Key Findings

- **Critical Parameters.**

The potential relative payoff with regard to the contributions towards the DE Factor was investigated for all the 6 critical parameters less the factor of Employment of Reserve (due to insufficient data collectable with ten ARVs). An estimate of the incremental contribution towards the DE Factor for improving each individual factor by 100% was shown in Figure 31.

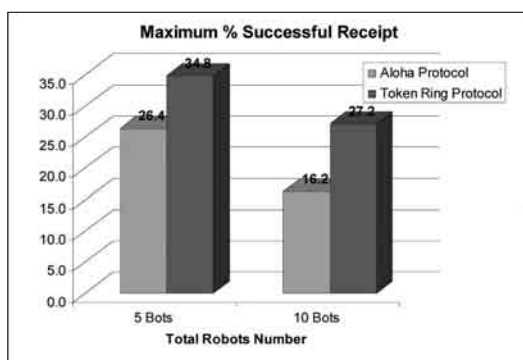


Figure 29. Comparisons of Aloha & Token Ring Protocol (5 & 10 robots)

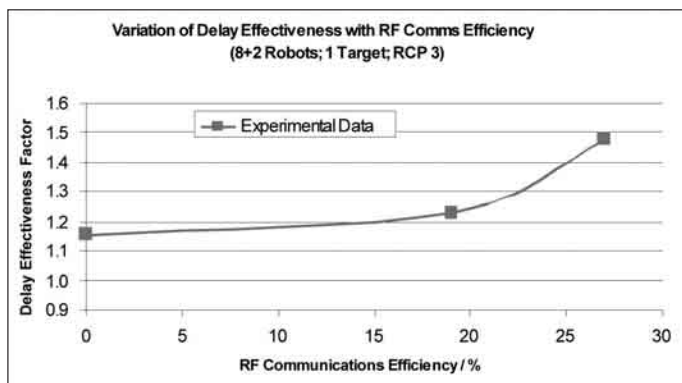


Figure 30. Graphical Results of DE with RF Receipt Communication Efficiency %

The results showed indicatively, the importance of focusing on critical parameters like RCP, Robot Density, Engagement Range and Communications, with the last factor standing out prominently. The military should henceforth leverage on the state-of-the-art technology to build a robotic system that could expand its sphere of influence, with superior firepower and lethality. Linking the robotic systems up into an integrated knowledge-based network with seamless communications would be of the highest priority.

It would be interesting operationally to assess the performance of the 10 ARVs against up to three targets i.e. battalion. Runs were carried out using engagement ranges of 60cm and 120cm. Figure 32 revealed that the DE Factor attainable, although

still far from ideal (desirably a DE of 2 to 3) were respectable, given the current state of robot autonomy.

- **Robotic Intelligence.**

It was opined that, given the dynamic operating environment, it might not be entirely practical to control a robot's behaviour based solely on priority arbitration. For instance, the ARV was distracted at times from engaging the target after a collision with another robot, and it could not 'remember' that it was engaging a target earlier. Some higher form of representation knowledge or intelligence appeared to be sorely lacking here.

## Recommendations

The scope for future work remained large. The followings were the recommendations proposed:

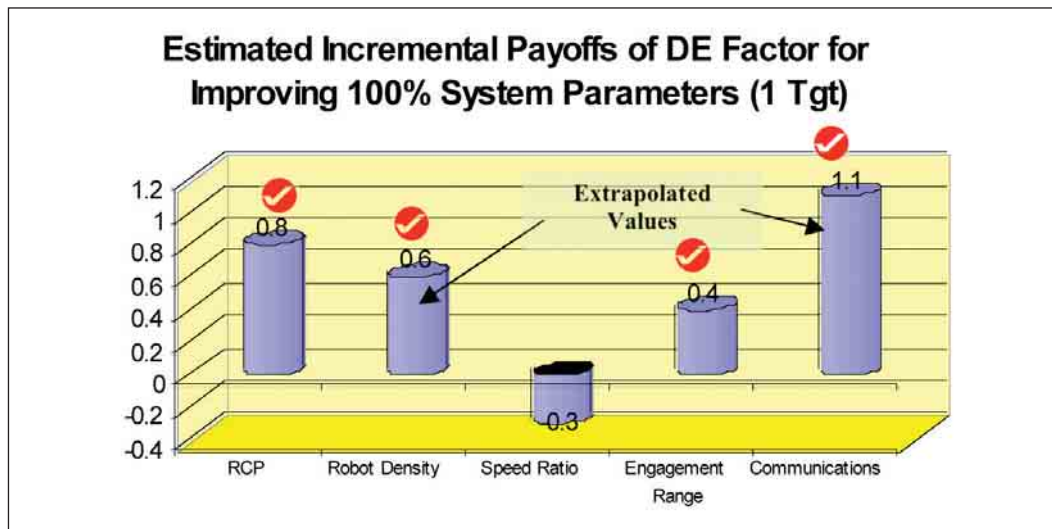


Figure 31. Relative Incremental Contributions of System Parameters Towards DE

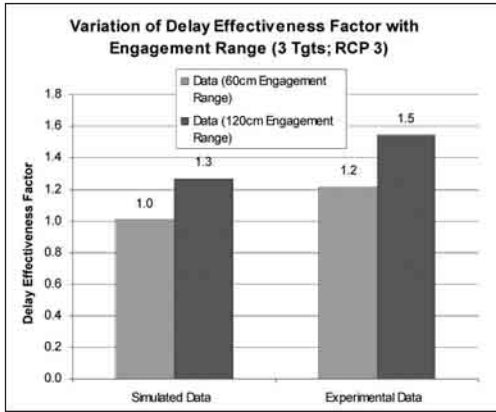


Figure 32. Graphical Results of DE versus Engagement Range (3 Targets; RCP 3)

### a. Fuzzy Control Logic.


The use of fuzzy behavioural control logic using fuzzy rules could be examined, by virtue of its robustness due to the absence of strict arbitrations.<sup>8</sup>

### b. Hybrid Architecture.

Having identified the deficiency of a strict subsumption architecture, an alternative approach might be to adopt a hybrid architecture. This is congruent with one of the principles of delay operations: “centralised control, decentralized execution”. The idea of pre-loading the map of the operational area could be experimented, to enhance the robotic navigational skills. The robotic platforms could also be more heterogeneous, with certain platforms performing certain dedicated role (e.g. scouting, as guard to hold positions, or patrols along a pre-determined route, etc). A good comparison between hybrid and distributed architecture can then be drawn.

## CONCLUSION

The exploratory study of the employment of cooperative autonomous ARV in a conceptual military delay operational settings had been an insightful one. With the design of a distributed behavioural-based robotic system using a modified subsumption architecture, the ARV platforms employed could achieve satisfactory results in terms of the DE factor, despite the several limitations encountered. There were also general good agreements between both the simulation and experimental results obtained. The injection of robotic intelligence saw the adaptive behaviour of obstacle avoidance using reinforcement learning proven useful in reducing robot collisions, and thus improving the robots’ area swarming time. The zonal swarming concept and the trail marking intelligence behavioural traits of the robots were also successfully validated.

While the employment of cooperative autonomous ARV platforms in the delay operations settings could be concluded to be conceptually feasible at this stage, a gap towards being operationally feasible still existed. Several critical areas of focus were identified to bridge this gap, such as RCP, Robot Density, Robot Engagement Range, Communications, and Robotic Intelligence. Future ARV robotic systems R&D studies should therefore focus on these areas while leveraging on the state-of-the-art technological advances to push the frontiers. 



## Acknowledgement

The author would like to thank his thesis supervisor, Prof. Gerard Leng from COSY Lab of NUS, for his excellent guidance and invaluable support for this research.

## Endnotes

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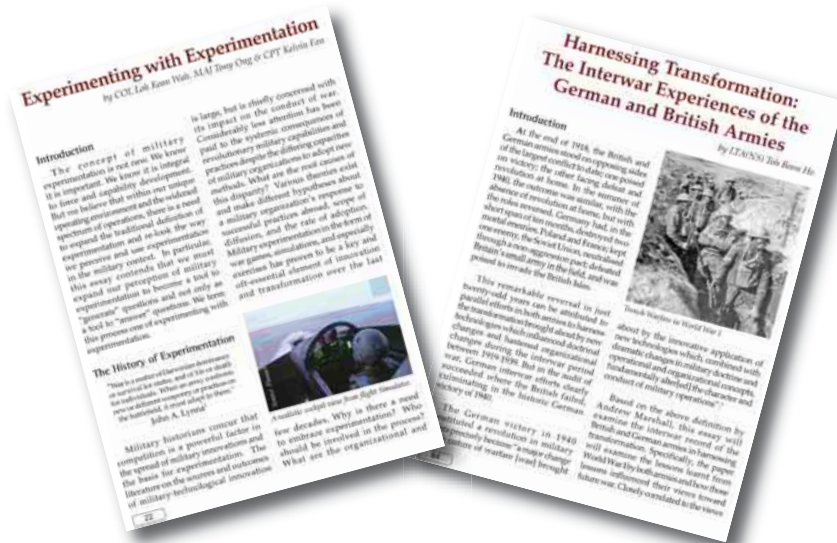
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20. 30 Monte-Carlo simulation runs were carried out for each data point, while 5 experimental runs were executed per data point. The latter were carried out with the sumo-bot running on 5 different column sectors of the operational ground, so as to ensure adequate coverage of the area, with the results indicative of the true value.



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# VIEWPOINT

## Don't Harbour High Hopes for Experimentation



Two articles in the last issue of *POINTER* that touched on experimentation piqued my interest. The article “Experimenting with Experimentation” by COL Loh Kean Wah, et. al. advocated the use of experimentation to both “answer questions” as well as to “generate questions”. LTA(NS) Toh Boon Ho’s award winning article, “Harnessing Transformation: The Interwar Experiences of the German and British Armies” briefly surveyed German and British military experimentation during the interwar period. By juxtaposing both articles, I would like to highlight the following observations concerning military experimentation:


Firstly, the first mover advantage cuts both ways. Pioneers make mistakes. Those that follow one step behind profit at the pioneer’s expense. British tank pioneers coupled the tank to the infantry’s speed. But as LTA(NS) Toh highlighted, the German Army eschewed this and unleashed the full potential of armour at great cost to the British army.

Secondly, military experimentation may undermine deterrence, not enhance it. British interwar experimentation with tanks and the indirect approach was viewed with great interest by German contemporaries. But it was the latter, building on their predilection

for manoeuvre and penchant for short, sharp wars that evolved the idea of Blitzkrieg and used it to undermine the Anglo-French deterrence.

Thirdly, military experimentation may cause more confusion than illumination. LTA(NS) Toh noted that the slew of British tank models that evolved from their armour experiments proved to be more bane than boon. Although German armour experiments proved more fruitful, the differing outcomes of British and

German military experimentation only shows that experimentation offers no easy panacea to the harassed military professional caught in a time of rapid change.

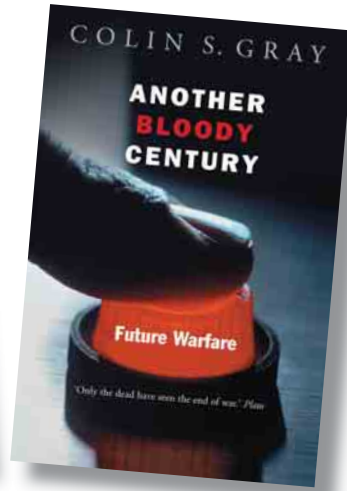
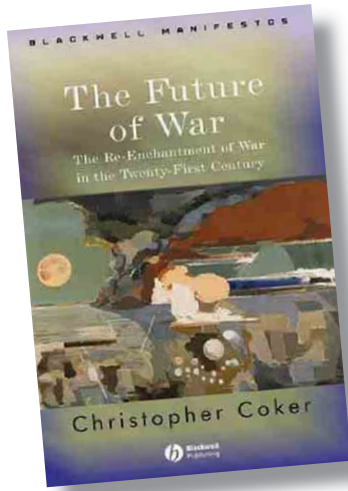
Where does this leave us? A closer reading of military history would bequeath a more realistic appreciation of military experimentation. 

*Mr Toh Boon Kwan  
(NSman, SAFTI MI)*

# BOOK REVIEW

## Wars of the Future

by LTA Phua Chao Rong, Charles



Colin S. Gray, *Another Bloody Century: Future Warfare*  
(London: Weidenfeld & Nicholson, 2005).

Christopher Coker, *The Future of War: The Re-enchantment of War in the 21<sup>st</sup> century* (Oxford: Blackwell, 2004).

Colin Gray's latest daring and highly opinionated piece is a culmination of his previous research on different aspects of strategic studies. Taking on the subject of future warfare, Gray employs a conservative and yet principled approach on the prediction of the future of war.

Gray starts with his basic framework of analysing warfare. In the first chapter 'Back to the future', he highlights the perils of predicting the future on the basis that it has not happened. In analysing the discontinuities and continuities of history, he opines that the essence

of war, those principles illustrated by Clausewitz, is the same despite the changing *character* of warfare. With this, he emphasises the study of history as humanity's best available means to know the future. His study of history points to the importance of social, political and cultural context as the determinants of our war-prone future (p55). He uses RMA and transformation to illustrate this point – weapons technology is only a strand contributing to military performance whereas the political and socio-cultural developments such as that of the end of Cold War (or for that



matter, September 11) had a far greater impact on the hearts of people which are the ultimate determinant of future war, driven by Thucydides's 'fear, honour and interest' (p105).

He goes on to challenge the existing grand narratives of war from 1800 to 2100 A.D. represented by themes such as 'Decline of war' thesis, to 'Rise of terrorism' to 'RMA, technology and the expanding geography of war'. It is apparent that Gray chooses the study of history as an insight to our future, highlighting the importance of continuities in history and pointing out that often, things only seem new because we have forgotten the past. When discussing 'Regular warfare', contrary to Mueller's thesis on the decline of inter-state war, Gray demonstrates the continual relevance of regular inter-state warfare albeit in a more complex way involving asymmetric warfare. Asymmetric warfare is used by relatively weaker states to counter stronger states, noting the US as the strongest military state. He, therefore, suggests the US to beef up their Special Operations (elite irregular regulars) capability to match the demands for warriors, over industrial-age soldiers, in such asymmetric conflicts (p207).

On 'Irregular warfare', Gray considers it to be 'an old story meeting post-modernity'. The industrial way of inter-state war was a result of the modern Westphalian state system, which has evolved considerably since then. Technicalities aside, Gray concludes that asymmetry is a feature of all warfare and that regular and irregular warfare is often fused, thus highlighting the tyranny of categories (p232).

On terrorism and specifically Al Qaeda, Gray opines that given their unpopularity even within the global Muslim community, the latter would be diminished slowly by natural ageing of their leaders and combat attrition (p241). However, meanwhile, it would still require a global counter-insurgency effort to reduce its incidence and severity. The concept of irregular regulars (Special Operations - SO) is elaborated further in this chapter. The central question is if most regular forces in the US have to be SO-capable, what need is there for a distinct SOF? That is a chicken-and-egg question. Nevertheless, we do see the blurring distinction between regular and irregular warfare. His insights into terrorism are pertinent to SAF's adaptation to this unconventional threat. The tasking of 2 PDF as the Subject Matter Expert formation for Homeland Security as well as making 6 SIR a dedicated Protection of Installations battalion illustrates how regular armed forces have increasingly taken on constabulatory duties.

Gray elaborates in his thesis that the essence of war has not changed and that new challenges such as [weapons of mass destruction (WMD) and space/cyberspace warfare] still adhered to the old rules – Clausewitz rules! (p327). Of relevance to the SAF is the section on cyber-warfare, which can be summarised as, 'cyber-warfare is still warfare' (p313). There is no separate strategic theory for cyber, space and arguably air power (p319). Information dominance is a tool for strategy and cannot compensate for low morale, poor discipline, inadequate training, poorly conceived strategy or incompetent command. Therefore, cyber-warfare is

still guided by the same old rules as the ancient human-based land warfare. It might serve us well to keep this in mind as the SAF embarks on our IKC2 program and to create that 'jointness'. We should not allow the novelty of technologies to obscure the importance of less novel aspects such as the human factor in warfare.

Gray also writes about the futility of grand solutions for peace such as disarmament, universal institutions, democracy, ethics, law and the 'inutility' of war. Instead, he recommends more realistic solutions such as cost, policy, strategy, power, fear and culture as potential controllers of war.

Finally, he concludes his book by reiterating his seven arguments on why the future will be a warlike one. In a nutshell, war is a permanent feature; war and warfare has an enduring nature but variably high character; interstate warfare is much alive amidst recent focus on irregular warfare; political context still drives war; warfare is also social, cultural and strategic behaviour, surprise is certain; efforts to regulate war need to be realistic.

Perhaps the most important lesson from Gray is the importance of context. While US concepts can serve as an invaluable role in advancing ourselves, it is important to contextualise the US concept of Transformation to Singapore's social, political and cultural context for maximum utility and relevance. This is abundantly demonstrated by how the US's notion of "full spectrum warfare" is vastly different from the SAF's with the US's FSW ranging from theatre nuclear war to policing occupied foreign countries.

Professor Gray's repeated evocations of Clausewitz and Sun Zi – which is also done by many of us in the military who may not have even read those classics – also remind us of the constancy of old wisdom in warfare and how we should always be acutely aware of the past and the present context in order to be better prepared for the future.

Professor Coker's book explored the re-enchantment/dis-enchantment of war in the 21<sup>st</sup> century by harnessing the power of cybernetics and biotechnology. The work is highly recommended for readers interested in the effects of technology on past and future war. It offers a critical reading of history to reveal how warfare has been transformed.

'The re-enchantment of war', drawing on a considerable body of philosophy and literature, seeks to explore the relationship between the instrumental (rational action), existential (warrior practice/culture) and metaphysical ('sacralises' death as sacrifice) dimensions of modern war (p6). He opines that modern war with mass production and mass conscription is a product of industrialisation, dehumanises (disenchants) war and degrades the enchanting heroic warrior to a worker-soldier. It shifts the pre-modern balance from between functionalism and human purpose to that of extreme utility without spiritualism. Man is instead a slave to his technology. Modern warfare was thus characterised by industrial values of functionalism; efficiency, mechanical coordination and discipline; practical rationality and systemic utility. These alienated the pre-modern values of chivalry, virtue and courage (p27).

In a broad historical analysis, Coker examined the manner technology has dictated military thinking. With the invention of the clock, time was force and money; warfare was based on precision, discipline, harmony and uniformity as seen by rigid formation of 'clockwork armies' introduced by Maurice of Nassau in the 1590s. The steam engine ushered in thermodynamic and power principles; it manifested itself with the thinking of timing and tempo attack, speedy manoeuvre and firepower.

The present paradigm dictates that the best informed survives. Cybernetics allows integrated systemic thinking and an ongoing process of data evaluation. Although soldiers are increasingly regarded as information-gatherers, the reduction of risk to humans makes war more humane. Notably, success now is characterised by the use of information superiority to direct firepower with precision and immediacy; this reflects the cumulative nature of warfare across time and warfare becomes increasingly more demanding.

Communications and computerisation has brought along three features of information warfare – optimisation (safety, lethality with precision against maximisation of kills); technology as cultivation (higher refinement of skill to ensure the stability, durability and sustainability of a society after war as against mere manipulation to destroy societies and humanity); and differentiation (network-centric, dispersed and mobile warfare as against centralised attritional warfare). Therefore, war is surprisingly re-enchanted by information technology, which allows people to re-engage with humanity.

The rest of the book discusses the effects of future technology on the concept of warfare. Two chapters on the future warrior and post human warfare illustrate how biotechnology can be better harnessed to give soldiers warrior attributes. It introduces concepts of cyborg warriors and bio-enhanced warriors. However, importantly, it questions the ethics behind this biotechnological revolution, which might blunt the human conscience and negatively dehumanise war from its human touch.

Next, the focus shifts to robotic technology. The seemingly positive side of technology is that less human casualties and sacrifices are incurred in war. This, however, benefits the bearers of such high technology more. Technology is instead used to not 'punish less' but to 'punish better', citing Foucault (p128), with a clearer conscience. Yet, the development of robotics essentially made redundant the need for human (heroic) sacrifice, and war is no longer 'sacred' (p130). The danger lies in the robots' indifference to human life; that essentially takes away the human element in micro-level decision-making during war. War is fought without a clear human conscience and is again disenchanted.


Whether war is ultimately to be re-enchanted or disenchanted by technology is the key question in his open ended – 'to be concluded?' conclusion. Coker opines that to aim for a middle way of war is still sacred in terms of sacrifice and re-introduce/retain the human dimension of war. A cold, rational war machine, like that of the past industrial war paradigm

and that of a possible future robotic/cyborg warfare, could be considered 'inhumane' in different ways (p141).

Professor Coker's writing can inspire SAF officers to re-look into the human aspects of SAF's Transformation and our concept of the future high-tech 3G warrior. Information technology such as IKC2 and precision-guided munitions can allow the SAF to attack with precision and agility, and suffer fewer casualties. The key question for the SAF is whether industrial warfare paradigm, such as centralised commands and divisional fighting units, can adapt to these almost totally opposite requirements of information warfare. Specifically, the SAF needs to consider the concepts of optimisation, cultivation and differentiation in the transformation of its doctrine, operations and organisation in order to fully exploit the potential of IKC2. This book signals the need for the IKC2 warrior to rekindle the existential warrior ethos/practice/culture of chivalry, virtue and courage, which has been neglected in modern industrial warfare. It constantly reminds

us to be a master of technology and not unknowingly be a slave to it.

Both books are concerned with the future of war and share some commonality in their historical survey of the past and the appreciation of high-end technology. To the 'end of war' theorists who would have possibly sparked off the entire 'Future of War' debate in 1990<sup>1</sup>, Coker and Gray's answers are clear. War is not obsolete; it has a future, which is bloody and technologically biased.

However, their arguments focus on different aspects of the future war and warfare. Coker's contributions revolve revisiting the much-neglected ethical and humanistic aspects and Gray focuses on the unchanging strategic essence of war as illustrated by Clausewitz and Sun Zi. Both writers are respected academic commentators and have equally valuable contributions to the ongoing discourse on the future of war. 

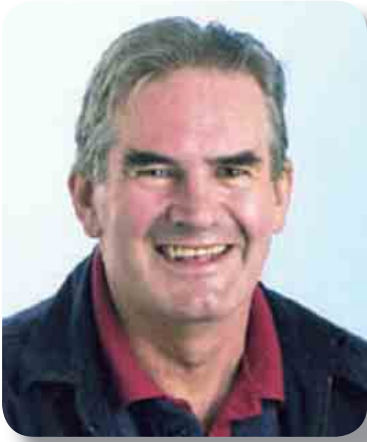
#### Endnotes

- <sup>1</sup> Kaysen, C. 'Is War Obsolete?' *International Security* 14(4), Spring 1990.



LTA Phua Chao Rong, Charles is a Signals Officer by vocation and is currently reading MSc (Research) in International Relations at the London School of Economics & Political Science (LSE), UK. He received a BSc (Hons) in International Relations from LSE in 2005. LTA Phua is also the recipient of the Goldman Sachs Global Leader Award (2004) for academic and leadership excellence at LSE and the 2005 HSBC Youth Excellence Award for youth leadership and community service. He is a SAF Academic Training Award(Overseas) recipient.

## FEATURED AUTHOR



### Colin S. Gray

Colin S. Gray is Professor of International Politics and Strategic Studies at the University of Reading, England, and is a Senior Fellow at National Institute for Public Policy, Fairfax, Virginia of which he is the founding Chairman. He was educated at the University of Manchester in 1965, and at Lincoln College, Oxford University in 1970. Previously, he has served as Executive Secretary of the Strategic Studies Commission at the Canadian Institute of International Affairs in Toronto, Assistant Director of the International Institute for Strategic Studies in London, and Director of National Security Studies at the Hudson Institute in New York.

Prof. Gray's wealth of experiences in the field of International Politics and Strategic Studies include him serving five years in the Reagan Administration on the President's General Advisory Committee on Arms Control and Disarmament. He has also served as an adviser both to the American and

the British governments, as he has dual citizenship in both countries. He also served on the Panel of Experts on the UK Strategic Defence Review. In April 1987, the US Department of the Navy presented him with the Superior Public Service Award. Prof. Gray is currently a member of the editorial boards of *Comparative Strategy*, *Journal of Strategic Studies*, *Naval War College Review*, and *Journal of Terrorism and Organised Crime* for the United Nations. He has served on advisory panels for the Congressional Office of Technology Assessment on Strategic Defence Initiatives and space weapons, the Department of the Army on tactical nuclear weapons, the Department of the Air Force, and US Space Command on the future of space forces.

The *Journal of Strategic Studies* once aptly said "Colin Gray's voice is one of the most penetrating in contemporary strategic studies; and it is one which will help to establish the character and agenda of strategic discourse in the years ahead."



On the basis that the only permanent thing in life is change, Prof. Gray is a strategic thinker whose ideas are firmly grounded in the laboratories of history. Always provocative and sometimes controversial, Gray often provides a probing discussion on some of the most important questions regarding the relationship between military force and foreign policy. Williamson Murray, the author of *German Military Effectiveness*, once described Gray as a “unique commentator” on the strategic scene, and that “what he has to say is of real relevance to policymakers, academics, and those concerned with where American defense policy must go in the new emerging world”.

Prof. Gray has written extensively on defence policy, strategic theory and military history. The author of 19 books, over 100 book chapters and almost 200 articles, his recent works include *The Second Nuclear Age*; *Strategy for Chaos*; and *The Sheriff: America's Defense of the New World Order*. In his latest book, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History (Strategic Studies)*, Gray presents three Revolutions in Military Affairs (RMA), namely the French Revolution, World War I and the nuclear age, in his analysis and illustration on the strategic functions of the RMAs. It is often argued that war occurs under extenuating circumstances, especially chance, and hence, “strategy” is almost always misconstrued as being frenzied and anarchic. Gray, however, argues that this chaotic unpredictability is in fact, a defining element of strategy.

Gray coyly points out in his book *Weapons Don't Make War* that the phrase “strategic errors” is a linguistic error as weaponry does not equal strategy, and

he contends that there is ultimately a greater relationship between policy and strategy. Although we are no longer in the arms race era, the arms race is a case study that highlights that without clear policy guidance, the weapons acquisitions process is eventually reduced into political arm-wrestling. We also learn that military technology is but only one of the many servants of defence policy, and thus, Gray's arguments transcends the barriers of time and hold regardless of the continuing evolution of the international political arena.

As one reads more of Gray's works, it becomes increasingly evident that his works are always thematically evolving to stay relevant to today's day and age. In light of global efforts to combat and deter the ever-present threat of terrorism, Gray observes in the monograph *Maintaining Effective Deterrence* that the scope of terrorism today has almost rendered deterrence obsolete. He illustrates that strategic reality is not simple. Instead, the two are inextricable. Gray also provides both the structure of the psychology of deterrence and policy guidance on how the United States, and ultimately the rest of the world, can most effectively use it. Gray eventually concludes that an adaptable and dynamic military with powerful land operations and military equipment is the only tool that can successfully maintain deterrence. In the monograph *Defining and Achieving Decisive Victory*, Gray places the war against terrorism in the context of the larger evolving global security situation, and states that an effective strategy forms the basis of eventual decisive victory. He concludes that although “dialogues among unequals is always difficult”, it

has become necessary for nations today to do so for greater cooperation in our fight against terrorism.

*The Daily Telegraph* aptly described Gray's recently released *Another Bloody Century: Future Warfare* as "The sooner this (book) is read by Western policy-makers, the better". Such is the immense influence of Gray in today's political climate. In the book, Gray states "War is organised violence threatened or waged for political purposes". Yet to concentrate on the war against al-Qa'eda, for example, is to ignore a far greater peril. He observes that there is an "early stage" of a new Cold War with the United States on one side and Russia and China on the other. He traces this development to 2003 when Russia had to decide whether to continue its "de facto quasi-alliance" with the US, or instead to join France in opposing American policy towards Iraq. It, however, chose the latter. More recently, Russia's decision to ignore US concerns about Iran's nuclear programme by providing technical and material assistance will only aggravate the gradually eroding alliance between the United States and Russia. Gray also admits that there will likely be an uprising of a political Sino-Russian threat

to US supremacy eventually, and he concludes that ultimately, the US military domination will not last indefinitely.

The common thread of all of Gray's books and articles is the continuous evolution of his thoughts on the global political developments juxtaposed against the increasingly uncertain social climate around the world. His undeniably thought-provoking work sometimes polarizes opinion, but his political predictions serve as an alarm for military strategists and governments from all over the world. Gray has successfully backed up his theses with historical precedence, hence successfully marrying both the past and the future into a concept that's both useful and accessible to us. Whether we agree with Gray's work or not, his work has the ability to urge us to stimulate our imagination and view the present political climate from a different point of view: through the crystal ball. Gray's willingness to challenge orthodoxy is noteworthy and especially relevant to military transformation. His works have been proven to be essential reading for anyone from military professionals and strategists to someone merely looking for an interesting and engaging read. 🧐

# PERSONALITY PROFILE

## Great Chinggis Khan and His Military Genius

*by Dr Gombyn Sukhee*



This is an extract of the most recent Viewpoint Talk organized by SAFTI Library. It is adapted from a highly insightful presentation by Dr Gombyn Sukhee, Consul General of Mongolia to the Republic of Singapore.

### Introduction

Chinggis Khan (1162-1227AD) was a great military leader and strategist respected by not only the Mongols but also the people all over the world. He united many disparate tribes to form the nascent Mongol nation. He led a devastating Mongolian army that

managed to subjugate more land and population in twenty five years, where the Romans had achieved it in four centuries. Chinggis Khan was named by The Washington Post as its “Man of the Millennium” for embodying the “half-civilized, half-savage duality of the human race” and also as an “apostle of extremes”.

This short essay is divided into two major sections: Chinggis Khan and his military campaigns – which would provide a brief synopsis of Chinggis Khan’s many successful military campaigns; and secondly Chinggis Khan and his military genius – which would highlight some of the Khan’s main contributions to the Mongol military organization and his leadership traits.

### Background

Chinggis Khan was born in 1162 to the family of a minor Mongolian tribal leader. He was the eldest son of six brothers. He was named Temuejin at birth. Chinggis Khan had a very difficult childhood. He was sent to live with his future wife’s family at nine years of age. Shortly thereafter, his father was poisoned by the neighboring Tatars. Over the next few years, Chinggis Khan and his family led a very troublous and impoverished life, relying mainly on

small game and wild fruits for their survival. It was during these trying years that Chinggis Khan learnt many survival skills from his mother, Hoelun. She taught him the importance of building alliances among other lessons of survival, in order to prepare him for the harsh political landscape.

## Chinggis Khan and his military campaigns

During his lifetime, Chinggis Khan scored two major military campaign victories against Western Xia in Northern China and the Khwarezmid Empire in Persia. Chinggis Khan united the various Turkic-Mongol nomad tribes to form his Mongol nation by 1206. He did so by building alliances, adroit diplomacy, as well as waging war against those tribes that opposed him. In addition, he implemented a strict code of law, called the Yassa code. He managed to gain total obedience by promising civilians and fighters wealth from future possible spoils of war. His unification of the Mongolian nation was no mere feat as these tribes had a history of internecine disputes and falling prey to the “divide and rule” tactics of their more powerful neighbors, such as the Jin Dynasty.

After uniting the diverse Mongol tribes as one common federation in 1206, Chinggis Khan turned his sights to Western Xia. He waged a well-organized campaign against the Tanguts and managed to capture its well-defended cities after initial difficulties. Chinggis Khan’s army managed to conquer Western Xia by 1209 and the Tangut emperor acknowledged the Khan as his overlord.

Chinggis Khan then turned his sight on his next target, the Nuzhen, who were the founders and rulers of the Jin Dynasty. He wanted to rid the Mongol people of decades of subjugation by the Nuzhen. In 1211, he waged war against the Jin Dynasty in Northern China. Two years later, his army successfully crossed the Great Wall of China. In 1215, Chinggis Khan’s formidable army besieged and captured the Jin capital of Yanjing (now known as Beijing), forcing the Nuzhen emperor to flee and shift his capital to Southern China.

When the Khanate of Kara-Khitan was hostile to the Mongols, Chinggis Khan sent his brilliant young general, Jebe, along with only 20,000 troops to conquer the Khanate of Kara-Khitan. Jebe employed intelligence warfare and managed to defeat Kuchlug (the Khan of Kara-Khitan). Mongol agents incited an internal revolt, which enabled the Mongol army to quickly defeat Kuchlug’s troops west of Kashgar. Kuchlug was eventually captured and killed by Jebe while the Khanate of Kara-Khitan was annexed by Chinggis Khan and added to his rapidly expanding empire.

By this time, the Mongol empire shared its western border with the Khwarezmid Empire. A fateful decision by the Shah of the Khwarezmid Empire to refuse commercial contacts with the Mongol empire resulted in his empire’s destruction by the fearsome Mongolian army. Chinggis Khan collected a lot of pre-campaign intelligence and carefully prepared his army for war. He divided his army into three groups, led by Jochi, Jebe and Chinggis Khan himself respectively, to form a pincer attack on

Samarkand. The Shah's troops on the other hand were divided into small groups to guard the numerous cities of the Khwarezmid Empire. This strategy along with internal disputes within the Khwarezmid Empire's ruling elite and the Shah's fearful attitude against the Mongol army resulted in Chinggis Khan speedily defeating and conquering the Khwarezmid Empire. The Mongols' capture of the capital city was brutal with widespread pillaging, plundering and raping. The bodies of citizens and soldiers laid all over the city. By 1220, the Khwarezmid Empire had ceased to exist and the Mongol empire had expanded further.

In the 1220s, Chinggis Khan split his army into three divisions: one led by General Muqali tasked with guarding Mongol-ruled China. The second was led by his trusted generals Jebe and Subutai, who marched through the Caucasus and Russia. Lastly, one division led by the Great Khan himself, raiding parts of Afghanistan and Northern India. The Mongol armies sacked settlements and defeated peoples who refused to acknowledge Chinggis Khan as their overlord. Although these raids did not add significant territory to the Mongol Empire, they increased the awe people had for the Mongols, and thus, more kingdoms and territories accepted Chinggis Khan as their overlord.

Towards the end of his life, Chinggis waged another war against the rebellious Western Xia. The Tangut emperor had at various times refused to obey Khan's orders, especially when the Mongols were preoccupied with waging wars against others. In 1225, Chinggis began

his final campaign to punish the Tanguts. His army quickly defeated the Tanguts and captured many of their cities. By 1227, the Tangut emperor surrendered to Chinggis Khan and was executed along with the rest of the Tangut royal family.

## Chinggis Khan and his military genius

Chinggis Khan was an excellent political leader and successful military commander because he was able to improve the organization, tactics, strategy and training of the Mongolian army under his reign. He also led by example and displayed traits of a good leader.

In terms of strategy and tactics, he made four enhancements that contributed to the Mongolian army's success on the battlefield. First of all, he improved upon the Asian traditional principle of being soft and yielding when one's enemy was strong, but hard and ruthless once the enemy's weakness was exposed or discovered. This tactical move was known as "the retreat" and the Mongolian army became an expert in this under Chinggis Khan's leadership. Outwardly, this maneuver was often interpreted by the opposing force as cowardice. In reality, the Mongols wanted their opponents to pursue them, and in so doing expose their own shortcomings and limitations.

The next strategy employed to great effect by the Mongols was the encirclement tactic. The Mongolian army would fake unwillingness to engage in close combat during the initial stages of an armed conflict. This was not due to any inferior physical strength on the part of the Mongols but rather, it



was a strategy to harass the opponent with feints and arrows till a suitable time for the Mongols to strike appear. As the opposing army gets outflanked, sufficiently angered, exhausted and disorganized, the Mongol army would then move in with great speed and lethality for a swift and decisive kill.

The third area of improvement under Chinggis Khan was his emphasis on intelligence gathering. The Mongolian army paid a lot of attention at attaining good pre-war intelligence about their opponents, including understanding the motivations of their enemies before the declaration of hostilities.

The last area of improvement was in the field of psychological warfare. Chinggis Khan used psychological warfare to greatly enhance the chances of success for the Mongolian army. He knew that in many situations, his Mongolian army would be outnumbered by his more populous enemies. In order to diminish and counter the effect of this inherent numerical disadvantage, Chinggis fostered and carefully cultivated a brutal image for his Mongol army, through regular plunder and killings of captured cities, so as to intimidate and diminish the morale of their opponents. This ruthless reputation of the Mongol army played a vital part in convincing some cities and rulers to surrender without a fight.

In the realm of training, it is well documented that the Mongolian army under Chinggis Khan's able leadership was highly trained, disciplined, efficient, tough, dedicated and, not

to mention, loyal. This was due to the strict application of severe discipline for minor infractions and the just dispensing of rewards to soldiers according to merit. The Mongolian army's weapons and armor were carefully chosen and continually improved upon to increase every soldier's combat capability.

The mobility of each Mongol soldier was another important factor in the success of the Mongols in the thirteenth century. On one hand, each Mongol troop had three to five horses in reserve during military campaigns, thereby guaranteeing their high level of mobility. On the other hand, their armor was lighter than other armies to allow for a higher level of movement and agility without compromising the level of protection provided by the armor. Therefore, each Mongol soldier was a self-sufficient unit that was able to function independent of supply lines.

Military autonomy is yet another reason for the success of the Mongol army. There was relative independence between the individual soldier, his unit and his leaders. This winning combination ensured the capability of joint engagement on one hand, and that of independent action and self-sufficiency on the other.

As for organization of the army, Chinggis Khan departed significantly from tradition. He refused to divide and group his troops according to ethnicity. This method of organization fostered a sense of unity among the entire Mongolian army, prevented racial

discrimination and further boosted the implementation of meritocracy within the Mongol Empire. It also enabled soldiers of different ethnic groups to be treated fairly and equitably, and at the same time allowed for shared experiences and the inevitable enhancement of a common identity and a single people among the Mongols.

A good leadership trait displayed by Chinggis Khan was his careful planning of an orderly succession to follow his eventual death. He anointed his third son, Ogedei, as his successor and specified that future Khans should be his successor's direct descendants, thereby ensuring smooth transitions of power from one generation to the next. This is an important trait of successful leaders, one which helps to ensure the longevity of one's empire and reduces the prospect of complicated tussles for power by having too many possible claimants to the throne.

## Conclusion

Chinggis Khan led a very rich and momentous life. He died in 1227. At the time of his death, the Mongolian Empire he had painstakingly built stretched from Korea in the east to the Persian Gulf in the west. It was the largest contiguous empire that ever existed. The memory of his numerous successful conquests lives on till the present with Chinggis Khan and his army remaining the epoch for many armies to emulate. 🙏

### Note:

Chinggis Khan is the direct transliteration of the legendary ruler's title from the Mongolian language.

*This year marks the 800<sup>th</sup> anniversary of Chinggis Khan's historic feat of uniting the fractious Mongol tribes and leading them towards the formation of the great Mongolian Empire of the thirteenth century.*



Dr Gombyn Sukhee is currently the Consul General of Mongolia to the Republic of Singapore. Prior to his current position, he has served as the trade representative of Mongolia to Singapore, and in the Mongolian Ministry of Foreign Affairs, where he worked in the International Trade and Investment Department. Dr Sukhee is also the Mongolian Representative to the International Advisory Group of the Pacific Economic Cooperation Council, and is a Scholar of Preventive Diplomacy, International Relations and Management, Military Strategy and Intelligence and Information Technology. He obtained his PhD degree in Technical Science from the Russian Military Academy in St Petersburg.

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