

POINTER MONOGRAPH No. 1

Creating the Capacity to Change

**Defence Entrepreneurship
for the 21st Century**

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FOREWORD

In 1819, the year of modern Singapore's founding, Shaka Zulu defeated the army of Ndwandwe. This marked the beginning of the Zulu nation. Shaka Zulu's military record stands as a paragon of innovation. His organisation and tough training methods created an army of professional and disciplined soldiers. He enhanced mobility by forcing his warriors to throw away their traditional sandals and run barefoot. He exploited technology to develop the short stabbing spear, called the "assegai". This new weapon revolutionised warfare in Southern Africa. Shaka Zulu's warriors used the assegai to close in for the kill, while the inaccurate long throwing spears favoured by the enemy bounced harmlessly off their large hide shields.

Shaka Zulu *changed* the rules of the game. He set aside the ritualistic forms of battle practised by the Zulu people since time immemorial, and replaced them with new and superior strategy, tactics and technology. In so doing, Shaka Zulu, the illegitimate son of the chief of a minor Zulu tribe, conquered a territory larger than Europe and united a constantly warring people.

History is full of examples of how change can be harnessed as a positive force in the military. In modern times, the Israeli Defence Force is a peerless example of how a capacity to change has ensured that it is always ready to fight and win the next war. The challenge is to develop such a capacity to change, and then to sustain it. It is as much a challenge of organisation as it is a challenge of leadership. Leaders and their organisations must share qualities of agility, creativity and adaptability.

Today, the challenges facing the SAF are more varied and more complex than the singular task we faced in 1965, which was to quickly build the SAF from scratch. The strategic clarity of the Cold War has given way to uncertainties of the post-September 11 environment. The SAF has plucked all the low hanging fruits. The SAF cannot safely assume that what it does well today will be good enough in the future. Going forward, uncertainty and the rapid pace of change suggest that the SAF should not tie its future development to linear projections from the present. Instead, the SAF must expect and assume that there will be non-linear disruptions to the strategic environment, in operational concepts and in technology. This demands that the SAF develop a capacity to change and innovate quickly in anticipation of, or in response to, emerging trends. But this is easier said than done. The SAF is no longer a simple command which marches to the beat of a single drummer. Today, it is a complex *system* that critically depends on the support of organisations outside the MINDEF hierarchy over which it has little control or influence. How a positive capacity to change is developed in such a complex system is one of the central questions that must be asked—and answered—if the SAF is to continue to be a force to be reckoned with in the future.

This monograph is an attempt to answer this question. It is the work of seven young officers. Late in 2001, I had the opportunity to spend some time with them discussing the critical challenges facing MINDEF and the SAF and, in particular, the challenge of keeping the SAF strong and relevant in an environment of increasing complexity and uncertainty. They had many ideas, and readily agreed to my suggestion to put these down on paper.

I commend this monograph as an excellent piece of work that deserves a wide audience. Its excellence reflects the enthusiasm of the authors, and the deep effort they put in to scope the issues and to propose solutions. All officers in the defence community should read this monograph, ponder the issues raised, and debate the solutions. It is my sincere hope that this monograph will generate serious discussion that in turn will be the catalyst for action to create a capacity to change in MINDEF and the SAF. This capacity to change will enable a new generation SAF to emerge, strong and able to face up to any challenge in future with confidence.

PETER HO
Permanent Secretary (Defence)

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FREDERICK TEO is currently in the business of moulding leaders out of men at the Officer Cadet School. Trained as an infantry officer, he has developed a deep-seated belief that there is always a better way to do things, and that a straight line to the objective is almost always a bad idea. Computer games take up the time not spent on more leisurely pursuits like thinking about the impact of global trends and driving forces and making work more fun and interesting. He has a childlike fascination with Japanese animation and an inexplicable urge to own the complete Robotech DVD set. He also loves music and enjoys tinkering with the piano. You can get in touch with Frederick at frederick_teo@hotmail.com.

CONTENTS

1	INTRODUCTION	1
2	FRAMING THE CONTEXT	5
	External Discontinuity	
	Internal Complexity	
3	AN ORGANISATIONAL STRATEGY TO BUILD THE CAPACITY TO CHANGE	13
	The Need for Organisational Duality	
	Creating C2C Space	
	A Simple Model for C2C Space	
	Building the Capacity to Change	
4	TAKING THE FIRST STEPS	39
	Strategy	
	Capability	
	Warfighting	
5	FINAL WORDS	51
APPENDIX 1	DARPA	53
APPENDIX 2	INTEGRATED KNOWLEDGE-BASED COMMAND AND CONTROL	61
	BIBLIOGRAPHY	63

DISCLAIMER

The opinions and views expressed in this monograph are the authors' own and do not necessarily reflect the official views of the Ministry of Defence.

INTRODUCTION

Military planning is almost an oxymoron.

In 1957, when the concept of the Harrier jump jet was developed, the British military saw it as a means of nullifying Soviet nuclear doctrine, which advocated using tactical nuclear weapons to take out airfields. Aircraft dispersion, it was argued, would preserve Western air power.

We now know, of course, what happened. Instead of World War III, the British found themselves engaged in the Falklands War. Instead of being deployed on the plains of Central Europe, Harriers were launched from commercial ships plying the South Atlantic. And instead of being used for close air support, as the RAF had envisioned, Harriers earned distinction in air combat.

The bad news is, the Harrier example is hardly unique. The good news is, this problem is hardly confined to the military. Albert Hirschmann, a distinguished developmental economist, found that planners of large infrastructure projects in developing countries often grossly underestimated the costs and overestimated the benefits.¹ Invariably, the projects were only redeemed when innovative uses and benefits were discovered subsequently.

¹ Albert O. Hirschmann, "The Principle of the Hiding Hand" in *Public Interest*, Winter 1967, pp. 10–23

The wrong lesson to draw from this is that planning is futile. If anything, the dictum “failing to plan is planning to fail” rings truer today. We would not be able to design, build and operate highly sophisticated weapon systems without detailed specification of requirements. Large-scale operations and large-force employment would become impossible were it not for careful planning. There is no substitute for in-depth analysis and rigorous calculations.

Nevertheless, we must begin to recognise that what conventional planning processes do not cope well with is complexity. Like the linear mathematical models that are completely useless for the study of non-linear dynamics, typical planning methodologies are inadequate for dealing with open-ended problems that are non-linear and discontinuous in nature, with open-ended governing parameters and variables that cannot be explicitly defined. Such issues are characterised by unstable emergent trends with cumulative systemic effects. The external manifestations of such effects may be spectacular but their underlying causes are more subtle, and often even elusive. We can thus be very confident at coming up with detailed operational requirements for new tanks, ships or fighters, but are reduced to opinion and conjecture when asked to consider whether tanks, ships and fighters will be relevant in the future.

Conventional planning processes do not cope well with complexity.

The challenge of complexity has become all the more pressing now because of the convergence of three emerging trends.

- **Discontinuities in Technology**

The exponential growth in information processing power promised by Moore’s Law has enabled quantum leaps in capability, but at decreasing costs. The processing power of a multi-million dollar supercomputer of the 1980s can now reside in any off-the-shelf notebook computer. When combined with rapid advances in the life sciences and nanotechnology, a whole range of new technological solutions emerges. These technological developments may take on radical forms and can have dislocating effects that catch us unawares.

- **Asymmetry**

The second trend centres on the emerging effects of asymmetry and disproportionality. The tragedy of 9/11 is instructive. A military and economic superpower that spends hundreds of billions of dollars on defence every year could not prevent a terrorist operation that cost less than a million dollars. This has turned our conventional understanding of power on its head.

- **Globalisation**

The third trend relates to the effects of globalisation. International capital markets, the so called “CNN effect” of the international media, and the rise of trans-national political movements mean that localised problems now have significant global effects. Economic collapse or religious friction in distant regions can now undermine and even threaten our core security interests. Conversely, what once seemed like trivial local issues can now rapidly flare up into events of regional or even global significance.

Taken together, these trends lay the foundation for any number of radical changes, and indicate a very real possibility of fundamental surprise – by events that fall outside our very conceptions of security. For MINDEF and the SAF, it is crucial that we learn to recognise when and where our existing planning tools are deficient. While our ability to solve complicated technological and operational problems is unquestioned, more serious doubts exist about our capacity to cope with the complexities generated by a changing strategic environment.

[We] must learn to live with the tensions between ... the effectiveness and efficiency (E&E) of current operations, and the more free-wheeling and innovative ... capacity to change (C2C).

This monograph looks at the coming challenges that MINDEF and the SAF will face and proposes a new conceptual compass for navigating the road ahead.

We will begin by identifying the specific challenges posed by complexity inside and outside our organisation. We will then outline an organisational strategy for dealing with such complexity. Essentially, we will argue that all successful organisations must learn to live with the

tensions between their main structure, which maintains the **effectiveness and efficiency (E&E)** of current operations, and their more free-wheeling and innovative components that give them the **capacity to change (C2C)**. Finally, we will tackle the issue of driving change—how the C2C model can apply specifically to the context of MINDEF and the SAF.

This handbook is therefore written to be a “single negotiating text” for effecting the changes necessary in our system. The purpose is not to lay out a bureaucratic charter for implementation. Rather, it is intended to challenge entrenched mindsets and to provoke reflection. The greatest, and most enduring form of change takes place at the most personal level—down from services, formations, departments and units to individual minds.

FRAMING THE CONTEXT

EXTERNAL DISCONTINUITY

PLAYING GAMES IN THE DARK

The last hundred years have witnessed a series of technological changes, each of which has revolutionised warfare.

At the turn of the last century, developments in rifles and machine guns made infantry so effective that the horse cavalry lost its utility. In the lead-up to World War I, rapid advances in aerodynamics led to reliable powered flight. In between the two World Wars, the scale economies of the production line were grafted to the military, making possible the creation of vast mechanised armies. The end of World War II marked the beginning of the nuclear age, the weapons of which forever changed the strategic calculus of major powers. Subsequent post-war decades saw the development of technologies that enabled the destructive power of the atom to be delivered faster, further, with greater precision and with more devastating effects.

Today, we live in no less exciting times.

Information technology now promises to lift the Clausewitzian fog of war, enabling more effective battle management and orchestration. Precision weapons already allow fewer units to take on the same adversary and exact more damage, completely reversing the numerical calculus of war. Simultaneous advances in the fields of robotics, computing and

An Accelerating Rate of Change?

One way of viewing the evolution of warfare in the 20th century is to study the introduction of ground-breaking technologies. These technologies, introduced every 10 to 20 years, were revolutionary in the sense that they led to radical changes to military doctrine, tactics and organisation. The examples below highlight this.

- 1900s Machine guns
- 1910s – 1920s Powered flight
- 1930s Radar
- 1940s – 1950s Nuclear bombs
- 1960s Extended delivery (ICBM)
- 1970s Satellites
- 1980s Computing

The last 10 years has seen the introduction of an inordinate number of technologies with effects that promise to be equally revolutionary. These include advances in the following.

- Genetics
- Biometrics
- Computing power
- Broadband data communications
- Global Positioning System
- Precision guided munitions
- Robotics
- Nanotechnology

The sudden surge in developments support the hypothesis of an accelerating rate of technological change. How is a military organisation to respond to the fluidity of such an environment in which weapon systems can become obsolete even before they are fully fielded?

guidance technologies introduce the possibility of fighting conventional wars by cybernetic proxy. At the same time, the spectre of biological and chemical warfare reminds us of the vulnerable nature of our own humanity.

Set against the environment of the post-Cold War and characterised by the rise of non-state actors, such as terrorist organisations and even rogue financial wizards, these revolutionary technologies can cause grievous hurt

We are once again at the brink of another major discontinuity.

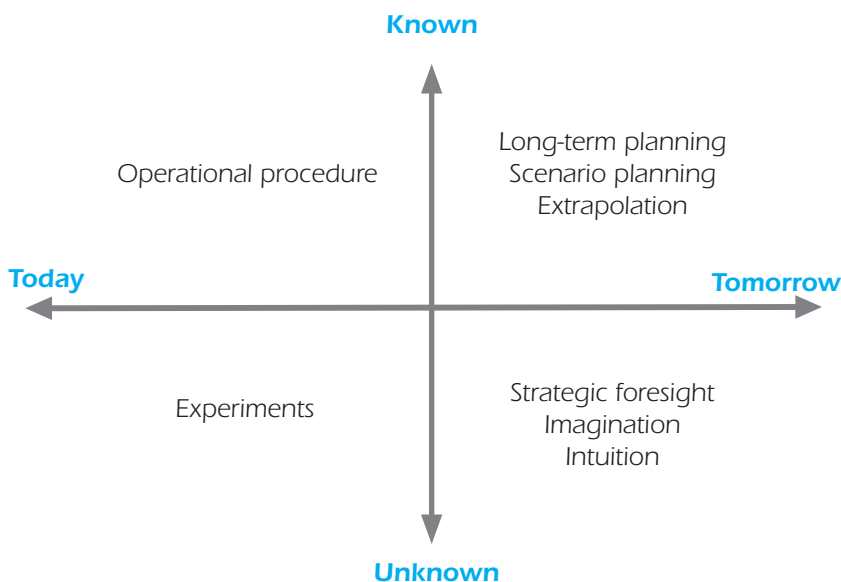
and frustration to traditional states in ways never imagined before. Even the most traditional of military conflicts can now be won or lost by non-military instruments of power, such as economic sanctions, media management and clever diplomacy.

So we are once again at the brink of another major discontinuity. And in comparison with the previous century, we are not in a significantly better position to predict what may ensue.

It is not as if one hundred years have not made a difference. They have. Today, we are better able to identify the key factors and trends that point convincingly to a revolution in the making. We sense that something great is afoot. The Soviets first recognised and termed it “Military Technical Revolution”, or a “Revolution in Military Affairs”, as commonly referred to today.

But we would be deluding ourselves if we think that we have become any better at predicting exactly what will be revolutionised, or how far-reaching the changes will be for the future. Today, our conventional planning tools can handle what we already understand well and have clear visibility of – the “knowns”. And we have sophisticated risk assessment and management techniques to handle identified knowledge gaps, the “known unknowns”. But the “unk-unks” (unknown unknowns) remain as intractable as ever. We might be able to see all the individual threads but, except in retrospect, still fail to see how they come together to weave the complex tapestry of events.

Coping with Uncertainty



The matrix above outlines the different degrees of uncertainty over the dimension of time and tabulates common methods for dealing with them. The challenge of complexity is in dealing with the uncertainty described in the bottom right quadrant—the unknowns that are unknown because they lie in the future. While all other quadrants describe common concrete organisational strategies, the bottom right quadrant, with foresight, imagination and intuition, merely describes characteristics of visionary individuals. Therefore, the key challenge is in formulating organisational strategies for dealing with the unknowns of the future so that organisational longevity is not wholly dependent on the ability of a few visionary individuals.

(Figure adapted from a presentation by John Kao at MINDEF Transformation Workshop held on 28–29 June 2002)

Still, this is not to say that we have no effective means of dealing with unknown unknowns. Indeed, with our increasing powers of analysis and gradual introduction of thinking tools such as scenario planning and systemic framing, we have converted many unknown unknowns into at least known unknowns. Shell, for example, is widely credited with having anticipated the plunging oil prices in the 1980s. But this is not because Shell was any better at predicting unknown unknowns. They were merely better (or, cynically, perhaps luckier) at creating an organisation-wide cognitive mechanism to generate a series of scenarios representing a set of known unknowns. This meant that they were more prepared for any contingencies.

Even internal strategic trends are showing signs of fundamental shifts. The size of the regular force and of the defence budget have probably reached their limits of sustainability so we can no longer expand capabilities simply by growing. There is an increasing sense that the fundamental roles and command and control structure of the SAF need to be reviewed. These represent serious internal challenges to the way MINDEF and the SAF have operated for the past 30 years.

A different approach is needed to address these complex challenges which typically involve a large number of unknown unknowns. It must be multi-disciplinary in order to adequately understand all the disparate trends that underlie the problem. It must not ask for singular deterministic solutions but instead recognise the importance of context in selecting from a multiplicity of parallel options. It must enable interaction of the networks that host information and capital flows. And finally, it must wield the competitive ruthlessness of the market to weed out the mediocre and pick out the gems.

This amounts to creating the organisational capacity to change and adapt, so that we are never caught flatfooted when confronted with fundamental surprise. Since we cannot control the future, we need to build the resilience to absorb its shocks, and the agility to adapt and respond. Indeed our competitive advantage will stem not so much from pre-empting the future but by effectively adapting to unpredictable situations.

INTERNAL COMPLEXITY

THE TRIALS OF ADOLESCENCE

MINDEF is no longer an infant organisation, young and malleable enough to easily accommodate radical changes and new developments. Today, by virtue of decisions made over the past three decades, we have developed into a military that is technologically advanced, professionally respected and organisationally complex.

But the clarity of youthful ignorance, which allowed us to single-mindedly build up a highly capable force for meeting present threats, has now been replaced by the self-doubt of nascent adolescent awareness. Like teenagers, we are now struggling to balance the comforting familiarity of childhood with the mysterious angst of adulthood. Instead of the unrestricted freedom of growth, every change now entails compromise, sacrifice and perhaps even demolition of the established order.

Such creative destruction, as it were, is painful but necessary in order to stay relevant. Not many organisations succeed in this transition. Dr Richard Foster, a senior partner with the McKinsey consultancy, found that, out of the 100 largest companies in 1917, only 18 still existed in 1987.² More shockingly, these 18 survivors tended to under-perform the market by as much as 20%. Time and history seem to stand against the large and the successful.

Inertia and the inability to manage change emerge as the key impediments to continued success. Having become large and successful, companies become afraid of trying out new ideas for fear of interfering with their existing highly profitable activities.

Inertia and the inability to manage change emerge as the key impediments to continued success.

² Richard Foster and Sarah Kaplan, *Creative Destruction: Why Companies that are Built to Last Under-perform the Market – And How to Successfully Transform Them* (New York: Doubleday, 2001)

Schizophrenic Organisation

Organisations, both private and public, are rapidly discovering the unavoidable dilemmas that confront every maturing organisation.

Centralisation	Decentralisation
Core	Periphery
Richness	Reach
Evolution	Revolution
Flexibility	Accountability
Interdependence	Self-sufficiency
Change	Continuity

Yet there is no clear recipe for achieving the right balance. In *The Innovator's Dilemma*, Clayton Christensen argues that in order to innovate in the face of disruptive technologies, it is sometimes necessary to create separate units that are freed from the control and established practices of the parent organisation. However, this must be balanced against the difficulties of re-integrating the ideas generated by the splinter unit back into the mainstream. Both AT&T's Bell Labs and Xerox's PARC are widely regarded as highly innovative and successful research organisations on their own, but their record has been less stellar when it comes to creating value for their parent companies. The transistor was invented at Bell Labs, but semiconductor companies like Intel are the ones who have profited most from it. PARC is credited with inventing graphic user interfaces, but it is Apple and Microsoft who have been the main beneficiaries.

Cognitive and cultural paralysis prevent them from maintaining their creative edge, giving others an opportunity to attack and erode their success. No matter how talented their employees, or how advanced their technologies, the barriers of fear stifle organisational creativity and ultimately result in their failure.

This is the pitfall we need to avoid. And to do so, we must confront the contradictions and dilemmas that plague every organisation. How do we strike the right balance between central control, which ensures uniformity of standards and clear direction for the different parts of our organisation, and decentralised freedom, which gives individuals sufficient space to innovate and unleash their potential? In which areas should we strive for self-sufficiency, as opposed to reaping the efficiencies of out-sourcing? How can we achieve inter-temporal optimisation of resources between training for current readiness and re-invention for future capability? When should we respect the accumulated wisdom of established procedures, and when should we adopt new practices that are more relevant to new circumstances?

We should, however, see this as an opportunity. We should not shy away from the tensions that accompany these dilemmas, as they provide the energy for us to generate innovative new approaches. More critically, the key to unravelling the inherent dilemmas is not simply a question of style or preference for generalities. It is a fundamental question of knowing and applying what is relevant to specific contexts.

The organisational challenge for MINDEF and the SAF is to nurture a hotbed of truly innovative ideas alongside our regular, well-functioning bureaucracy. There must be space for both change and continuity, for both are important to the success of the organisation.

AN ORGANISATIONAL STRATEGY TO BUILD THE CAPACITY TO CHANGE

THE NEED FOR ORGANISATIONAL DUALITY

To meet the challenges posed by external discontinuity and internal complexity, while at the same time dealing with the demands of the present, it is clear that we must develop a model that allows these two divergent paradigms to co-exist.

Firstly, we need to clarify the existing framework which has been developed around the twin precepts of **effectiveness and efficiency (E&E)**. Effectiveness because we will always need an organisation aligned to mission-driven outcomes, and efficiency because resources will always be outstripped by an inexhaustible list of legitimate demands. The E&E paradigm by nature handles the “knowns” well, and approaches unknowns systematically, seeking to make them “known unknowns”. Since fundamental changes are not a daily occurrence, the E&E paradigm should underpin the bulk of what we do on a daily basis. The command model (see box on page 15), embodied by our established processes and procedures and incorporating accumulated wisdom and experience, will characterise this mode of operations. And as MINDEF has experienced, this paradigm can deliver high returns. We would not be able to effectively manage a multi-billion dollar defence establishment were it not for this E&E framework.

Nevertheless, the E&E paradigm has its limits. Every organisation must also match or even stay ahead of changes. If we do not position for the future, we would be setting ourselves up for slow stagnation and eventual decay. So the capacity to change—to continuously reinvent, to remake oneself to stay relevant, to be able to respond to disruptive changes—is a key parallel organisational paradigm. While we can convert resources into capability with great efficiency, we must be careful that we are building the right capability for the future. There is no point being very good at producing tanks if tanks are ill suited for future operational needs.

The second paradigm is therefore that of the **capacity to change (C2C)** to deal with the complex problems that arise from ensuring our relevance in a dynamic environment. Handling the imponderables of the future with E&E mechanisms and approaches would be foolhardy. No matter what resources and processes go into uncovering the unknowns, there will always be those that remain unknown. On the other hand, coping with the resultant shock of “unknown unknowns” is the domain of C2C. The new competency required is a keen understanding of context and an ability to blend multivariate approaches to meet it.

The values and processes inherent in these two paradigms are poles apart. So one final challenge remains: the marriage of the two paradigms into a single system. At first glance, the keen sense of efficiency, so highly valued in the E&E framework, would clash with the divergent, failure-tolerant entrepreneurial approach when building C2C. The deep respect for experience and past wisdom, as represented in the E&E framework, would sit uneasily with the radical, even anti-establishment, character of C2C. Enlightened management of these two cultures will thus be a key leadership challenge for the future.

The Mother of All Contradictions?

- Order
- Linear
- Deterministic – possible to isolate and separately value-add
- Intensive but regular
- Interactions relatively predictable, precision and detail important

- Disorder, discontinuity, fluidity
- Non-linear/multiplicity, diversity
- Stochastic – cause and effect can be chaotic, outcomes not predictable
- Irregular and varying in intensity
- Specifics of internal dynamics unknown and unimportant. Potential for surprise and shock. Focus on global effects.

Conventional Context space Unconventional

E&E – a complicated system System space C2C – a complex system

Command Model

- Values: singular ownership-accountability, consensus, convergence
- Mechanistic hierarchical organisation – precision, quality
- Functional entities accomplish outcomes via formal processes – efficient and incisive
- Clear method, process and doctrine – regular, reliable and consistent results
- Natural strength in richness
- Effective and efficient –
Downside: stovepiping, groupthink, determinism trap

Organic Model

- Values: individuality, uniqueness, diversity, divergence, duplication
- Distributed, decentralised, fluid structure
- Autonomous entities make adaptive, voluntary responses – diverse and seems noisy
- Creativity and innovation important – thinking and doing new things – new method, processes, doctrines – irregular, “messy”
- Natural strength in reach
- Good for brainstorming and experimenting, not as good for operationalising, conventional ROI

Working out the Dichotomy

CREATING C2C SPACE: A COMPLEX ADAPTIVE SYSTEM

The theoretical template on which we base our model of C2C is that of a complex adaptive system. A complex adaptive system describes the sophisticated system-level behaviour that can result from the simple interaction of a large number of autonomous individuals responding to external stimuli.

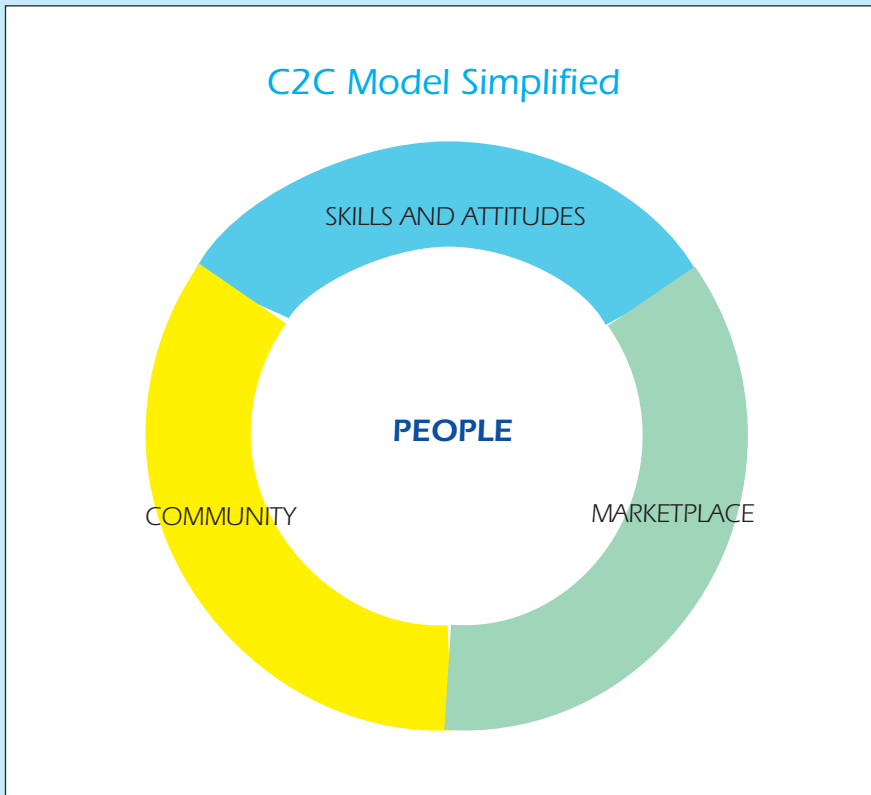
One way to understand such systems is to look skyward to the manoeuvrings of birds. A lone bird follows simple rules of behaviour. However, a group of birds flying together exhibit complex, unpredictable, creative behaviours that emerge naturally from the interactions of individual birds. For example, a flock in V-formation is able to fly farther and faster, and navigate with more precision than an individual bird. The flock that is formed when autonomous agents—birds—interact is known as a complex adaptive system.

The key organisational lesson from complex adaptive systems is that leaders and managers should find ways to allow creativity to emerge naturally within organisations rather than impose pre-conceived solutions on their followers and employees.

So, to bring out the best in their people, organisations need to give them space—be it physical space, time, resources or intellectual bandwidth—to be creative. The task of leaders and managers is no longer that of coming up with all the answers, but of creating space and creating the right conditions for the interactions and relationships within that space. If these conditions are correct, it is likely that the energy and enthusiasm that are unleashed will yield successful results.

To bring out the best in their people, organisations need to give them space...to be creative.

A SIMPLE MODEL FOR C2C SPACE



MINDEF has always focused on people as its key organisational resource.

This will not change because people are the only resource with the organic capacity of self-adaptation, a key ability in a C2C environment. Thus people will remain at the centre of our model of C2C. What needs to be done is to equip these people with the right set of cognitive skills to operate in a complex world, and to ensure that they are motivated, even inspired, to rise above the day-to-day

operational requirements of their jobs to dream, innovate, experiment and try.

People are the only resource with the organic capacity of self-adaptation.

People are social beings who thrive in the presence of others. Hence the importance of community in our model. People in our C2C space must be fully networked to a **community of communities** so as to draw on added layers of knowledge and perspective to develop and implement their ideas. This community of communities forms the social environment for our people. Since no one has a monopoly on knowledge in the world of C2C, a wide-ranging network of communities that cuts across functional and hierarchical lines will be a key resource to expand our collective horizons.

People also inherently transact to gain access to ideas and resources. As such, our model advocates immersing them in a competitive environment of an **internal market** to test their ideas. It is also in this space that they will be given the initiative to act and gain access to a mobile pool of resources. The forces of competition will create a dynamic capital market that ruthlessly weeds out inferior, or non-performing ideas, hence freeing up resources for experimenting with and eventually implementing promising new initiatives.

In such a C2C space, people will be equipped, empowered and motivated to constantly challenge existing mental models, and to come up with innovative alternatives. They will be networked with like-minded parties, and will be able to obtain real resources to experiment with, and to subsequently implement significant change. In other words, we are asking our people to be entrepreneurial within the marketplace of MINDEF.

The spirit of **defence entrepreneurship** therefore lies at the heart of the C2C model. We hope to inspire some of our people to be defence entrepreneurs and to create a conducive environment to bring out the best in them. The defence entrepreneur is contrasted with the defence professional who occupies an analogous place in the world of E&E. While the defence professional's strengths are detailed planning and efficient execution, the defence entrepreneur's edge will be his ability to independently search and explore, and ultimately define, his own parameters and chart out his own directions.

THE DEFENCE ENTREPRENEUR

Who is the Defence Entrepreneur?

"Ailsa Petchey was a young flight attendant at Virgin Atlantic Airways. While helping her friend plan her wedding, she was struck by an idea. Like most brides-to-be, her friend was overwhelmed by a seemingly endless list of to-dos: find a church and a reception hall, arrange for catering, hire a limousine, pick out a dress, outfit the bridesmaids, choose the flowers, plan the honeymoon, and send out the invitations. So, why not offer brides-to-be a one-stop wedding planning service? Ailsa took her idea to Virgin chairman Sir Richard Branson, who gave her his full support. The result: a 10,500 square foot bridal emporium, replete with an array of bridal co-ordinators who will help arrange everything for the big day. Today, it is Britain's largest. The name of the business: Virgin Bride, of course."

From Gary Hamel, Leading the Revolution (Boston, MA: Harvard University Press, 2000), pp. 255–256

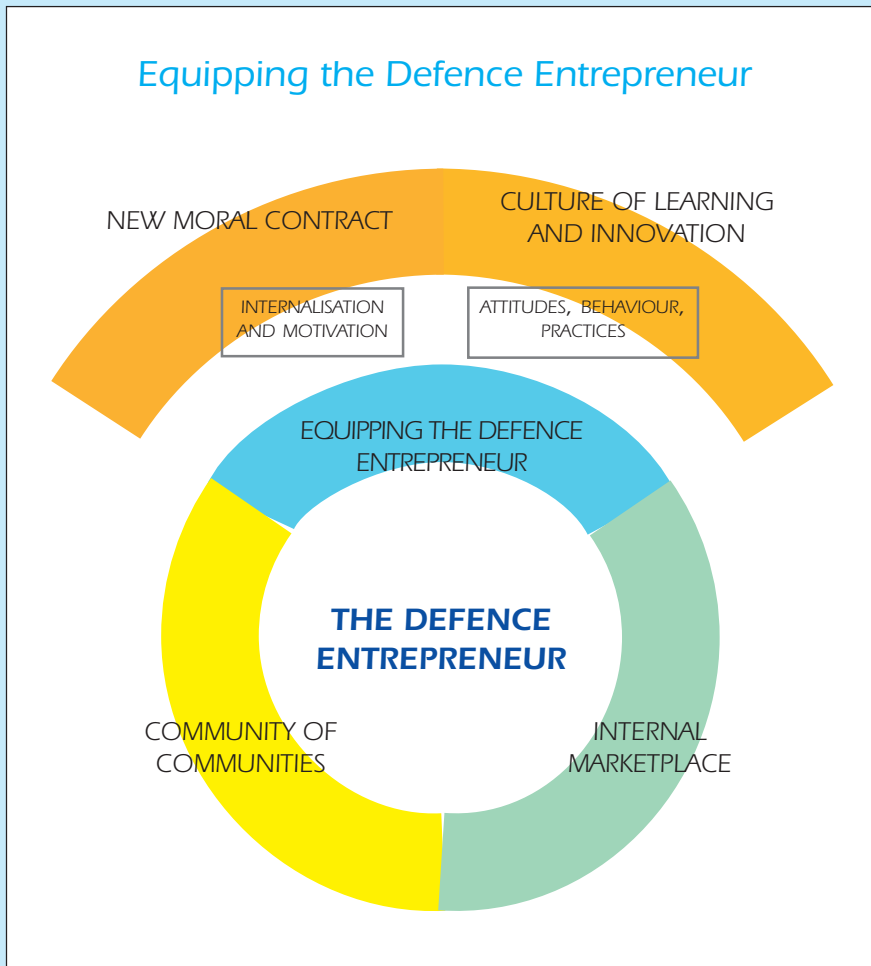
Ailsa Petcheys probably exist in all organisations. But do the right conditions exist to tap their creativity? How do they even get their ideas? How can such people be motivated to innovate and challenge existing norms? Will their ideas ever get to the ears of those who make the decisions? Can new ideas be readily absorbed and implemented? Most importantly, how do we synthesise such disparate strands of creativity into an organisational capacity to change? These questions lie at the heart of the challenge to develop defence entrepreneurs.

Like the entrepreneur in the world of business, the defence entrepreneur is on the constant lookout for new opportunities. With an understanding of organisational goals, he identifies unmet needs and opportunities for arbitrage. Once these are identified, he brings to bear

the force of his creativity and intellect towards developing ideas and shaping them into implementable business plans. He then aggregates resources behind a plan and brings his idea to market through its execution, turning his ideas into reality.

SKILLS AND ATTITUDES: EQUIPPING THE DEFENCE ENTREPRENEUR

As in the world of business, entrepreneurs in the defence establishment are not just born, they are also made. We need to equip and inspire some of our people to be defence entrepreneurs and bring them into the arena of C2C through a new moral contract and a culture of learning and innovation.



Culture of Learning and Innovation

“A kaleidoscope, not a computer, is the ultimate weapon to help leaders meet the challenges of the twenty-first century. It represents the ever-changing patterns and endless new possibilities, powered by human imagination, that lie at the heart of innovation.... To create a culture for innovation, leaders must distribute virtual kaleidoscopes and encourage their use.”

Rosabeth Moss Kanter, Creating The Culture For Innovation³

For the defence entrepreneur to generate creative ideas, two important conditions must be fulfilled. First, there has to be an environment that supports learning and innovation. We should build on existing processes and, where necessary, create new ones, to systematically allow good ideas to be recognised and followed through into experimentation and implementation. There must be credibility in the system such that our people are confident that every idea will be judged purely on its merit and that opportunities will always be available.

Second, our people must be empowered with the right skills to take advantage of this creative space. These are skills for thinking and operating in an environment characterised by complexity. Handling complex problems will require skill sets that go beyond the existing modalities of linear problem-solving and rational planning to encompass softer competencies like pattern recognition and lateral thinking. Though there

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is no single complete solution, some thinking tools introduced in recent times—Systemic Reframing Tool (SRT), Scenario Planning and Mind-mapping—have helped to expand the collective cognitive space of the organisation.

Beyond the creation of a suitable environment and the nurturing of new individual

³ Rosabeth Moss Kanter, “Creating the Culture for Innovation” in Frances Hesselbein, Marshall Goldsmith and Iain Somerville (eds.), *Leading for Innovation & Organising for Results* (New York: Josey-Bass, 2002)

skill sets, realising a culture of learning and innovation will require a more fundamental rethink of the very nature and practice of learning in MINDEF itself. We need to encourage the simple trait of intellectual curiosity—of intently watching the world—to learn how things work, to look for ideas and to spot emergent trends.

For this to happen, in addition to being taught the “how”, our people must come to learn the “whys” of what they do. A thorough understanding of the underlying rationale will form the basis for them to question, challenge and innovate. This would entail a move towards education rather than just vocational training.

Learning Culture: A New Model of Education

A key initiative to creating such a liberal learning environment could be the adoption of a university model (as opposed to a vocational based polytechnic model) for the SAF's training institutes. Students would be required to master a raft of fundamental ideas and concepts before moving on to learn vocational skills. In addition, teaching staff would double-hat as researchers, providing analysis to future practices and capabilities.

New Moral Contract

“Every Silicon Valley CEO knows that if you don't give your people truly exhilarating work—and a dramatic upside—they'll start turning in their badges... Imagine what would happen if 20 percent of your best people got up and left in a single year. It happens all the time in Silicon Valley. Valley workers change employers with less angst and anguish than most people change jobs within companies. Sure they jump for money, but more than that they jump for the chance to work on the next great thing.”

Gary Hamel, Leading the Revolution, p. 258

The new moral contract moves beyond a hierarchy of fixed material and monetary rewards to address what is at the heart of the independent drive of defence entrepreneurs—their aspirations. The ultimate aim must be to harness the passion of our people as a powerful engine for organisational change. The moral contract must create the incentive structure that encourages risk-taking, championing causes and taking ideas to their fruition. In terms of tangibles, the new moral contract could take the form of opportunities to work on projects of their choice and opportunities for personal development. But it also includes intangibles such as recognition, job satisfaction, a sense of achievement, the independence to pursue ideas, a sense of growth and intellectual challenge.

Communist revolutionaries of past decades seemed to have been able to forge this sort of moral contract with their cadres. The organic, decentralised and resilient structure of their cells integrated with their ideals with revolutionary effects. However, when victory came and they put themselves to the task of building a functioning state, their movements became institutionalised and bureaucratised as government systems, and the conviction and passion of earlier years were snuffed out. Indeed it is ironic that the institutional communist systems of China and Vietnam face threats from religious and economic systems that display the very organic qualities that their revolutionary predecessors were famous for.

Incentive structures therefore have a tremendous influence on behaviour. So care must be taken to ensure that personal incentives are aligned to organisational objectives. Incentive and reward structures need to be in place to encourage entrepreneurial behaviour and, more importantly, for such behaviour to arise spontaneously rather than result from a structured attempt to solicit “safe” ideas. In this respect, extrinsic rewards such as pay, bonuses and awards will not be enough. The C2C space demands that people make real sacrifices to pursue convictions and so intrinsic motivation, not just a material transaction, is needed. It is therefore imperative for the organisation to strike a new moral contract with the defence entrepreneur, one in which individual aspirations occupy a primary place.

INTERNAL MARKETPLACE



The internal marketplace is the space in the C2C system where numerous ideas are adjudicated by a competitive process. Only the best ideas survive, and are given the resources to be implemented. Just as the commercial landscape is continually remade by the fall of outmoded companies and

Only the best ideas survive, and are given the resources to be implemented.

the rise of new ones in their wake, the logic of the internal market will provide both the flux and energy for remaking MINDEF.

MINDEF's current mode of organisation is predicated on a division of labour based on specifically assigned "roles and missions" for which formations, departments or agencies have sole responsibility. This essentially sets up a hierarchy of functional monopolies, each of which has no incentive to look beyond its respective turf. Lacking any threats to their survival, there is little impetus to do better and come up with creative solutions.

A slew of anti-trust measures will be required to restore the competitive nature of the internal market. First we need to un-tether resources from their proprietary owners by beginning the deconstruction of cumbersome and, in some cases, archaic parts of our E&E system. It is only then that incumbents will be shaken out of their complacency and new entrants given the opportunities to compete, thus creating a measure of institutional flux—an inherent capacity to continuously change organisational fundamentals and manoeuvre resources to meet new demands. Mechanisms operating on competitive tensions will then direct the resultant systemic changes to useful contexts and purposes.

Deconstruction

Excessive structure and bureaucracy stifle innovation and crowd out change. So deconstruction focuses on the creation of organisational space, be it spatial, temporal or even cognitive. Potential space is identified by a keen focus on the essential. This involves continuous efforts at delegation and de-layering and the outsourcing non-core functions.

Deconstruction is about disaggregation and simplification of elaborate hierarchies.

Deconstruction is about disaggregation and simplification of elaborate hierarchies. It brings decision-makers closer to ground realities, and where this is not possible, it gives ground units the initiative to make changes. As MINDEF evolves into an increasingly complicated organisation operating in an increasingly complex world, we need to acknowledge the limitations of the top-driven

command model, and recognise the collective power of people operating in a self-organising mode. Devolution of responsibility will follow and, as the CEMEX example below illustrates, deconstruction can yield powerful results.

Deconstruction also involves a concerted effort at continuous organisational pruning—the trimming of excess organisational growth and allowing, or in some cases even forcing, entropy. By removing unnecessary structures, deconstruction releases organisational resources, making them available for new areas of growth. It also injects scarcity into the minds of incumbents, forcing them to innovate to remain relevant.

CEMEX in the Early Years

Cemex (Cementos Mexicanos) runs a ready-mix cement business that is overwhelming competitors and attracting world-wide interest. It used to be that getting a load of cement delivered to a construction site in the Guadalajara region was close to a miracle. Traffic delays, poor roads, contractors who weren't ready when they said they would be, all added up to an on-time delivery rate of less than 35%. Cemex transformed the cement business by promising to deliver cement faster than pizza. Using extensive networking technology—GPS real time location signals from every truck, massive telecommunications throughout the company, and full information available to drivers and dispatchers, with the authority to act on it—the company was able to promise that if you got your load more than 10 minutes late, you got a 20% discount. Instead of trying to schedule everything ahead of time in an environment of chaos, Cemex let the drivers themselves schedule deliveries ad hoc and in real time. The drivers formed a flock of trucks criss-crossing the town. If a contractor called in an order for 12 yards of mix, the available truck closest to the site at the time would make the delivery. Dispatchers would ensure customer creditworthiness and guard against omissions, but the agents in the field had permission and the information they needed to schedule orders on the fly. Result: On-time delivery rates reached about 98%, with less wastage of hardened cement, and much happier customers.

Example from Kevin Kelly, New Rules for the New Economy: 10 Radical Strategies for a Connected World

Institutional Flux

Ecologists are familiar with the notion of constant flux. The sustained vitality of ecosystems requires that they be periodically pushed out of balance. In the biological world, species respond to a constantly changing environment through mutation and sexual recombination. The genetic pool is constantly being stirred and remixed in search of higher fitness. The Darwinian process of natural selection imposes harsh consequences on species entrapped in equilibrium. Most species, when challenged to adapt too far from their origins, are unable to do so and gradually disappear. Thus a complicated network allowed to settle permanently into a state of harmonious equilibrium will eventually stagnate and die.

Silicon Valley serves as good example of the importance of constant flux. Its success as a centre of innovation lies in the collective ability of its companies and workers to constantly adapt to, and even stay ahead of, trends and technological changes. What is particularly striking is that the success of Silicon Valley has been independent of any particular company's success. In effect, it operates as one large distributed system—with no clear leader and no discernible order.

The “flux” in Silicon Valley is an aggregation of frequent job hopping, information leakage from one company to another, rapid company life cycles, and networks of financiers and venture capitalists who ensure that resources flow to promising ideas. The greatest innovation of Silicon Valley is not any of the hardware or software it develops, but the networked social architecture among its companies that gives it the flexibility to respond to rapidly changing market and technology trends.

In the context of a large organisation, the systemic characteristic of institutional flux is the real and ever-present reality of continuous structural change. An organisation that possesses institutional flux is one in which nothing is sacred, and where no parts are immune to entropy. The system is dynamic, with the processes of creation, growth, decay and termination powered by self-driven and self-organising units. Institutional flux gives an organisation the capacity for structural evolution, allowing it to change to meet the challenges of new external and internal realities.

**Nothing is sacred,
and no parts are
immune to entropy.**

Institutional Flux: Resource Taxation & SPOs

Resource Taxation

Sometimes flux has to be created through imposed scarcity. The MINDEF Control Figure is an annual 1.8% tax on manpower established on each Service. The resources freed up by this tax are redirected towards funding new capabilities for the SAF. Such a taxation system forces incumbents to stay on their toes through constant innovation and reassessment of their relevance. It creates the potential for flux by forcing a certain degree of entropy in low pay-off areas and has the potential to free up resources to fund new deserving ideas. Could the C2C space of MINDEF be funded by a more radical annual tax of up to 10% on manpower and budget?

300-day/1000-day Special Project Offices (SPOs)

In order to rapidly develop capabilities in certain areas, special project offices with limited life spans can be set up. They will be allowed greater latitude in their work through fewer hierarchical structures and less red tape, as well as more scope to carry out experimentation. The limited life span of such organisations would serve notice that experiments can run their course without the associated stigma of failure, and ensures that their institutional shells will not continue to populate the organisation when they have outlived their usefulness.

Competitive Tension

Underlying the internal marketplace is a set of values that prizes the creative energy of competition over the smooth coordination of cooperation. In a large number of contexts, aggressive competition under the right market conditions yields the best results. Competition generates energy and unleashes creativity. It shakes up incumbents and creates the space for talented newcomers to enter the field. When properly applied, competitive tension imposes a dynamic brand of self-organising discipline that the strictest of command systems cannot hope to match.

An organisational space that operates on the basis of competitive tension is one where market practices are pursued wherever possible, and where a certain degree of duplication in function and “wastefulness” are tolerated. This is a marked departure from the corporate organisation that is defined by a well-delineated division of labour and non-overlapping responsibilities.

In fact, to term the duplication of efforts as wastefulness may obscure its benefits. Innovation and progress require experiments, and experiments by their very nature are risky. Parallelism in experiments increases the odds of having one that will yield useful results. In addition, what fits today may not fit tomorrow. So having a standing portfolio of diverse options on hand increases the odds of organisational survival when the environment changes.

A prime example of both pitfalls and benefits of competitive tension can be found in the post-war development of the U.S. military, specifically in the competition between its Services. With the current emphasis on joint and integrated warfare, inter-Service rivalry is often ridiculed for producing waste and unnecessary friction. Thanks to this rivalry, it could be argued that the U.S. today has four air forces (three fixed wing and one rotary), two armies (the U.S. Army and the U.S. Marine Corps), three strategic forces (nuclear submarines, ICBMs and strategic bombers) and two navies (the amphibious assault ships of the U.S. Marine Corps are as big as the aircraft carriers of most other navies).

Such wasteful competition has sometimes created embarrassing situations where the Services seem to fight each other more than their common enemies. It is even joked that the U.S. Navy used to have a sign in its Pentagon offices proclaiming , “Never forget our true enemy: the U.S. Air Force.”⁴

⁴ Scott Shuger, “Fort Bragging Rights” in *Slate*, posted 20 Dec 2001 at www.slate.com

And yet, it is interesting that this competition has accounted for many significant benefits. Were it not for each Service pursuing its own satellite navigation system—each with its own unique strengths and advantages—the foundation would not have been laid for the Pentagon to eventually integrate these projects into the Global Positioning System. And when the U.S. administration wanted the Services to develop a cruise missile as a bargaining chip in arms limitation talks with the Soviet Union, the USN eagerly signed up to develop the Tomahawk while the USAF debated the impact of cruise missiles on their bomber fleet.

Similarly in sports, a little good-natured rivalry can do wonders for creativity. But certain conditions need to be in place to ensure that players' energies are directed towards the achievement of sporting excellence rather than on-field brawls. Rules of the game need to be carefully designed to channel efforts to a useful purpose. Fair refereeing is needed to ensure the rivalry does not get out of control. Finally, regulations have to be in place to ensure that different teams have access to the resources to compete. While we should aggressively pursue competitive policies to foster good ideas and weed out bad ones, we need to also have 'market rules' to manage the tensions that rivalry inevitably brings.

An Example of Competitive Tension: Reverse Auctioning for KMCs or OCFs

A key initiative in establishing competitive tension in the field of capability development could be an auction mechanism for future Key Mission Components (KMCs), Operational Concept Formulations (OCFs) or parts of them. Such portions of KMCs or OCFs (which are presently distributed to individual Services for conceptualisation and development), once defined, could be opened up to a competitive reverse auction. Both autonomous entities and existing departments, or even consortiums of interested individuals could 'bid' with their plans to develop these KMCs. Such a system would force greater creativity in capability development, and open the door to non-incumbents and talented newcomers to enter the fray.

A COMMUNITY OF COMMUNITIES

The Defence Entrepreneur needs to be situated within a social environment—a community or, even better, a number of diverse communities. Networking the defence entrepreneur with other similarly motivated individuals from a diversity of backgrounds can unleash significant creative energy. The free flow of ideas, information and expertise, and resultant collaborative efforts, are powerful means for experimentation and venture.

Therefore the final part of our C2C model relates to the creation of a community of communities, essentially a mass of inter-locking and mutually beneficial relationships both within and without the organisation. Our organisation can leverage on a networked system to maintain its current competitive advantages and to foster innovation so as to respond more rapidly to the complex environment of the future.

A community of communities operates on the logic of networks. Simple mathematics tells us that the sum of a network increases as the square of the number of members. As the number of nodes increases arithmetically, the value of the network increases exponentially—when the number of people (n) involved in a network is large, the total number connections can be approximated as $n \times n$ or n^2 . A thousand members can have a million friendships.⁵

Creating a community of communities in MINDEF is important for three reasons.

- First of all, it allows a sharing of perspectives and cross-fertilisation of ideas that expand the cognitive space of the defence entrepreneur. The regular (and occasionally violent) collision of ideas and perspectives guards against intellectual lock-in, and can spawn interesting hybrids.

⁵ Kevin Kelly (1998), p. 23. The network's tendency to explode exponentially was first pointed out by Bob Metcalfe, the inventor of the ethernet. This phenomenon is sometimes referred to as Metcalfe's Law.

- Second, a community of diverse communities will allow us to better address the many real-world problems that do not fall within (and sometimes fall between) neat disciplinary boundaries.
- Finally the combination of these communities into a complex network will boost the capacity of the organisation, allowing it to tackle complex problems that tax even the sum of its individuals cognitive powers.

The final point on cognitive capacity cannot be underestimated. The power of a network greatly exceeds the sum of its parts. The best analogy for this phenomenon comes from the world of distributed computing—mathematical problems that were once intractable for supercomputers have now been solved using an interconnected swarm of small PCs. The complex problem is broken down into small parts and distributed throughout the network.

The organisational analogue of this can be seen in the successes of revolutionary communist cells. When unified by a single idea, they achieved stunning results. They were able to take on better-armed and more structured establishments because they have learned to “swarm”, that is, to act in a decentralised fashion towards accomplishing a common goal.⁶

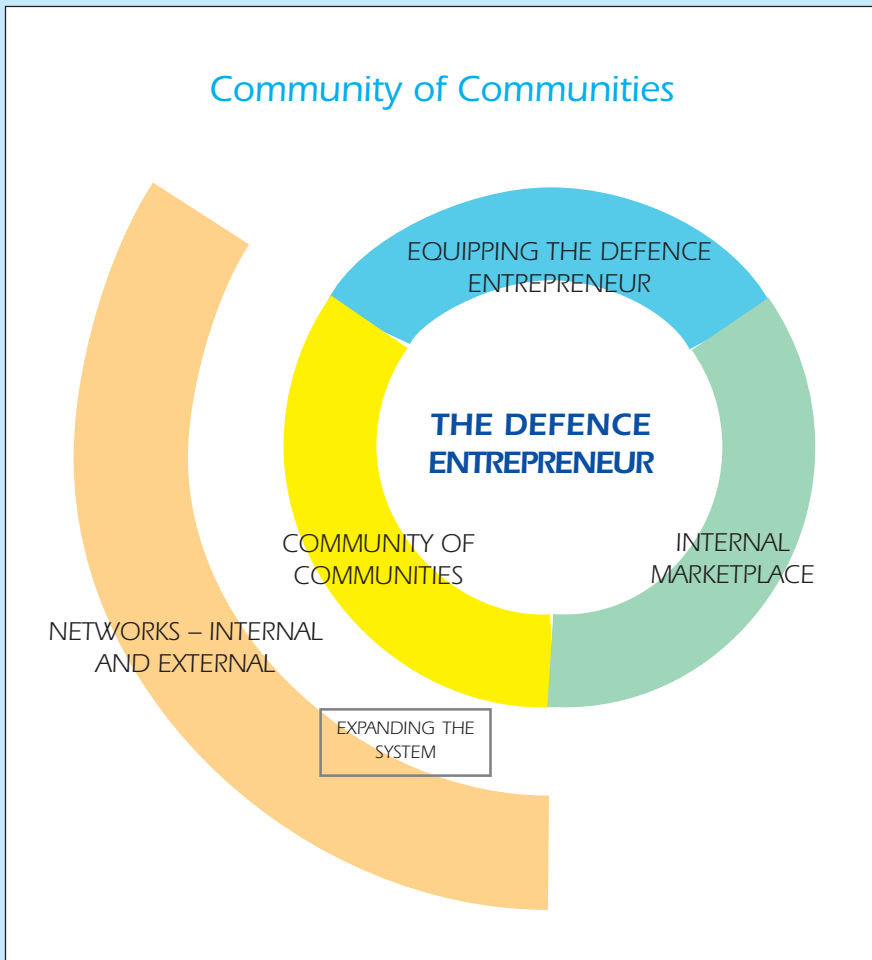
Internal Networks

MINDEF is presently characterised by functionally delineated groups of specialist agencies. This grouping of expertise allows each agency to have a thorough understanding of its area of responsibility. It could be said that the current system finds its strength in its “richness”—the ability of each agency to know its issues in depth, and bring the full force of its specialised abilities to bear on problems that emerge. Where the present system falls short is in its “reach”—opportunities for free association and exchange across expert agencies.⁷

Where the present system falls short is in its “reach”...

⁶ See Arquilla and Ronfeldt (2001).

⁷ See Evans and Wurster (1999) for a detailed discussion on “richness” and “reach”.



Some of this lack of opportunities can be attributed to the “need to know” culture of secrecy that permeates all military organisations. Yet even if all restrictions on information exchange were to be lifted, it is far from clear that such networks would be free forming. Almost every large organisation is rife with examples of information hoarding that is borne of turf guarding and non-receptivity to outside views.

Our leaders have to think carefully about both the structural and cultural conditions for the creation of multiple cross-cutting internal networks that will help break down and link information stovepipes in MINDEF and allow for the cross-fertilisation of expertise and ideas within.

Networking Security: The National Security Secretariat

The National Security Secretariat (NSS) was set up to coordinate the work of various security agencies in protecting Singapore against unconventional threats. Staffed by officers from various ministries and backgrounds, and working in partnership with a diverse range of parent organisations, it provides a coordinated multi-disciplinary, multi-agency response to the complex security threats confronting us today. The NSS maintains the operational readiness of the National Command Structure (NCS) in partnership with other ministries and agencies as common stakeholders in the overall national security effort. It has established itself as a vital strategic network node in the overall national security architecture designed to help Singapore stay on top of all emergent challenges to our national security.

External Networks

The importance of external networks stems from the recognition that MINDEF does not have a monopoly on knowledge and wisdom in key security issues. More importantly, the answers to some of these issues require expertise from outside our security agencies. This is particularly so in our present security environment where a broader definition of security entails the involvement of external parties in policy formulation and decision-making.

External networks provide for a “virtual” organisational expansion to mirror the complexity of issues at hand. External networks also facilitate the introduction of competing ideas to contest conventional wisdom. Some initiatives in the field of external networks could include the setting up of multi-disciplinary think tanks to study security issues, the initiation of greater co-ordination and exchanges with other relevant government agencies, and the institutionalisation of policy exchanges with academic institutions, external consultants and thinkers. These linkages must go beyond the purely institutional and encompass freely forming informal social interactions among individuals.

Defence and Venture Capital

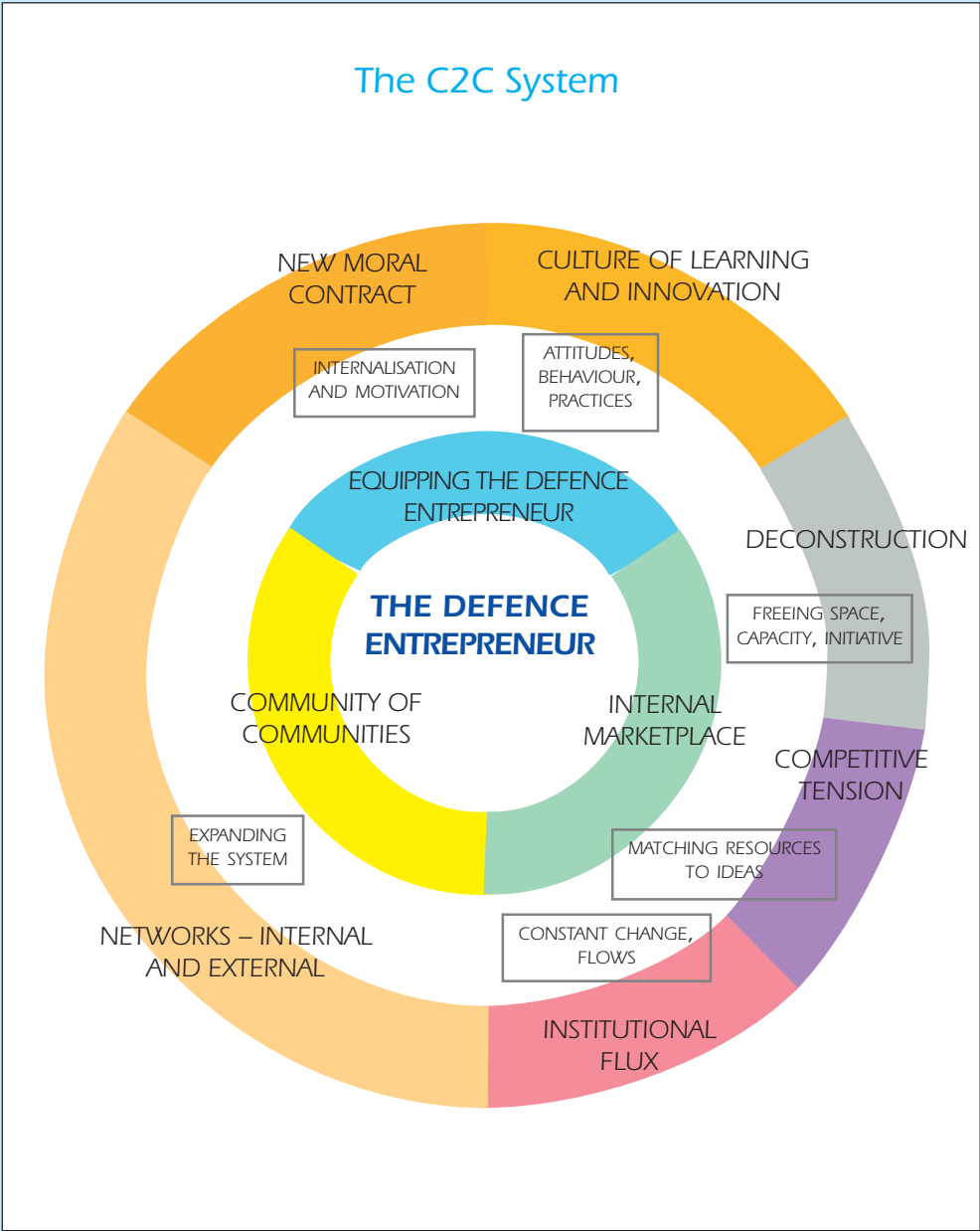
In *Foreign Policy*, David Rothkopf writes that the seeds of victory in the war against terrorism were planted long before the emergence of Al Qaeda. During the Cold War, the Eisenhower administration—worried that traditional military-industrial partnership were not producing the technologies essential to defeating the Soviets—created the Small Business Act of 1958, which allowed the predecessors of today's venture capitalists (VCs) to leverage their private capital on a three-to-one basis with funds borrowed from the government at below-market rates (increased to four-to-one in the 1970s). This pledge mitigated the risk and increased a pool of risk capital that could flow to entrepreneurial ventures. And the government programme has worked big time.

The subsequent growing pool of venture capital produced a number of success stories even before the tech boom of the late 1990s. Companies such as Minute Maid, Digital Equipment Corporation, Eastern Airlines, FedEx, Apple and Genentech provided the kind of returns on investment that drew ever greater amounts of capital to the higher returns of venture investments. The connection to the government, and in particular, to the security establishment has been apparent in a number of instances since the very first days of this industry.

The venture capital boom of the 1990s provided yet more proof of the symbiotic relationship between the security and venture-capital communities. The Internet and many fundamental breakthroughs in computer and software development emerged from R&D organisations from within the defence establishment, such as DARPA. Entrepreneurs, in turn, used funds from VCs to develop the companies that enhanced those technologies, which enabled the creation of the commercial World Wide Web. Today, the military is upgrading its systems by using many of the software, switching and routing technologies and content innovations developed by the private sector. Since the boom of the late 1990s, the U.S. has moved away from the R&D model that drove most of its growth in the second half of the 20th century, wherein funds flowed from corporate budgets into well owned and operated corporate laboratories like Bell Labs or Xerox's Palo Alto Research Center. What has happened, in effect, is that the corporate world has outsourced many of its R&D functions by letting others take the risks.

Extracted from David Rothkopf, Foreign Policy, 2002

BUILDING THE CAPACITY TO CHANGE



We have described a model for building a capacity to change. We began with the concept of the defence entrepreneur and the fundamental premise that he or she must be at the centre of the C2C system. The defence entrepreneur constantly senses the external environment to test the validity of organisational assumptions and to watch for new ideas. When they come upon promising ideas, defence entrepreneurs are willing to stick their necks out to experiment with them, develop them into a meaningful concepts and market them. The C2C system must be purposefully designed to ensure the right conditions for such entrepreneurs to emerge and flourish.

We have articulated three functional requirements of such a system.

- The first is the need for a correct set of skills and attitudes. Potential defence entrepreneurs need to be empowered with the right sets of skills to operate in an environment of complexity and uncertainty. Their personal aspirations need to be harnessed as an engine for organisational innovation by means of a new moral contract. A culture of learning and innovation is also critical.
- The second is the need for a competitive market space for the defence entrepreneurs to operate in. Such a marketplace will serve as a capital market for groups and individuals to bid for the resources necessary for implementation, weeding out all but the best ideas and concepts. To make such a marketplace a reality, we need free up resources by deconstructing outmoded structures and hierarchies. This will give us a measure of institutional flux necessary to ensure the free flow of resources to deserving ideas. Finally we need to ensure the right market rules to guide the emergent competitive tension towards a useful purpose.
- The third is the need for social context via community. Defence entrepreneurs need to be linked to a wide network of people from diverse backgrounds both inside and outside MINDEF. This

will serve to broaden their perspectives, widen their access to ideas and even allow them to lobby for resources. The collaborative efforts that emerge from such communities tap the rich veins of creativity that lie at interdisciplinary interstices and allow the organisation to better address complex problems of the day.

This model is not meant to replace the existing organisational structures of MINDEF. Rather it is being put forward as a complementary operating space alongside our existing and equally important E&E institutional framework. It will be essential if MINDEF is to have the capacity to change.

TAKING THE FIRST STEPS

It was just a day before the unanticipated horrors of 11 Sep 2001 that Donald Rumsfeld, in a speech to the U.S. Defense Department, said that “we must change for a simple reason—the world has. And we have not yet changed sufficiently.” For MINDEF to develop an organisational capacity to change, fundamental change needs to be effected in three areas.

- **Strategy**
 - where, in response to how we sense and read the environment, we decide how to position MINDEF and the SAF. This is where key decisions are taken and directions for change are charted to effect significant macro-level outcomes.
- **Capability**
 - where we decide what capabilities we need and how we invest and allocate scarce resources to build them.
- **Warfighting⁸**
 - where our capabilities are applied to achieve the desired effects. In essence, the warfighting space encompasses the employment of armed force (whether actual or perceived) to pursue vital interests within the competitive dynamic between nations.

⁸ While some may prefer the more generic term “operations”, warfighting is retained to align with the growing trend towards unrestricted or total warfare.

Deconstruction and Innovation in Inter-War Germany

After the First World War, a defeated, downsized and deconstructed Germany was able to leverage on the introduction of armour forces to generate a revolution. In effect, a *blitzkrieg* force was created from the ruins of World War I. In contrast, France, Britain and Italy, intoxicated by victory, remained champions of fixed fortifications, artillery and deliberate battle. Armoured forces existed in these nations but doctrines never changed to realise the true power of armour. There was neither the necessity nor the impetus for change. Williamson Murray has this to say about the Italians' failure: "When you have a fine plate of pasta guaranteed for life, and a little music, you don't need anything more."

Murray goes on to make several pertinent observations on inter-war innovation in Germany.

1. Emphasising that revolutionary innovation can occur as a top-down approach, but for sustained systemic innovation, the organisational factors must support non-linearity and even complexity.
2. Pointing out that change is not just about transformational leaders—it requires a much larger scale of collective education—in Germany's case, the officer corps. "Messiahs are not enough; they need disciples," he asserts.
3. Warning that "the bureaucratisation of innovation guarantees its death."

Taken from Millet and Murray (1999), pp. 301–328.

Collectively, these three areas represent the essence of the MINDEF/SAF system, where strategy is formulated, capability is raised and war⁹, in whatever form, is waged. It is in the core of each of these areas that the C2C space needs to be created if we are to truly possess the capability to change.

⁹ Emphasising that new wars remain competitive in nature, and employ a much wider range of weapons, soldiers and battlefronts.

Although often pursued in the E&E mould, history does seem to indicate that a fundamental prerequisite for discontinuous, radical adjustments often start with a sense of discontentment with the status quo, whether externally imposed or internally generated. This is the first step to creating the C2C.

The Hundred Schools of Thought

The Spring and Autumn (770–476 BC) and Warring States (475–221 BC) periods of ancient China, though marked by disunity and civil strife, witnessed an unprecedented era of cultural prosperity—the “Golden Age” of China.

The atmosphere of reform and new ideas was attributed to the struggle for survival among warring regional lords who competed in building strong and loyal armies and in increasing economic production to ensure a broader base for tax collection. To effect these economic, military and cultural developments, the regional lords needed ever-increasing numbers of skilled, literate officials and teachers, the recruitment of whom was based on merit. Also during this time, commerce was stimulated through the introduction of coinage and technological improvements. Iron came into general use, making possible not only the forging of weapons of war but also the manufacture of farm implements. Public works on a grand scale—such as flood control, irrigation projects, and canal digging—were executed. Enormous walls were built around cities and along broad stretches of the northern frontier.

So many different philosophies developed during the late Spring and Autumn and early Warring States periods that the era is often known as that of the Hundred Schools of Thought and Hundred Flowers Blooming. From the Hundred Schools of Thought came many of the great classical writings on which Chinese practices were to be based for the next two and one-half millennia. Many thinkers were itinerant intellectuals who, besides teaching their disciples, were employed as advisers to one or another various state ruler on methods of government, war and diplomacy. It was during this time that Sun Tzu wrote the classic “Art of War” which has influenced military thinkers of East and West even till today.

STRATEGY

STRATEGIC CONVERGENCE

National security interests, previously seen as largely the domain of the military, are being redefined. As threats manifest themselves in a multitude of forms, demonstrate a global reach and attain catastrophic proportions, a diverse range of experts and practitioners are being drawn into the security equation. These represent competencies that clearly cannot reside in the mind of a single leader or even in a single organisation.

This diversity has essentially created a converging security milieu for a wide range of previously distinct agencies and specialists. We have entered the era of strategic convergence. The knowledge, information and intelligence relevant to the security equation have not widened but has become widely distributed. Traditional functional structures, by themselves, have therefore become inadequate. The responses today require collective and integrative efforts that rely increasingly on qualities of dynamism, initiative, invention and drive rather than on prescribed institutional norms. An extensive community of experts and operators is also required to form the collective pattern-recognising capability to recognise threats and issues, and to develop solutions where well-defined procedures do not as yet exist. It is no longer enough to just rely on integration at a very high level forum. The recently formed National Security Secretariat, Island Defence Headquarters, INSCA, NSTF and even the MINDEF Ops Group are institutional manifestations of increasing convergence at levels of actual practice.

Knowledge, information and intelligence have become widely distributed.

STRATEGIC AGILITY

If significant, even radical, changes in direction are needed, these key turning points must be effected at the strategic level. The strategic space must therefore feature a dedicated space for strategic discourse and deliberation based on a collective understanding of the strategic context (both present and future) amongst a select group of decision-makers. With increasingly dynamic contexts, static frameworks and “key thrusts” are no longer adequate. Space is therefore required for unfettered dialogue and diversity.

First Steps: Strategy

For strategy, the thrust is to mitigate the lack of reach and skilfully handle strategic complexity and diversity. The focus is centred on cognitive approaches and skills as well as the ways to enrich our outlook with diverse perspectives so that we can sense the environment better and crystallise shifts in cognitive understanding.

- **Build new networks and communities**
The community of practitioners will include utilities experts, radiologists, chemists, land transport authorities, port agencies, airport and aircraft specialists. It is becoming increasingly clear that these people cannot simply be consulted just to react to the “threat of the month”. They need to remain plugged into a strategic network.
- **Introduce a MINDEF / SAF Strategic Forum** where strategic, long-term and macro level decisions made in key areas such as capability build-up, defence policy, defence budget are addressed from a macro, systemic perspective.
- **Introduce transient organisations**
Spin-off 100-day and 1000-day organisations populated by defence entrepreneurs to pursue scoped studies, analyses or any deliverables of value. The willingness of the organisation to grant “time out” for such entrepreneurs to pursue their ideas is often reward enough, and has the effect of constantly reshuffling our talent and ideas—the raw ingredient of innovation.
- **Foster diversity**
Widen the range of our sources of analysis and cultivate even those diametrically opposed to our conventional wisdom. In addition, actively nurture people within our own organic pool of talent who represent diverse perspectives. We can encourage a wide range of courses of study, sabbaticals in other organisations and source for diverse experiences and perspectives.
- **Create white space** in every corner of the system, promote the creation of new spaces, time and bandwidth to reflect, dialogue and generate ideas. Generative conversation and exploration should not be mistaken for fruitless talk.
- **Beware determinism and linear thinking**
Challenge cultural biases and mental models by regularly making them explicit. Key assumptions should be identified and then questioned using cognitive tools such as the Systemic Reframing Tool, scenarios, red teaming, gaming, simulations, alternative futures and alternative histories.

A strategic forum will, in effect, orchestrate how our organisational capabilities, capital and resources, tangible or otherwise, are acquired and used to strategic effect—whether in the short, medium or long term. Such a strategic capacity cannot be undertaken solely by the command model, in which perspectives and considerations, by nature, tend to be based on an advocacy of narrowly scoped interests without a common strategic backdrop.

CAPABILITY

CAPABILITY DIVERGENCE

Complexity in the realm of raising military capability stems from the convergence of revolutionary technological developments that:

- compress production and development cycles, and
- make possible such radical emerging operational concepts that they fundamentally shift the foundations of traditional, “proven” force structures.

The trouble is that options are as diverse as they are expensive, and no one is the wiser as to what will prevail. The risk of change and innovation is minimised through experimentation and ventures. This is the new efficiency paradigm of the C2C space. Certainly not all ideas, even good ones, merit immediate capital investments.

The C2C space in the capability dimension will need to encompass multiple parallel projects and bottom-up, even renegade, initiatives. We cannot demand to chart the entire road ahead, nor can we expect to always know the destination before we depart. Long-term planning becomes a foolhardy exercise if it is reduced to defining end-states and then “working backwards”.

We need a capability innovation ecosystem where multiple ideas arise, are considered, and are then quickly moved on or moved out. Those that move on turn into experiments. When experiments succeed (though many must fail because they are experiments), the equivalent of internal venture

First Steps: Capability

The challenge is how to develop a capability space, distinct from the existing E&E development and operationalisation structures. The space will naturally be messy and even chaotic as ideas and concepts compete for resources. But it is precisely through this tension that we surface the gems.

- **Enrich the experimentation initiative**
Build an innovation ecosystem of ideas, experiments and ventures. It is not the simple act of experimentation that guarantees the capacity to change. The key is to systemise a self-reinforcing cycle that is founded on a diverse pool of ideas, is populated by risk-takers willing to try, fail and try again, and supported by internal venture capitalists willing to identify and back promising ideas.
- **Make available venture capital**
Set aside a specific proportion of capital (in terms of both budget and talent) to feed this ecosystem. Also consider plugging into external sources of venture capital and ideas.
- **Get the rules right**
This space needs to be self-organising and not based on a set of officially sanctioned projects. One example is to allow for “KMC or OCF auctions” which define the ends but allow complete freedom of ways and means. Equally important is ensuring the quality of entropy. Experiments and ventures must be allowed to fail so as to regenerate resource for trying out new ideas.
- **Avoid a top-down approach**
This will stifle and guarantee only what the bosses want.

capitalists must be available to sponsor start-ups and pilots. As a system, this means a cycle of ideas, experiments, ventures¹⁰ where we will have to accept a degree of disorder and duplicative, wasteful, and even incompatible, solutions.

¹⁰ Hamel (2000), pp. 297–306

The system will need to be self-organising. People need to be motivated and inspired to try, fail and try again. Equally important is the need for diverse perspectives and specialties to mingle in intellectual “soup”. This must happen independently of institutionalised processes, as the fundamental prerequisite of such a system is the free-flowing flux of ideas and talent, unhindered by established interests, conventional wisdom, prejudice, stovepipes and bureaucratic norms.

Success in such endeavours cannot be mandated nor directed. We simply have to create the space, inside or outside MINDEF and the SAF, to let people try, making available a resource mechanism and feed the information and knowledge necessary for them to understand the market and the demand. The perspective of DARPA, documented in Appendix 1, is a thought-provoking model.

WARFIGHTING

NEW WARS

In this age of “unrestricted warfare”, MINDEF and the SAF needs a diverse range of capabilities to deal with what constitutes a virtually infinite range of threat possibilities. Today we worry about aircraft and airports. Tomorrow, it may be a dirty radiation bomb, anthrax, small pox, shipping containers and ports, hang gliders, water and food supplies. The list is endless.

M.J. Akbar, a leading Indian journalist, argues that the new threat transcends institutions of state and territorial control. He writes: “The Taleban and Al-Qaeda and many organisations with a similar dream, can survive without a government, or even a country, because the recruitment is done in the mind. You cannot fight a battle in the mind only with special forces and cruise missiles ... Defeat is only a setback in the holy war. The jihad goes on.”¹¹

¹¹ M.J. Akbar (2002)

The New Threat

Ralph Peters' "hourglass" of threats model suggests that the new enemy is hate and a graphic depiction of its manifestation would look like an hourglass.

"The broad bottom is filled with that most expendable resource of bullies, excess population. Simple armaments, from personal weapons to anti-aircraft missiles and bombs will be widely available to them. At the top of the hourglass, our most capable enemies will concentrate their resources on off-the-shelf technologies for communications, information manipulation, and cyber-attack; on lawyers and propagandists; on media coercion; on eliciting sympathy from third parties who can impede us in international fora; and on weapons of mass destruction. Their Pattons will be programmers, their Jacksons men of iron will, obsessive vision, and enthusiastic cruelty. From drug lords to warlords, and from charismatic nationalists to religious furies, the common trait of these enemies is that they will not present suitable targets for the military we have constructed. Our forces are designed to strike where this new breed of enemy does not exist. For all of our intelligence and targeting capabilities, we will be shooting at thin air. We are aimed at the middle of the hourglass, at a mirror image of our own force...we will fight saints and opportunists and everyone in between. Greed tends to be cleverer than Belief, but Belief is more enduring."

Taken from Peters (2002), p. 77

OPERATIONAL METAMORPHOSIS

The increasingly emergent and diverse nature of threat presents a challenge to the traditional orders of battle. Now, the need is to be able to configure any structure or form to achieve the necessary operational or even strategic effect.

The SAF needs to develop a metamorphic quality in the next stage of our operational development. But metamorphosis is not just about having drawer plans, static structures and the right capabilities. It is firstly about a fundamental change of orientation that happens in the mind, enabled by the flux of inherently flexible structures, and insured by cognitive ability to conceive of and apply a range of diverse forms.

But metamorphosis is ... firstly about a fundamental change of orientation that happens in the mind...

OPERATIONAL DECONSTRUCTION

Operational deconstruction is an important prerequisite for a metamorphic capacity. One author has argued that we cannot think “straight” in the fight against terrorism.¹² She points out that the complex adaptive system of Al Qaeda defeated the bureaucracy and hierarchical command and control structure of the United States. As a deconstructed network of cells, Al Qaeda had no institutional hang-ups to inhibit experimentation, ideas, freedom of means, initiative and ultimately achievements. Deconstruction, by breaking down into modular entities, may well be a necessity in achieving operational metamorphosis. A good example is our current efforts in Integrated Knowledge-Based Command and Control (IKC2). A more detailed discussion on IKC2 can be found in Appendix 2.

Is there a space in the SAF with deconstructed characteristics? Something that already has the inherent flexibility that we can build on? Perhaps the Special Forces model is a deconstructed modular entity that forms the nucleus of a radically different SAF.

Special Forces function and fight in a way quite distinct from the rest of the organisation. In many ways, Special Forces Commands operate best when they have the flexibility and autonomy to sense and understand their operating environment intimately, constantly re-interpret their missions, dynamically adjust training regimes and doctrines, and watch for trends in operational methods and equipment. Their build-up is less

¹² Irene Sanders (5 May 2002)

First Steps: Warfighting

In the warfighting space, E&E and C2C elements sit closest together, perhaps even uncomfortably. But we need to exploit this tension constructively so that the SAF can leverage any method, any form to fight any war. Real innovations emerge from managing the C2C as pockets within the E&E space.

- **Introduce deconstructed entities**
Consider setting aside operational formations or set up new commands or formations that are given a free hand to directly envision, procure, equip and organise as they deem fit. The sole focus should be on operational effectiveness, free from existing norms and practices.
- **Operationalise deconstruction**
Over time, deconstruct into modular reconfigurable force entities and teams capable of being recombined into any force mix necessary for the task at hand.
- **Widen the warning network**
In intelligence, the traditional “warn the boss” paradigm is too rigid for the current set of complex challenges. Vertical chain of command approaches risk causing crippling delays and lost opportunities for better systemic understanding. We must expand the notion of a “warning customer” to include a wider network of stakeholders and a diverse group of experts who collectively spot anomalies, see connections and significant spikes.
- **Introduce warfighting innovation ecosystems**
Distributed pockets of innovation need to exist to develop, study and experiment with fighting concepts from different perspectives. Doctrine and operational ideas, unlike operational procedures, should not be the sole domain of “singular accountability” organisations. Anyone with a good idea and passion should have the avenue to convince bosses to allow them 100 to 300 days to work fulltime on developing their ideas. One possibility is for ideas to be submitted and made available to sponsors who, if attracted by an idea, provide the ‘capital’ to sponsor transient organisations.
- **Creating creative tension**
Constantly, and deliberately, challenge norms and consider alternative frames by using cognitive tools such as the Systemic Reframing Tool, scenario planning, red teaming, gaming, simulations, alternative futures and alternative histories.
- **Be careful how we build**
Avoid building organic capabilities for every emerging threat. Consider external sources by leveraging on networks and communities. Operational networks unified only by a common context are harder to achieve but have the potential for radically superior outcomes.

encumbered by the bureaucratic concerns of large-scale uniformity and supportability. Change is self-generated and rapidly realised.

Their operations are also decentralised. Operating in small, tightly networked organic teams, they are designed to achieve asymmetric effects on the ground. The use of widely dispersed cells of special forces in Afghanistan brought down a large, visible and institutional Taleban. And it remains to be seen how successful the U.S. will be now that the roles are reversed—with the Taleban in the shadows.

FINAL WORDS

As we chart a path for our future, it is useful to recall that MINDEF and the SAF were recently built from scratch. Our earlier processes to build an armed force relied on proven methods, solutions and capabilities. Such a linear approach was not surprising. After all, it was the most efficient way to build baseline capacity quickly. As the SAF matured in the 1980s, it became important to build secret-edge capabilities that would give us a decisive advantage in combat. The process of identifying these selective capabilities, or “silver bullets”, was no longer purely a linear process. These capabilities had to offer an element of surprise and be decisive force multipliers. Nevertheless, they had largely been tested by more advanced militaries.

Today, as we stand at the threshold of the 21st century, our dominant operating context has shifted from one of relatively predictable futures to the realm of the unknown. The modes of learning, understanding and responding required for this new context have also changed in tandem. Hence, we have not argued for a single one-time change, but rather for building the capacity to change, that is, C2C. The new paradigm is characterised by multiplicity, plurality, parallel even apparently duplicative solutions, thinking in terms of emergent rather than clear outcomes, readiness to admit we “don’t know” and act as such, as earlier sections have explained. In other words, a complete change of gear is necessary.

CREATING THE CAPACITY TO CHANGE

But are we capable of operating differently? Our very notions of core competencies, measures of return on investment, our definitions of intellectual talent, our models of success and our conceptions of the future will be called into question.

Constant change and innovation involves risk. After all, one cannot be sure that new capabilities and complexity-driven initiatives will prove successful. There are no past campaigns or case studies to rely on. This is the reason why military organisations, without major upheavals or crises, have traditionally tended to be wary of change and have often adopted an attitude of “if it ain’t broke, don’t fix it.” Armed forces are always more ready to fight the last war. In a rapidly changing world, such a fear of the unknown, if taken to its logical conclusion, will result in strategic paralysis. What “ain’t broke” may well become irrelevant in a new context.

We are by no means in crisis. In fact, we have been very successful for the past 30 years. However, it is precisely because we have been so successful that there is an imminent danger of relying exclusively on safe and proven methods. To extrapolate an orderly trajectory where there is none blinds one to possibilities of the future. Having the capacity to change is not an option. It is an imperative.

DEFENCE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)

LEADING THE TECHNOLOGICAL REVOLUTION

The Defense Advanced Research Projects Agency (DARPA)¹³ was established in 1958 as the first U.S. response to the Soviet launching of Sputnik. Since that time, DARPA's mission has been to assure that the U.S. maintains a lead in applying state-of-the-art technology for military capabilities and to prevent technological surprises from her adversaries. For decades, DARPA has invested in the fundamental technologies that have been important in the military technical revolution.

Virtually, every current military system has been affected to a substantial degree by DARPA work in information technology, microelectronics and materials. Technology transition from DARPA has also been pivotal in stimulating revolutionary changes in the commercial market that result in new commercial off-the-shelf products and services for the DoD.

¹³ This section was written based on information provided by Mr Larry Lynn, Special Advisor to Chairman, DSTA and a former Director of DARPA.

Technology Leader

- The Internet

DARPA's world-famous development of packet switching and the Internet began with the development of ARPANet and its associated TCP/IP network protocol architecture. In the 1970s, the technology was first adopted by the Defence Communications Agency for the "Defence Data Network". In the 1980s, the technology was used in the National Science Foundation's NSF Net for research community networking. These developments were responsible for the creation of today's multi-billion dollar computer networking industry. The TCP/IP protocol suite has been adopted by all major computing and communications vendors as the basis for their future networking products. Packet switching is now the fundamental element of both public and private network approaches and spans the DoD, the federal government, the U.S. industry and the world.

- Ceramic Matrix Tiles

DARPA began a programme in ceramic composites in 1985. The development concentrated on novel ceramic composite synthesis concepts. After some initial success, the programme continued into the development of processes and systems for the manufacturing of this novel material. Silicon carbide-reinforced aluminium heat sinks, one of the products of the DARPA programme, are now utilised in printing the wiring board cores of the F-22 EW subsystem. This heat-spreading material is also used in the Longbow Missile, the EA-6B, the SMUG, and the power supply subsystem for the F-18. The ubiquitous applicability of this new material in solving a multitude of heat distribution problems of modern electronic subsystems illustrates one contribution of fundamental materials research conducted at DARPA.

ALWAYS TRYING SOMETHING NEW

In many ways, DARPA resembles an investment firm more than a traditional Defence R&D organisation. To a much larger extent than most R&D organisations, the priorities, strategies and investments of DARPA are strongly dependent on its Director. The programmes during each Director's tenure are driven strongly by what he believes is important rather than through a bureaucratic process. This freedom and flexibility has allowed DARPA to create programmes and invest in teams of researchers at universities, laboratories and companies to develop and demonstrate the potential of technologies that are high risk but yield high returns—technologies considered too risky by the Services—long before anyone envisions a use for them. Once DARPA has successfully demonstrated these technologies, they are judged on their own merits. In technologies where potential is recognised, they are further developed by the military acquisition community or by private industry to the point that they may be purchased and used by the warfighter. A number of such projects have made major contributions to modern warfighting systems.

The freedom and flexibility has allowed DARPA to create programmes and invest ... to develop and demonstrate high-risk technologies long before anyone envisioned a use for them...

PRINCIPLES GOVERNING DARPA

DARPA is designed to be an anathema to the conventional military and R&D structure and, in fact, to be a deliberate counterpoint to traditional thinking and approaches. Some of the more important founding characteristics are listed below. Over the years, DARPA has continued to adhere to these founding principles.

Small and Flexible

DARPA is an organisation of 240 personnel (approximately 140 of them technical). This small set-up, however, manages 25–30% of the U.S. DoD Science and Technology budget. It is able to do so as, at any given era, DARPA buys whatever supports it needs, including from other government organisations. Necessary supporting personnel (technical, contracting and administrative) are ‘hired’ on a temporary basis to provide complete flexibility to get into and out of an area without the attendant problems of sustaining fulltime staff. Technical staff are assigned for three to five years and rotated to assure fresh thinking and perspectives.

Flat Organisation

DARPA has a flat organisation structure comprising the Director, Office Directors and Programme Managers. There is likely to be one or more deputies largely because of the high turnover so that continuity can be maintained. The general rule is to minimise organisational structure. As such, offices are named vaguely (for example, Tactical Technology) so that the content can change with the times, and attention can be focused on getting good people and producing good results. Programme Managers are the heart of DARPA. They are selected to be technically outstanding and entrepreneurial. The best DARPA Programme Managers have always been freewheeling zealots in pursuit of their goals. They integrate, innovate and readily accept new ideas proposed by others. Each Programme Manager formulates a vision for his programme; positions and advocates the programme within the context of DARPA’s overall mission; charts a course for the near-and long-term accomplishments necessary to reach the programme objectives; and controls all technical, procurement and financial aspects of the programme.

Substantial Autonomy and Freedom from Bureaucratic Impediments

DARPA reports to the Director of Defense Research and Engineering who is responsible for all DoD R&D. It operates in co-ordination with but is completely independent of the military research and development (R&D) establishment. DARPA's independence is protected by the DoD senior management who recognise the value of an agile, forward-looking R&D group unconstrained by conventional thinking and able to investigate ideas and approaches that the traditional R&D community finds too outlandish or risky.

Continuous Entropy

DARPA activities are project based—all efforts typically three to five years long, with a strong focus on end-goals. Major technological challenges may be addressed over much longer times but only as a series of focused steps. The end of each project is final. It may be that another project is started in the same technical area, perhaps with the same programme manager and, to those outside, this may be seen as a simple extension. For DARPA, though, it is a conscious weighing of the current opportunity and a completely fresh decision. The fact of prior investment is irrelevant. A complete acceptance of failure is taken if the potential payoff of success was high enough. This becomes the mechanism for deconstruction and generating institutional flux to ensure that limited resources are free to flow to areas where they will be optimally used.

Networking

A typical DARPA technical project might be structured as follows:

- \$10–40 million over 4 years;
- Single DARPA Program Manager with direct control over the efforts and the funding;
- A Systems Engineering and Technical Assistance (SETA) contractor or contractors to support the Programme Manager in his or her primary roles of managing the efforts and representing the programme with Congress, the Office of the Secretary of Defense, the military Services and/or involved Unified Commander; an Agent (furnishing from a fraction of a person to several people) in a military R&D laboratory to provide technical and contracting support (paid from programme funds to provide this support);
- Five to 10 contractor organisations and two universities executing tasks focused on a specific aggregate goal.

Obviously, there are variations to this ‘typical’ case. Some projects cost under \$1 million while a few are in the hundreds of millions of dollars. However, the management paradigm is the same; the variation is in the amount and type of ‘hired’ assistance. Even in larger programmes, the emphasis is on having small teams of high quality people. The freedom to act quickly and decisively with people that are not “hard-wired “ to the organisation but able to network as the need arises will continue to be characteristic of DARPA’s success.

From Technology to Capability

- **M16 Assault Rifle**

The M16 Assault Rifle is the standard issue shoulder weapon in many military organisations. It may not have been the case. The M16 was based the Colt AR-15 design that had already been rejected by the Chief of Staff of the Army in favour of the heavier 7.62 mm M14. Colt brought the weapon to DARPA in 1962. Through Project AGILE, DARPA purchased 1000 AR-15s and issued them to combat troops in Southeast Asia for field trials to prove that the high-velocity 5.56 mm round had satisfactory performance. The subsequent DARPA report, documenting the lethality of the AR-15, was instrumental in motivating the Secretary of Defence to eventually adopt a modified AR-15 as the U.S. individual military weapon of choice. The move to use the high-velocity 5.56 mm was also subsequently adopted by the Israelis, the Soviets and NATO countries. Through DARPA's willingness to think outside of the box, what was nearly rejected became the industry standard.
- **Directed Energy**

DARPA recognised the promise of speed-of-light weapons based on lasers and particle beams early, and a major programme in developing laser technology that was scalable to the high power levels required by BMD was initiated under the DEFENDER Program. These laser programs remained in the DARPA Strategic Technology Office upon transfer of DEFENDER to the Army in 1967. In the 1970s and 1980s virtually all the new high-power lasers that were invented resulted from DARPA programmes. These programmes spun off laser technology to all three Military Services that sought to develop tactical weapon systems based on these laser systems. In 1980, the Directed Energy Office was formed at DARPA to exploit newly emerging laser and particle beam technologies for BMD applications. In 1983, all of these high-power laser programmes, together with cognizant personnel in the Directed Energy Office, were transferred to the newly formed Strategic Defence Initiative Organization (SDIO), which later became the Ballistics Missile Defence Organisation (BMDO).

CONCLUSION

In summary, DARPA's ability to adapt rapidly to changing environments and to seek and embrace opportunities in both technology and in processes, while maintaining the historically proven principles of the Agency, makes DARPA a unique organisation in filling an important role in Defense R&D, complementary to the more conventional Science and Technology structure.

INTEGRATED KNOWLEDGE-BASED COMMAND AND CONTROL (IKC2)

Integrated Knowledge-based Command-and-Control¹⁴, or IKC2, is a concept that attempts to deconstruct existing work processes to take advantage of enhanced situational awareness conferred by networking sensors and databases together. It asks the question: “How can we do things differently if we had all the information at our fingertips?”

At the technological level, IKC2 attempts to unify C4ISR systems across the three Services into a single network, as well as to specify additional sensors that may be required to achieve the objective of Comprehensive Awareness. But that is only the first step. Full situational awareness does not merely allow current work to be performed slightly more efficiently; it allows a complete rethink of vertical and horizontal work processes to achieve quantum jumps in efficiency and effectiveness.

For example, during the U.S. attacks on Al-Qaeda in Afghanistan, the use of sensor fusion and data networking turned the 40-year-old B-52 bomber into a potent weapon system. The B-52s could receive real-time changes to targeting plans via a common network connecting UAVs, special forces and other sensors. Precision guided munitions could then be launched to attack targets of interest and opportunity while the B-52s

¹³ This section was written based on information provided by the IKC2 Office, JCISD-JOPD.

patrolled overhead with its long mission endurance. This dramatically cuts down response time compared to conventional short-legged strike fighters that had to be vectored in from a distant operating base, and completely destroys the usual notions of what constitutes an ideal strike platform. Evidently, better information will transform work process, not merely improve them.

The greatest challenge for IKC2, thus, is not technology but rather bringing together a community of communities that will deconstruct old processes and work out new ones to harness available information. This is important because traditional boundaries and areas of responsibilities will need to be redrawn to take into account new realities and assumptions. Special forces might find themselves working more closely with the air force than with their army counterparts; air defence aircraft more with island-defence army troops than with other air force strike units.

IKC2 must thus convince disparate communities to come together on critical work processes and identify ways to rethink them in the light of comprehensive battlespace awareness. It must be vigilant against the danger that because improved situational awareness already offers easy, quick improvements to existing processes, users will be tempted to pluck the low-hanging fruits and shun the pain of change needed to achieve more far-reaching transformation.

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