GETTING MORE BANG FOR THE DEFENCE DOLLAR

Practical applications of System Dynamics

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Abstract

Governments around the world spend vast sums of money procuring defence assets. In times of changing global circumstances and tight fiscal policies, getting more for less is the ongoing challenge. A need has been identified for systems that:

a. minimise the risk of over or under procuring additional defence assets;

b. maximise the value obtained from existing defence assets; and

c. balance the level of logistical support required to support the assets.

If an asset is under procured, or lacks the appropriate level of logistical support, it may fail to provide the capability or level of deterrent required and thereby be of little or no value. If an asset is over procured, or has a greater level of logistical support than is required, then funds that could have been utilised by Governments in other areas are trapped in fixed assets and ongoing support expenditure.

This paper deals with how systems based on the practical application of SD modelling can be used and have been used to help improve defence capability. Case studies include improving the efficiency of fleets of strike reconnaissance aircraft, army helicopters and radios. It also outlines how this modelling can be extended to give a *whole of system* perspective.

Introduction

National security and prosperity are increasingly entwined. Maintaining an effective defence capability is integral to stability within the South East Asian Region. This situation is now more fluid, complex and uncertain following the so called ‘Asian Meltdown’. Given the tight fiscal policies being applied, the effective utilisation of defence resources is even more critical to maintaining a credible defence posture. These security risks are managed by establishing and maintaining the right force structure, with the right capability, ready to perform the right task with adequate skill. This gives rise to the concept of preparedness.

System dynamics can be effectively applied to get better defence capability for the dollars spent. A fully integrated systems management methodology has evolved that includes SD modelling to aid in fleet management. This paper will outline the successes we have had in applying System Dynamics techniques to optimising defence capabilities.

Defence Logistics

During the late 1980s, logistics organisations within Australian Defence started to produce business orientated strategic plans. The plans typically include mission and vision statements, statements about values and objectives and reference to key result areas. Adopting best business practices introduced concepts like Program Management and Budgeting (PMB), organisational redesign based on empowerment, devolution and outsourcing. Emphasis was placed on Integrated Logistics Support (ILS) and the use of Logistics Support Analysis (LSA) for in-service weapon system management. A pre-occupation with the *inputs* and *processes* however detracted from focusing on the *outputs* that enhance defence capability.

The challenge was to adapt the classic strategic planning process (Viljoen, Chapter 2) to the business of defence. This process is illustrated in Figure 1. To forecast the likely progress towards the objectives and targets under rapidly changing environmental circumstances ideally suits the application of system dynamics. This approach has provided knowledge and insight into the causality of inputs to achieving capability outputs.

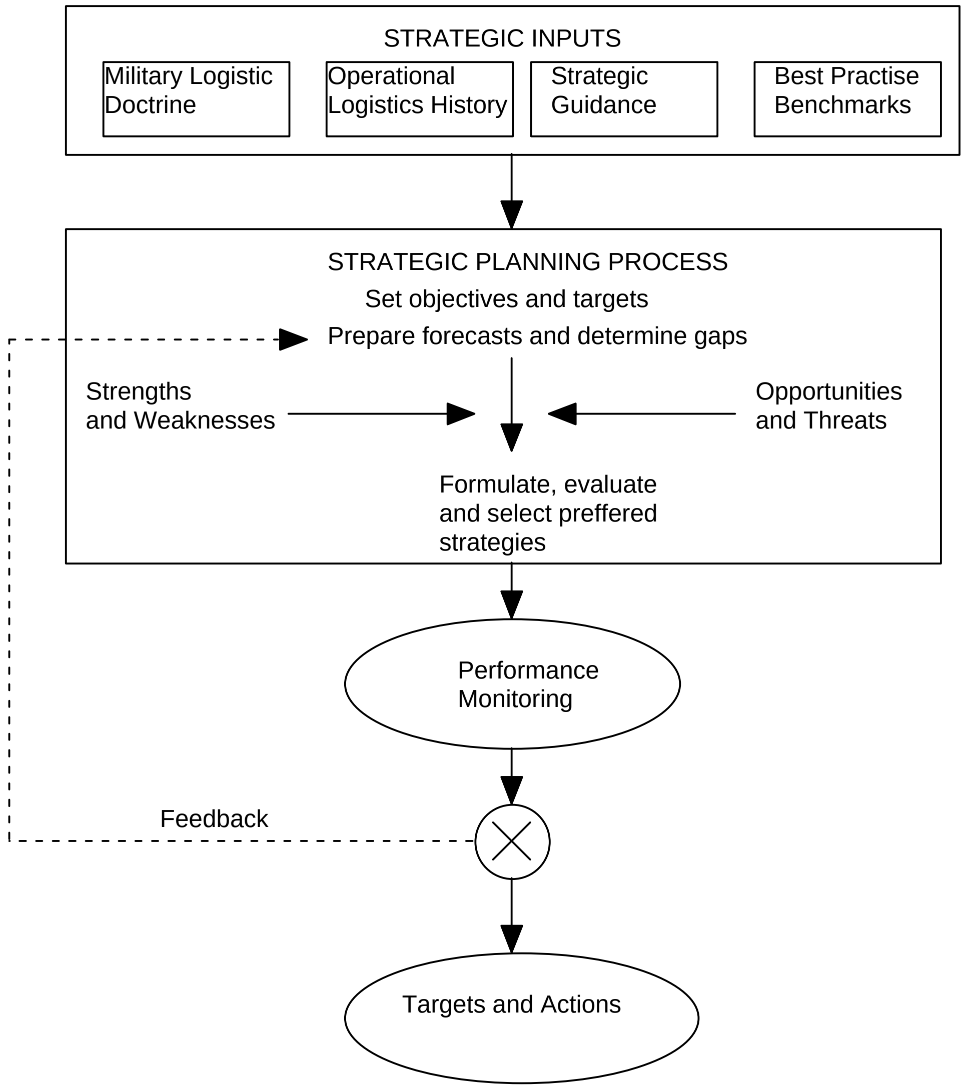

Figure 1. Planning and Control for Defence Logistics.(Coles, 1996)

System Dynamics Applications

The management of defence capability is now the process of gaining maximum utility from each defence asset. The effective utility of any weapon system is its current capability in light of acquisition cost, logistics cost and potential life expectancy. In times of changing global circumstances and tight fiscal policies getting more capability for less life cycle cost is an ongoing challenge rather than a once off procurement decision.

A causality diagram that illustrates the inter-dependency within a fleet of military assets is shown in Figure 2. If an asset is under procured, or lacks the appropriate level of logistic support, it may fail to provide the desired Defence Capability (level of deterrent). It will be of little value in spite of high cost of acquisition. Conversely if assets are procured but not fully utilised then a nation is not receiving the full benefit from the investment. If a nation is to maintain its Defence Capability then ongoing weapon system upgrades will be required to enhance and update the assets capabilities. Enough flexibility is required within the system to be able to adjust for changes in operational effort, changes in upgrade requirements and changes in logistics.

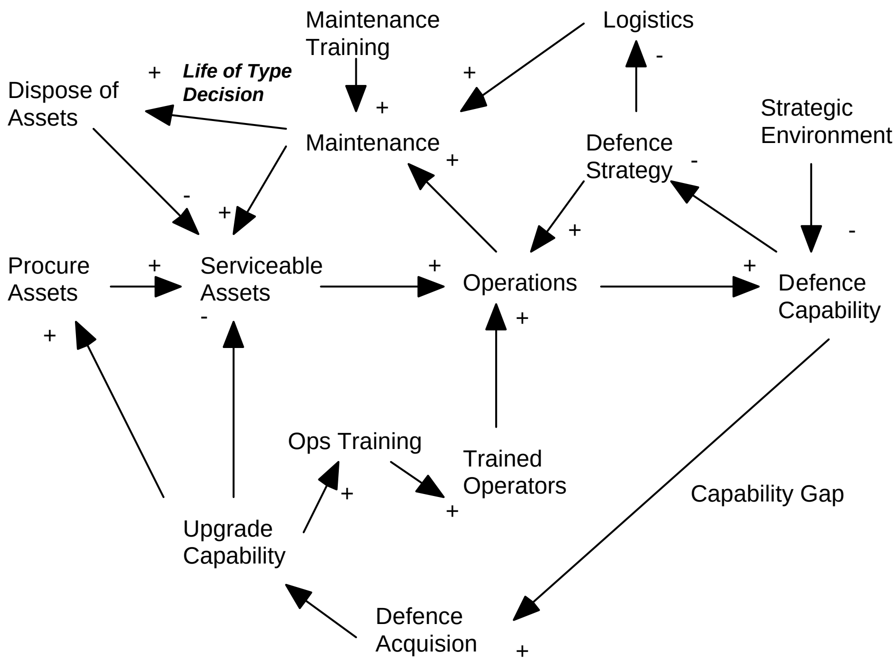

Figure 2. Causality Diagram for Defence Capability

Defence Fleet Management Techniques

A survey carried out by the Royal Australian Air Force (RAAF) and later confirmed by Logistic Command Australia has shown that complex fleet management is not performed effectively by many agencies in Australia. A manual spreadsheet based technique was being used within the RAAF to schedule maintenance and modifications by manual sequencing. A similar technique is also employed by Qantas and other organisations that utilize assets of high value. An opportunity existed to apply system dynamics techniques to this fleet management problem in order to try to optimise the balance between operations, maintenance, logistics and capability upgrade (modification).

The development of system dynamics models for optimising this balance between the number of assets, maintenance capability, logistics and capability upgrade has been achieved using the ithink® modelling environment. Strategic models, with significant simplifications were developed for the F-111 strategic bomber weapon system and the BlackHawk / Chinook helicopter weapon system. More detailed tactical, or execution models, have been developed for the F-111 weapon system and the Army *Raven* radio systems. Common to all these models is the organisational need for iterative and interactive strategy development in order to optimise fleet management.

The use of iterative and interactive strategy development (McLucas, 1998) builds on the work of Ackermann, Eden and Williams and is at the heart of the system dynamics modelling approaches proposed by Forrester (1961). The Defence applications described in this paper have used the methodology illustrated in Figure 3.

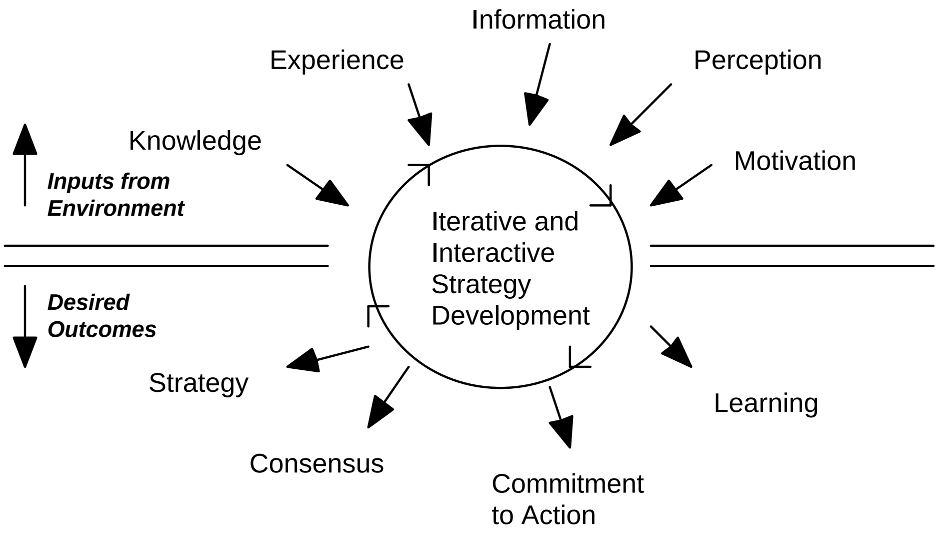

Figure 3. Iterative and Interactive Strategy Development

The success of the applications of system dynamics in the Defence arena has been built on the recognition that more than just a model is required. At a strategic level the modelling facilitates the generation of mental models that use strategic guidance and doctrine to develop consensus and commitment to action. The tactical or execution models have been used to cultivate the information feedback and decision making processes associated with achieving fleet management. Furthermore, a table based game, called "Airpower 2100", has been developed that enabled players to experience, and attempt to manage, the long term dynamics of the system over an accelerated time frame. The 'double loop learning' process, coined by Argyris (1994), is fundamental to the approach used in Defence. It promotes the development of strategy, structure and decision rules for dynamic control.

Current Practice and Case Studies

The ability of system dynamics models to be adapted and to react to changing environment circumstance has made their application in Defence effective. A key benefit derived from the ithink® modelling experience is the ability to test strategy before implementation. The ability to predict the outcome within a dynamic environment is cost effective when compared to classical weapon system management based on manual projection methods and application of experience.

F-111 Experience. The F-111 fleet management problem was characterised by significant changes to logistics support and major capability enhancement. This combined with the acquisition of additional F-111 assets caused declining asset availability. The strategic model was developed in a three day workshop and was able to identify key leverage points for strategy implementation. The tactical model was then developed to forecast the maintenance and upgrade schedule based on the strategy developed using the strategic model. The results achieved include:

a. improved utilisation of aircraft;

b. prediction of effective fleet life;

c. better integration of systems upgrades; and

d. ability to rapidly respond to changing circumstances.

BlackHawk / Chinook. The BlackHawk / Chinook assets are a rotary wing fleet of aircraft used by the Australian Army for tactical air support. The fleet has suffered logistics supply problems which have impacted on aircraft availability. The strategic model was developed concurrently with the use of some of the helicopter assets in humanitarian food delivery in Papua New Guinea at very high rate of effort. The strategic model highlighted adjustments that were needed to the maintenance and logistics support processes in order to sustain operations. The model is being used to determine fleet recovery strategies and as the basis for development of a tactical model.

Raven Radios. The Army have procured a large pool of *Raven* VHF combat radios as a new asset. The Army commissioned the development of a strategy model of the radio assets in order to determine appropriate maintenance and logistic support strategies to obtain maximum operational benefit. The model was used to establish maintenance support requirements as well as procurement quantities in order to achieve a specified level of preparedness. The model has continued to provide fleet managers with insight into asset distribution and the effects of logistics supply disruptions

Conclusions

Systems thinking, system dynamics and traditional OR literature contains a myriad of examples of discrete applications of specialist tools and techniques together with arguments about their veracity. There have been few serious attempts to integrate these tools and techniques to make them broadly applicable. Iterative and interactive frameworks in which soft systems and system dynamics modelling have been integrated are the key reasons for our success in relation to the Defence capability management.

The approach involves capturing then analysing the mental models of those with relevant knowledge, experience and perception of the problem.

The Defence world is littered with examples of expensive weapons systems or support systems that have failed to achieve the required outcomes. This has often resulted from a failure to understand, manage or respond to the dynamic environment within which the assets are required to operate. The application of System Dynamics to the management of defence assets can and has achieved real and tangible benefits that ultimately result in more efficient use of scarce taxpayer funds.

References

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