Preparedness and Mobilisation - The Role of Systems Dynamics in Managements Approach to Resource Allocation

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Aim

In a complex, vertically integrated organisation it is often difficult for individual parts to recognise and maintain focus on a wider common goal. The aim of this study is to describe how a highly complex problem in a system which crosses several organisational domains has been addressed through system dynamics modelling and a gaming interface. The defence context addresses a shortfall in analysis of military preparedness where previous modelling, which concentrates on the period after identification of a specific threat, is not sufficient for planning in the Australian strategic environment.

Defence Mission

"The Mission of the [Australian] Department of Defence is to promote the security of Australia and to protect its people and interests. It does this by maintaining the military capability required to implement the strategic guidance received from Government. This capability is achieved through a combination of force structure and preparedness of that structure for operations."[1]

Defence, as a major consumer of public resources, is under continual scrutiny for budgetary savings. It is critical that defence planners can demonstrate not only that the armed forces are able to meet the strategic requirements of government, but that this is being done in a cost effective manner. Conversely, they need to be able to demonstrate the implications of proposed budget cuts.

Strategic Parameters

In essence Australia's defence planning since 1976 has assumed no strategic threat from any identifiable source within a (rolling) 10 year time frame. Around this policy a number of scenarios have been developed as the basis for contingency planning. These scenarios, which include support to the UN, have varying degrees of intensity, duration, and lead time.

Management Environment

The functioning of any Defence unit is influenced by complex interactions between; resource decisions, personnel management, logistics management, and training doctrine etc. Each of these areas, however is likely to be subject to separate and discrete policy development and resourcing processes. This problem is exacerbated where peacetime resourcing processes for many elements are not applicable during preparation for or after deployment.

Finally, many decisions take years to have an impact. Equipment acquisition may take up to 10 years for an off the shelf purchase (much more if the asset is locally developed). Decisions to change the mix of officer commissioning source may take 4 years to have an effect (the minimum time to attend and complete study at the Australian Defence Force Academy).

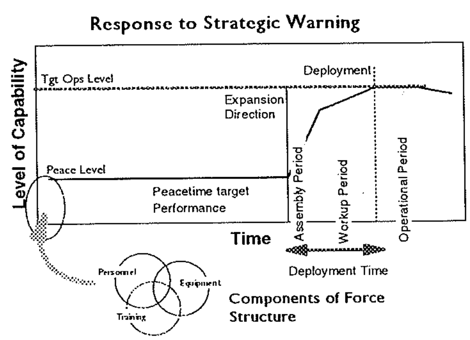
System Dynamics Modelling

The ability of System Dynamics to model feedback with delay would appear to make it the ideal tool to examine this problem. Unfortunately there are a number of issues that affect both the complexity of the modelling process and the possible validity of the constructed model. Central to these problems are issues of developing appropriate conversion scales as discussed by Nuthman[2], and general managerial scepticism of computer models.

Conceptual Model

The conceptual preparedness model adopted by Defence contains two elements illustrated in Fig 1. The first element is a relationship of required preparedness over time. The peace time level of capability is set at the minimum value consistent with the ability to get to the target operational level of capability within the scenario time frame.

Figure 1: Conceptual Preparedness Models



The second element represents the components of force structure; personnel, equipment, and training. Much of the difficulty in developing effecting resourcing strategies lies in a lack of quantified understanding of how the components of force structure combine to create a position on the capability axis. The problem is to quantify them so that policy decisions can be rigorously tested.

Fundamental Relationships in Preparedness System

This project has set out to develop a general model of preparedness applicable though all levels and across the components of the Armed Services. Qualitative examination of a range of these component organisations reveals that the fundamental relationships contained in the conceptual model are widely applicable but may vary in relative importance and complexity. This degree of repetition allows us to illustrate and explore the relationships by detailed examination of a selected component without attempting the enormous task of representing the entire system.

An Army helicopter unit, The 5th Aviation Regiment, was selected as the platform for thorough study. The reasons for this were:

- In June 1996 two of its aircraft had collided killing 18 aircrew and passengers. "The board (of inquiry) found a number of long term systemic factors which contributed to the accident...."[3]
- Reliance on aircraft availability to conduct any activity forces inclusion of maintenance and logistic issues.
- Close training relationships with other units requires the model to cross organisational boundaries and adopt a capability output focus.
- The system complexity and multiple roles of the unit allow testing of the relationships in a highly sensitive case study.
- Aviation is the only combat or combat support capability represented in all Services which allows the Defence Headquarters to consult stakeholders with a commonly understood framework

Broad Structure of the Model

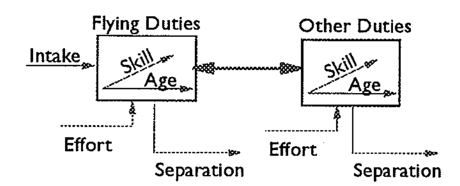
The components of force structure; personnel, equipment, and training; form the modules of the preparedness model. Each of these components can be separated for individual validation.

but it is the links between them which are critical to this study.

Personnel

Personnel are assumed to exist in one of two states (shown in Fig 2): Active flying duty, or other duties. Attributes of length of time in the system (which controls promotion and separation rates) and a scaled measure of skill (derived from rate of effort), are maintained for each intake cohort as array variables.

Figure 2: Personnel Component



The personnel management system is fundamentally geared to long term (peacetime) stability of career structure based on broad command experience. This objective conflicts with the short term horizon of the operations manager who wants to ensure sufficient numbers of personnel with a skill mix appropriate to potential short lead time scenarios.

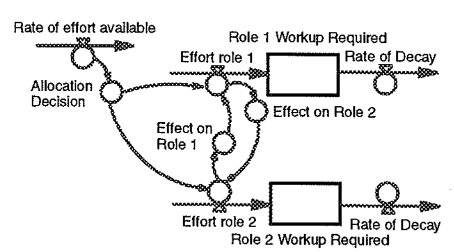
Equipment

The equipment module has a similar structure to personnel except that an additional state is required for unserviceable equipment. In the case of 5 Aviation Regiment aircraft serviceability, affected by both the supply of spares and the capacity to perform maintenance, critically affects the ability to train and maintain crew skills.

Training

The model assumes that all flying activity directed to a given task (eg. Counter terrorist) contributes in some degree to training effect for other roles. This is illustrated in Fig 3, where training for a task may have some effect on the retained skill in another. Priority is given to minimum currency activities such as emergency drills, after which general tasks or role specific training may be conducted. A critical relationship is how much the effort directed at one role contributes to skill in the

Figure 3: Impact of Activity on Effort Required to Deploy



others. The capacity to achieve training tasks is limited by crew and aircraft availability.

This module provides the critical performance indicator of time required to deploy. Each role has a defined set of work up activities required before deployment. The length of time required for these activities depends the recency of training effort in that task and on the rate at which skill in that task decays.

The actual time required to conduct these work up tasks, and hence deploy, still depends on crew and aircraft availability

Impact of Simulation Game

Simulation games have an established place in management development. In most cases, such as the beer game, there is sufficient commonality between participants' stations as to allow fairly simple comparison through a single unit of measure such as money. The simulation game built from this model has no such luxury.

In this game there are 5 stations, each of which is operating on a different length of decision cycle, different length delays for the impact of decisions to occur, and different performance measures and criteria. Players form two broad groups. First are those responsible for long term policies such as training standards, manning levels, and promotion windows. The second group are those responsible for resourcing and tasking, usually within an annual cycle although there may be long term effects from some decisions.

Figure 4: Game Interface

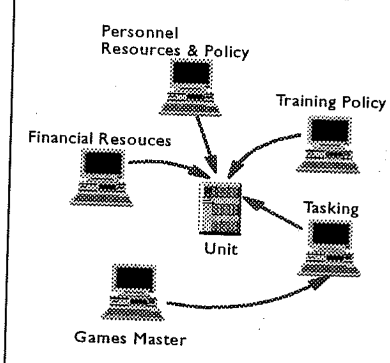


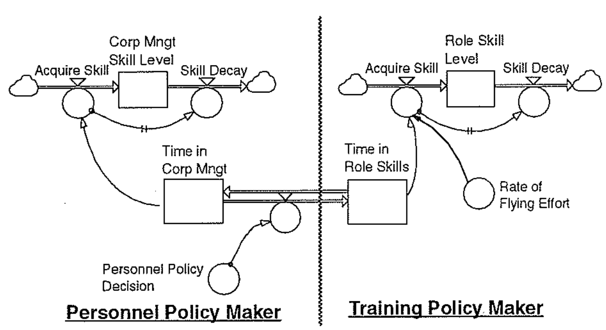
Figure 4 Illustrates some of the major information flows in the game. Throughout the game each player receives only the information normally available to his position in the organisation, and is able to judge his performance only by that information (eg. manning levels or task hours achieved). The complex decision events such as what type of training to conduct are retained by the players. The model simulates the impact of policy, resource and tasking decisions on aircraft availability, crew skill, and training levels.

At any stage the games master can impose a Defence Scenario which may differ radically in both lead time and size from the planned responses to contingencies. Success in the game is judged by the capacity to reach deployment standard in the required time. This can only be achieved if all players have worked cooperatively during the early part of the game, attempting to understand how their decisions will impact on force capability. In the current management systems, however, performance indicators encourage 'individualistic' behaviour.

The requirement for cooperation can be illustrated by a sample of the interactions between the players responsible for personnel and training policies. The personnel agency sets policy related to the length and spacing of rotations into the unit. Performance is reported back in terms of manning levels by rank. The training policy agency identifies the experience required for skill progression and the relationship between flying activity and training effect. Performance is reported in terms of numbers at each skill.

Because flying skills decay when pilots are posted to corporate duties, personnel policies impact on training policy decisions, without training policy decision makers being able to adjust personnel policies. Action to address training deficiency by increasing activity will in turn impact on the serviceability of the aircraft.

Figure 5: Interaction Between Training and Personnel



Initially, the game is used to validate the difficult relationships in the system by exposing them to the players as decision parameters. The intent is for domain experts to fix levels and then discuss the results of the simulation to validate these relationships. This validation is expected to produce a very robust model of this particular, but unusual, organisation suitable for use by training and personnel planners.

I would argue that this is exploiting only a small part of the potential of the model. More senior executives exposed to this simulation are faced with quantified relationships captured in a dynamic simulation. The impact on capability of particular decisions on the relative importance of individual tasks can be tested. Especially interesting is that this impact is tested beyond the expected tenure of those making the decision.

The use of an aviation unit as the platform for the simulation means that differing assumptions of the three services are exposed, and a common understanding developed. Thus, during resource allocation the debate can focus on the relative strategic importance of the specific role with a clear understanding of the impact over time and the contribution to other roles. More than this, debate does not need to be preoccupied with understanding the analysis when the fundamental relationships have been developed in a joint environment.

Conclusion

The peculiar strategic environment of Australia's Defence Force requires a sound understanding of the complex interaction between components contributing to preparedness. Without this understanding the long lags between decision and impact make effective peace time resource allocation impossible. This study has developed a learning environment which allows the impact of resource decisions to be explored in a system with no common scales of measure, competing objectives, and substantial organisational barriers to communication.

Now that the concept is proven, however, the next step identify representative classes into which units may fall. A set of models can then be built which would allow decision makers to test the impact of their decisions and determine the information requirements of key participants for capability based resource planning.

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[1] Minchin T, Robinson P, Long T (1996). Management of Australian Defence Force Preparedness, in: The Auditor-General Preliminary Study Audit Report No 17 1995-96 . Canberra Australian Government Publishing Service. p3

[2] Nuthmann C (1994). Using Human Judgement in Systems Dynamics Models of Social Systems, in: Systems Dynamics Review Vol. 10, No1 . US John Wiley & Sons, Ltd

[3] Ministerial statement from Board of Inquiry 6 Mar 97 www.adfa.oz.au/DOD/Minister