An Interactive Planning Prototype for Task Force Air Defense

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Abstract

This work reports development of an interactive prototype of a military planning workspace, implemented in Macromedia Flash. The interface was structured to support the natural reasoning strategies that are encouraged by a functional structure based on an Abstraction-Decomposition Space. A scenario involving planning for naval task force air defence is used to illustrate the use of the system. The prototype demonstrates a pictorially rich information workspace for planning and also the flexibility of Macromedia Flash for developing a prototype that permits interactive exploration of an information work system.

An Information Workspace

Lintern (2006) has developed a structured information workspace for planning military air missions. An air strike on a cell of insurgents located in a fictitious country (Kartania) was used as an illustration case. One element of that illustration case involved the planning of the defense posture for a naval task force located off the coast of Kartania (Figure 1).

A storyboard was developed to describe how the resources available for task force defense could be organized to counter an offensive sortie by the known air assets of Kartania. That storyboard was used to develop an interactive prototype of the information workspace as it related to the specific problem of naval task force air defense.

The prototype, implemented in Macromedia Flash, allows interactive exploration of the information workspace in its use as a support for planning. Although the information objects are emulated, the Flash prototype allows an evaluator to simulate the working through of an operational problem with a preferred strategy by selecting and displaying information objects in an opportunistic, flexible sequence.

Storyboard Scenario

The storyboard scenario has a naval task force deployed off the coast of Kartania, a country that is known to be antagonistic. An air defence plan is to be developed to counter any offensive sortie launched by Kartania's known air assets. Figure 1 depicts the default panel for this planning problem.

The task force's air defence planner navigates through this problem by reference to the Abstraction-Decomposition Space shown in the upper left corner of Figure 1. The planner navigates to functional descriptions at different levels of abstraction or degrees of decomposition via the buttons embedded in the nodes of the abstraction-decomposition space.

By interrogating (clicking on) the relevant physical resource button, the planner can identify the type of air attack assets owned by Kartania. Figure 2 shows the air asset types normally available to a well-equipped air force. Negation symbols identify air asset types that are not available to Kartania's air force. Figure 2 shows that Kartania has limited air attack assets but that it has strike fighters and anti-ship ordnance. Those assets can be transferred into the Abstraction-Decomposition Space within the default panel via a double click (Figure 3).

The planner can identify the number and location of Kartania's air assets by interrogating the asset icon now inserted in the Abstraction-Decomposition Space. By hovering the mouse cursor over the asset icon button, a call out (not depicted) showing number and location will appear. In this scenario, Kartania has 12 combat aircraft (R-9 Python) located at Airbase One. Latest intelligence indicates all 12 are operational.

Similarly, asset capabilities (range, speed, maneuverability) can be ascertained by hovering the cursor over the threat footprint button. The callout (not depicted) reveals that the R-9 Python is a deep strike, 24-hour, all weather, air-to-surface platform. It is capable of carrying D-97 anti-ship missiles. The Python is rated high in terms of speed but low in terms of maneuverability.

The offensive capabilities of the R-9 Python in relation to the task force (e.g., can it reach the task force and can it inflict damage if it does) can be ascertained by first double clicking the geographical center of task force to specify task force location and then hovering the mouse over the button in the mission function node connected (via a means-ends link) to the R-9 Python threat envelope at the

physical function level. Mission coverage capabilities are depicted with range envelopes (Figure 4).

A similar process is used to identify defensive assets available to the task force, their functional properties and their capabilities in relation to the adversary's assets. Through consideration of the relative capabilities for the task force versus those of the adversary, the air defense planner develops a defensive strategy, which is then assessed by a more senior officer.

The assessing officer is already familiar with the priorities set by the task force commander and has specified these priorities as a set of ratings on a histogram (Figure 5). The value histogram shown in Figure 5 is based on a notional selection of values from US Air Force operations manuals. The height of the histogram's bars can be adjusted individually in the interactive prototype via select-and-drag action.

The ratings in the lightly shaded bars are based on the task force commander's guidance but, in assigning specific ratings to this guidance, the assessment officer is required to establish a mean of 5.0 to ensure that the ratings reflect the relative emphases placed by the commander on the different values. The dark bars are used to show the assessment officer's evaluation of the defensive plan. Initially, these bars are set at the default value of 5.0 as shown in Figure 5. The assessment officer adjusts these (Figure 6) and then, in collaboration with the planner, compares the profiles of the demanded and assessed values.

Defense Plan

Within the scenario presented here, the initial plan is to have six fighter aircraft from the task force always on standby, ready to launch and intercept any enemy aircraft that threaten. Because Kartania can potentially send 12 aircraft against the task force, shipboard surface-to-air missiles will back up the six fighter aircraft. However, those missiles have automated tracking and firing systems and pose a fratricidal threat if activated when task force aircraft are within their range. While the six fighters on standby will be able to launch promptly enough to intercept the attacking aircraft at a distance beyond the range envelope of the shipboard anti-air missiles, aircraft not on standby will take longer to launch and may not clear that range envelope before the missile tracking-and-fire systems are activated.

If outnumbered, superior maneuverability of the six task force fighters launched from standby will enable them to distract (but not engage) the enemy aircraft and the shipboard missiles will be able to defeat any anti-ship missiles that are fired. Nevertheless, robust defense against a maximum enemy sortie will require more task force aircraft to engage the enemy. However, it will not be possible to launch more aircraft from the task force without risking either aircraft loss from the task force's own missiles or an unacceptable delay in activating the missile tracking-and-fire systems.

Plan Assessment

That assessment officer considers these issues during evaluation of the submitted plan. Figure 6 shows that the value profile of that submitted plan does not conform to the demanded profile based on commander's guidance. Asset protection, personnel protection and fratricide prevention are unacceptable primarily because of the conflict between possible requirements to launch more task force fighters and to activate shipboard missile systems in time to intercept incoming anti-ship missiles.

Although there is no mathematical balance in the value structure (decreases in the rating of one value do not automatically lead to an increase in another), a comparison of the value profiles can be diagnostic and can suggest how the plan might be adjusted. For example, Figure 6 shows that ratings of operational economy, operational simplicity and operational safety are well above demanded levels so that adjustments of plan details that reduce one or more of these ratings could be acceptable. A plan that had several fighter aircraft already aloft and on continuous patrol outside the range of the task forces own missiles would be more costly and more complex but offers a possible solution.

Summary

This interactive prototype was developed primarily to demonstrate the potency of a pictorially rich information workspace, structured around an Abstraction-Decomposition Space, for military air operations planning. The planning sequence narrated above offers only one possible trajectory through this problem of air defense planning and is intended specifically to illustrate the exploratory manner in which the prototype can be used. The interactive prototype permits an evaluator to explore a range of planning strategies and trajectories. An interactive prototype of this type is likely to have more influence in future design decisions than non-interactive options such as verbal descriptions or storyboards.

Reference

Lintern, G. (2006, October). A Structured Reasoning Space for Design of Complex, Socio-Technical Systems. Wright-Patterson AFB, OH: Air Force Human Resources Laboratory, Human Effectiveness Directorate, Warfighter Interface Division, Cognitive Systems Branch, Technical Report AFRL-HE-WP-TR-2006-0159.

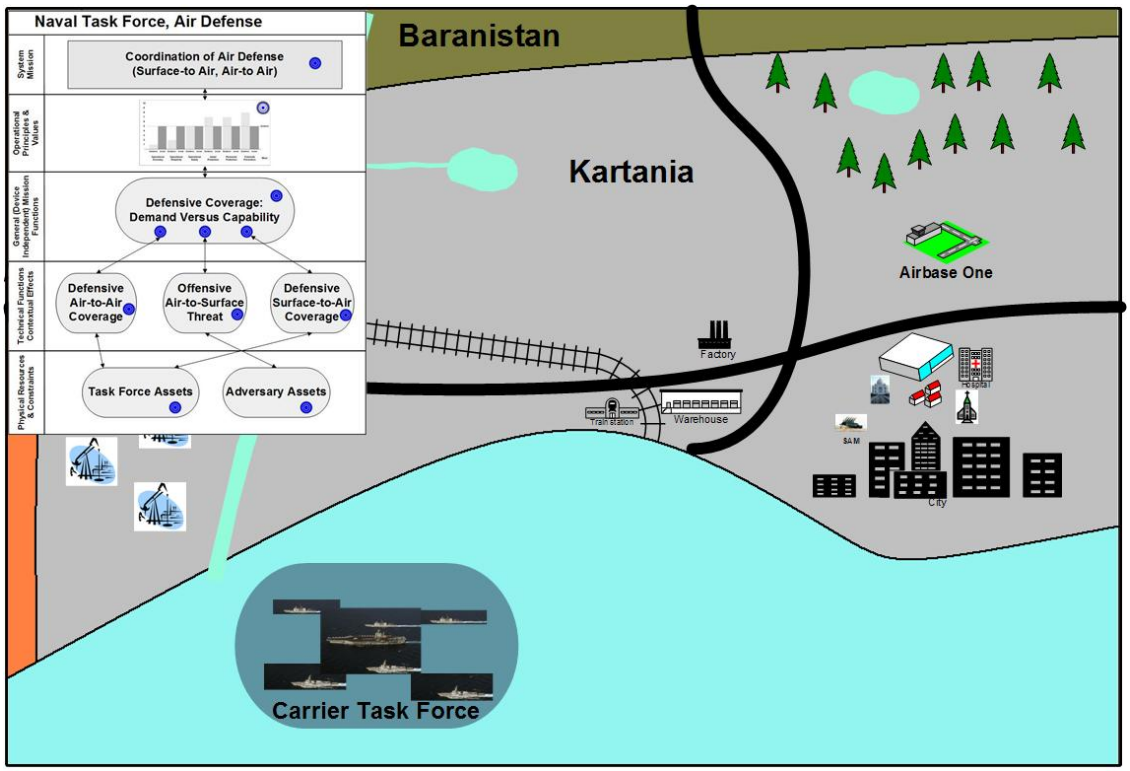

Figure 1; Default panel for developing a defense plan to counter an air attack by Kartania's Air Force.

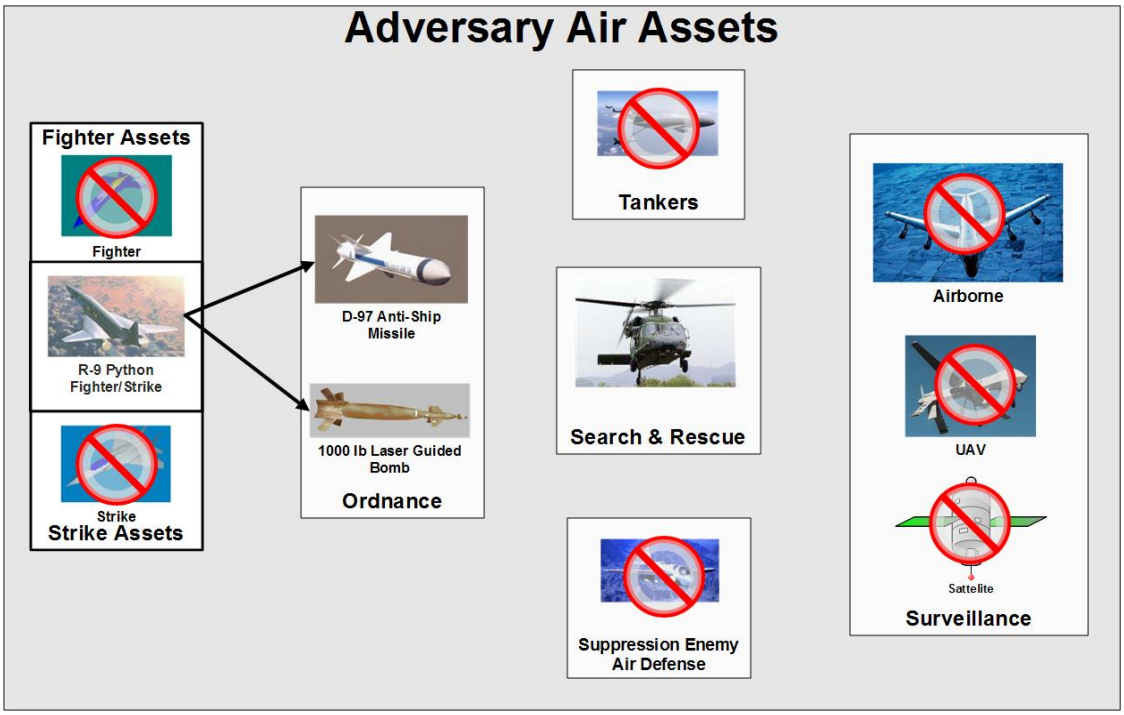

Figure 2; Air asset template (Kartania does not have any of the assets distinguished by the negation symbol.

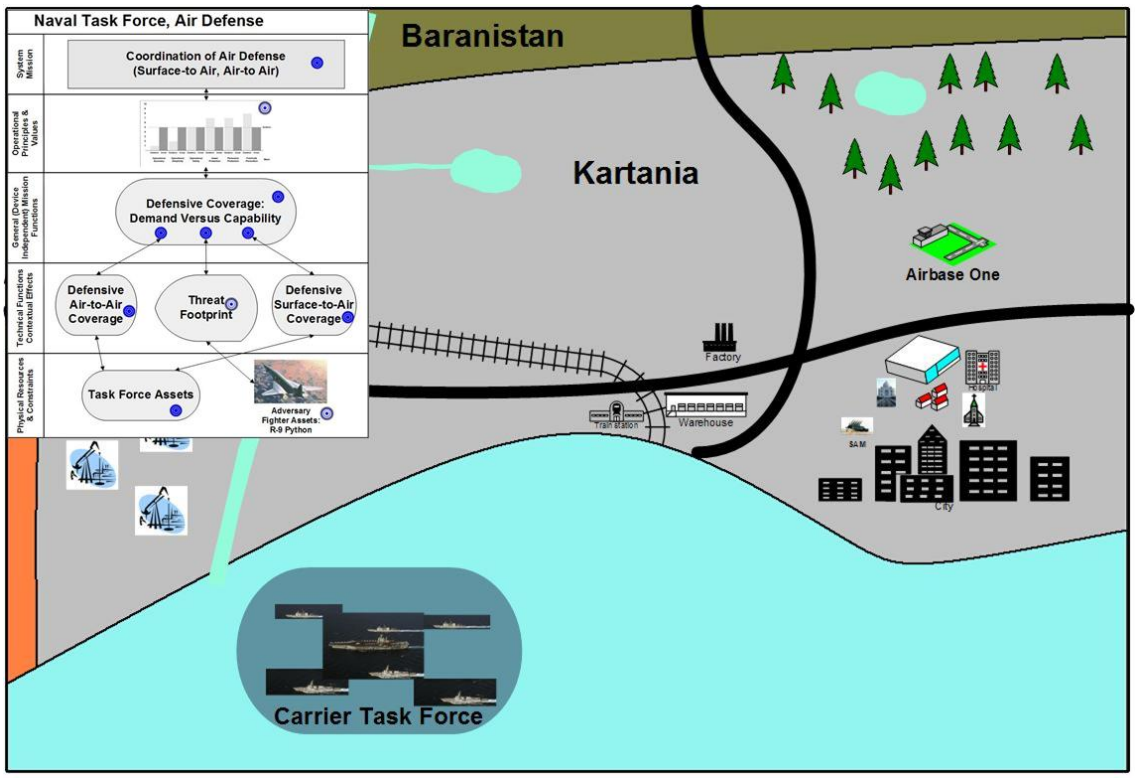

Figure 3; The default panel with Kartania's air assets inserted into the Abstraction-Decomposition Space

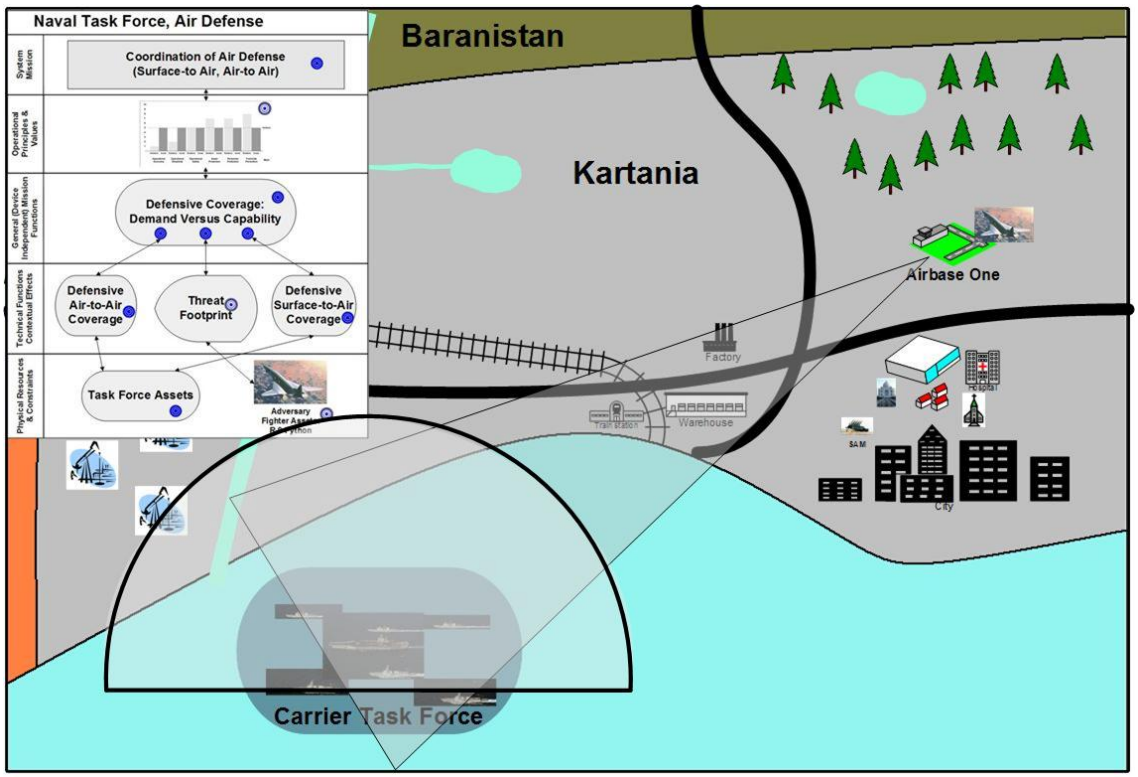

Figure 4; Mission capabilities of the R-9 Python and its anti-ship missile shown as an aircraft range envelope and a missile range envelope

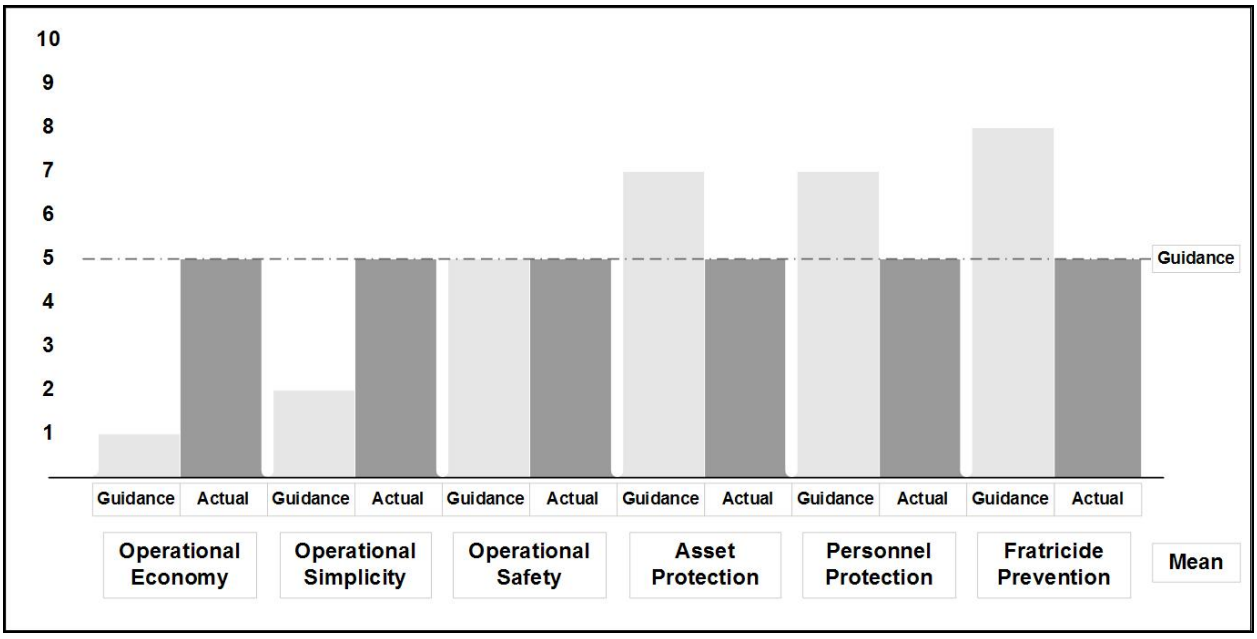

Figure 5; The value histogram showing the relative priorities set by the task force commander (light bars) and assessed values of the defensive plan (dark bars set at default values prior to the plan being assessed)

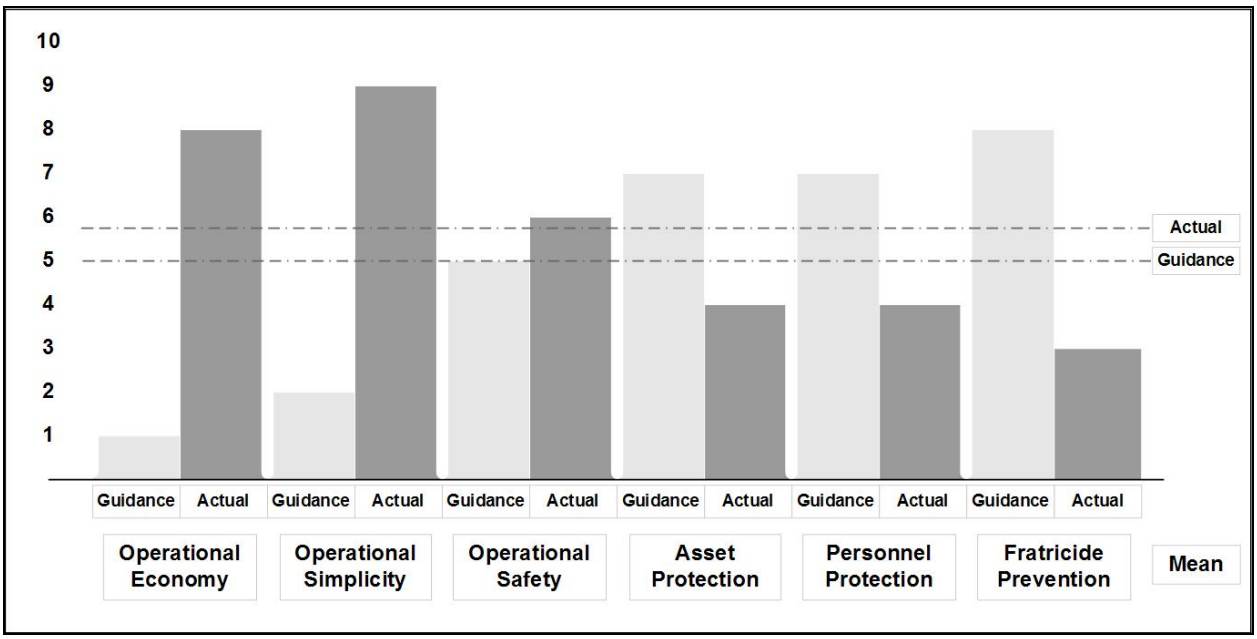

Figure 6; The value histogram showing the relative priorities set by the task force commander (light bars) and assessed values of the defensive plan (dark bars) as set by the assessor