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MODELING FORCE RESPONSE TO SMALL BOAT ATTACK AGAINST HIGH VALUE COMMERCIAL SHIPS

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ABSTRACT

This study examines ways to prevent the success of a small boat attack (SBA) against a larger high value commercial vessel, or high value unit (HVU), through the utilization of an agent-based simulation. The geographic area of concern is the Straits of Malacca. An essential element of the scenario is the limited time available to act against the attackers. Subsequently, the two alternatives considered are the deployment of patrol craft, as well as the placement of well-armed Sea Marshals on each high value ship.

1 INTRODUCTION

Commercial shipping vessels use shipping lanes that transit vast expanses of desolate ocean area. These shipping lanes pass through marine territory that is barely, if at all, monitored or policed by forces that could protect or assist any merchant vessels that become distressed. This vulnerability, coupled with the quantity and value of cargo that is shipped on the open seas, provides a potential target for terrorists that were intent on disrupting the global economy.

This research is part of a larger study that examined Maritime Domain Protection in the Straits of Malacca. The focus here is to examine ways to prevent the success of a small boat attack (SBA) against a larger high value commercial vessel, or high value unit (HVU), through the utilization and analysis of an agent-based simulation. While the geographic area of concern is the Straits of Malacca, particularly near the extremely busy port of Singapore, the results of this analysis were extended to other ports and their local waterways.

2 SCENARIO

The scenario was a small boat attack (SBA), designed to demonstrate the quick reaction capabilities of the maritime domain protection system. It was based on the French tanker Limburg attack off the coast of Yemen, where a speedboat carrying explosives rammed and blew a hole in the side of the tanker. The scenario called fr an explosives-laden small boat to attack a merchant vessel transiting the Strait of Malacca.

The small boat was approximately seven meters long, capable of 30 knots, and loaded with 1000 pounds of TNT armed with both an impact fuse and a remote detonator. The SBA scenario was set around midday with standard environmental conditions for the region. The scenario had the small boat exiting from a fairly narrow portion of the Straits that is frequently congested. This allows the maritime domain protection system to be tested against a very time-critical target, in a congested traffic area. The SBA scenario forced the system to react in a timely manner and to be selective enough to define not only the attack, but also to determine which ship is the target of the attack so that it can be defended. A graphic of the scenario is below in Figure 1.

3 FORCE RESPONSE ALTERNATIVES

While a variety of possible force response alternatives were considered, two significant operational requirements resulted in the final consideration of just two distinct alternatives. The first limitation to a broader set of alternatives was time available to any response team. The chosen scenario dictated that

Figure 1: Small Boat Attack in MANA

only minutes were available to have a capable force response in place to stop an attack. The second limitation was the need to stop the attacker before it was within 80 meters of the HVU. This would prevent significant damage to the commercial vessel, even if the TNT was detonated at that range.

Essentially, these requirements meant that the force response capability had to be in place before an attack. Therefore, the two alternatives consisted of the use of patrol crafts to protect HVUs as they transit the Straits of Malacca, as well as the use of onboard Sea Marshals that would act as an organic defensive unit for the HVU.

In the first alternative there were six Sparviero (an Italian-made vessel) patrol craft conducting a continuous patrol pattern in the Straits. The Straits were divided into two sectors, with three patrol craft each. This was believed to be the most effective use of the craft to counter the terrorist threat.

The Sea Marshal team alternative consisted of a three man team, with two crew served weapons and one observer. The team members were to be placed onboard the HVU prior to the attack commencing, meaning some time prior entering the Straits. This follows procedure, as the HVUs would be identified prior to entering the most dangerous part of their journey.

4 MODELING AND ANALYSIS

4.1 Operational Design Parameters

The three factors that were of most concern in the analysis of force response options were:

1. Engagement range
2. Probability of kill per single engagement (P_{KSE})
3. Number of HVUs in the area of responsibility (AOR).

It was assumed that the Sea Marshals would have rules of engagement (ROE) in place to actively engage any threat that came within a certain engagement range of the HVU. The engagement range was varied from 100 meters to 240 meters in 20 meter increments. On the other hand, the patrol craft alternative had the capability to go beyond the horizon at great distances. Its values ranged from 9 to 50 nautical miles.

P_{KSE} was varied to show the effect that training and readiness levels would have on the engagement. P_{KSE} was set from 0.3 to 1.0 for both alternatives. A full factorial simulation experiment was conducted with each treatment consisting of fifty replications. Figure 3 shows the contour plot for the probability of kill (at distance greater than 80 meters) considering P_{KSE} and initial engagement range.

Finally, the number of patrol craft used and the Number of HVUs to protect were varied only for the Patrol Craft alternative. First, it was of interest to determine how much improvement in P(def) would occur when increasing the number of patrol craft in use. Additionally, the patrol craft alternative provided a chance to examine the effect of trying to protect various numbers of HVUs with a specific patrol of Sparviero craft. For the Sea Marshal alternative, on the other hand, it was assumed that each designated HVU would have a team placed aboard. A summary of these factors and the values they were assigned for MANA model are found in the table below.

Table 1: Significant Modeling Factors

Factor		**Values Evaluated**
P_{KSE}		0.3 – 1.0
Number of HVUs	***Patrol Craft***	1-50
	Sea Marshals	1
Number of Patrol Craft	***Patrol Craft***	3 - 9
	Sea Marshals	N/A
Engagement Range	***Patrol Craft***	9-50 nautical miles
	Sea Marshals	100 – 240 meters

4.2 Performance Measures

The primary performance measure was the probability that an attack was defeated by the defending force P(def), represented by either the patrol craft or the sea

marshals. While time to defeat would seem to be a significant measure, that was addressed as a minimum requirement. Essentially, if the force response team could not defeat the attackers within the time needed to prevent the attackers from getting within minimum distance, the attack was a success. Of additional interest, for the patrol craft option, was to examine both the number of HVUs that could be adequately protected and the number of patrol craft that would provide the best level of protection.

4.3 MANA Agent Based Simulation

The agent-based simulation used in this effort was Map Aware Non-Uniform Automata (MANA). MANA was developed by the New Zealand Defence Technology Agency to analyze the effect of chaos and complexity theory in armed conflict. MANA is considered a distillation since it has the characteristics of transparency, speed, ease of answering specific questions, and requires little training to use.

A major advantage of MANA is that as an agent-based model, its entities are not controlled by central, predetermined, decision-making algorithms, but make their own decisions as they adapt to the environment. Thus, MANA is a good tool for exploration. Because of the nature of MANA and other agent-based models, behavioral characteristics of entities could be represented and defined. However, for the purposes of this research, these traits were assigned and maintained as constants throughout all of the alternatives. This allowed the model to focus on isolating operational performance. An example of these types of behavior representations in MANA is red force hostility, which was set at a high degree.

Another major benefit of using the MANA package was the ability to realistically represent the scenario. Current intelligence reports show that the most likely attack scenario would be a vessel disguised as a fishing vessel, which would operate covertly near a choke point until a target of opportunity passed within range. This capability was easily modeled using the MANA software package. In the scenario the red vessel was identical in appearance to all of the other thirty-five fishing vessels in the area.

4.4 Model Results

The overall modeling results showed that the Sea Marshal alternative had a better probability of success than the Patrol Craft alternative. Specifically, for Patrol Craft alternative (using 3 Patrol Craft), P(def) was 60%. For the Sea Marshal alternative, P(def) was 92.5%, even at a moderate setting of P_{KSS} = 0.5 and range of engagement of 150 meters. Figure 2 below shows the entire breadth of engagement ranges and P_{KSS} that were varied in MANA for the Sea Marshall Alternative, with the mean P(def) identified by the various colors labeled in the legend.

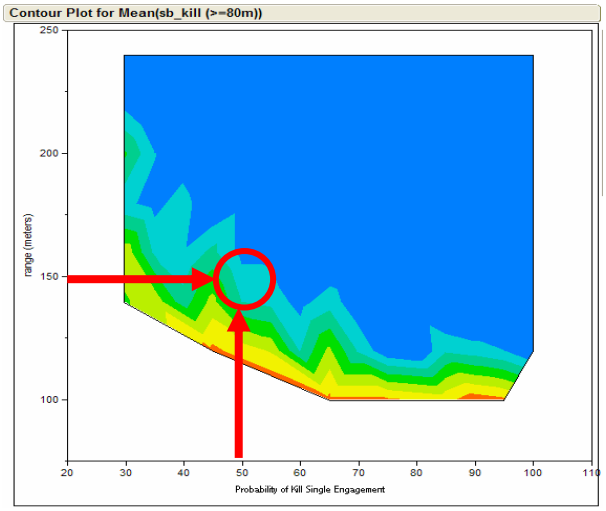

Figure 2: Contour plot for Sea Marshal Alternative

Figure 3 below shows the range of values for P(def) for the Patrol Craft alternative as both the number of Patrol Craft vessels (Sparviero) and the number of HVUs being guarded were varied. It shows that doubling the number of patrol craft from 3 to 6 would result in an expected increase in P(def) of approximately 0.2, regardless of the number of HVUs.

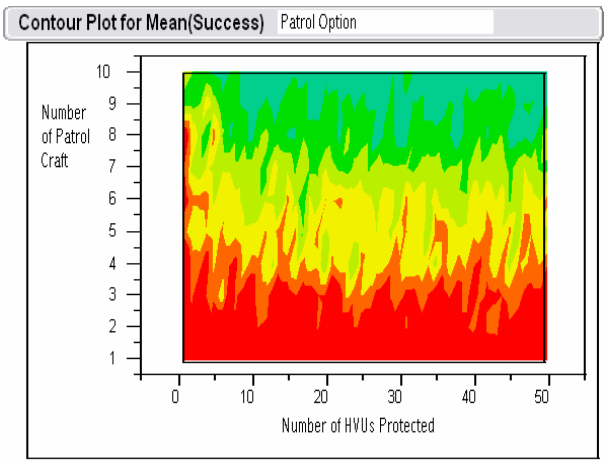

Figure 3: Contour plot for Patrol Craft Alternative

As an excursion of the scenario, the Sparviero vessels were used as convoy assets. The results from MANA showed that the number of HVUs inside the protected area was irrelevant. The patrol craft escort,

using 3 Sparvieros, was capable of defending up to 50 HVUs with P(def) slightly higher than 0.9. This led to the recommendation that the Sparviero vessels be used as a convoy escort rather than as a traditional patrol craft.

5 CONCLUSIONS

The primary conclusion from this study was that the use of sea marshals armed with crew served weapons is the best way to counter a small boat attack against an HVU. An additional finding was that the escort of HVU convoy produced a noticeable improvement over patrolling.

Additionally, it is apparent that the weapon range and P_{KSE} affect have important impact on P(def). This is particularly true when considering weapons with extended range and precision such as the over the horizon missile system. While this system was included as a possibility alternative for this study, the operational feasibility of such a weapon may be questionable. In a cluttered environment such as the Straits of Malacca, it would take much risk of collateral damage to fire such a weapon at great distance on a small target beyond visual line of sight.

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