Threat and Control in Military Decision Making

Introduction

Military decision-making means putting peoples life at stake in order to reach military objectives. The military decision makers are not only faced with risk of their own lives, their decisions also means subjecting own personnel and maybe even civilians to grave danger. Furthermore, the decisions often have to be made in highly stressful situations and in almost all cases under conditions of uncertainty and time pressure. When deciding what to do the military commander has to weigh possible gains against possible losses to determine the worth of each alternative. If an alternative where the possible gain outweighs the possible losses can be found, the risk of that alternative is considered worth taking, and it is chosen and implemented. How military decision makers make such tradeoffs have not been studied to any great extent and empiric data in this field is almost nonexistent. Consequently, research is needed to investigate how military decision makers judge the risk of a certain course of action, and how they decide if that risk is worth taking. The rationale for this is that if we want to devise proper decision support we must first understand how such decisions are made in order to identify possible difficulties and pitfalls. This study is based on the assumption that determining acceptable risk means making a decision that strikes a balance between the factors that increase risk, the factors that decrease risk and the factors that justify risk. If such balance can be found, the risks following from the decision are acceptable and are worth taking. This paper focuses on how a commander estimates the threat posed by an enemy in a tactical situation and what he or she does to controls that threat. The results will be used as the groundwork aiming at devising a military decision support system.

Figure 1. Part of the Swedish coast line

Method

The participants were nine officers who either were or had been in active duty in the Swedish navy. One of the participants had served as Chief of Navy, the highest commander of the Navy and a direct subordinate commander to the Supreme Commander. One had served as Chief of Fleet, the highest commander of the Fleet. Two participants had served as Commander of a Surface War-fare Flotilla (the highest tactical commander of a naval mission consisting of 15-20 navy ships often coupled with support units such as helicopters, attack, fighter, or surveillance aircrafts). Three participants had served as Commanders of Surface Warfare Divisions (subordinate to a Flotilla Commander and in charge of approximately four to six navy ships). Two participants had served as Commanding Officers of a ship. Eight of the participants were specialized in anti surface warfare and/or anti sub-marine warfare and one officer in mine warfare. The participants had led between 10 to 100+ military planning processes on the tactical level or above, and they had led between 10 and 100 naval missions (exercise and/or live) . All respondents were men.

The study was conducted using semi-structured interviews, duration ranging between 0.5-1.5 hours. The questions were based on the steps and tasks prescribed by the Swedish Navy's decision-making process (SNDMP), which like other military decision making processes is highly proceduralized process where of a number of distinct steps should be completed in sequence. However, none of the steps or tasks in SNDMP explicitly states that the decision maker should carry out risk estimates, or assess how the respondents made such estimates would probably yield little or no data. Instead it was assumed that risk estimates would be embedded in the decision-making process and consequently all respondents had to describe how they carried out each of the steps.

The interviews were transcribed verbatim, leaving out pauses, humming etcetera and analyzed using content analysis. As no stage of the SNDMP explicitly calls for risk estimates it was suspected that the participants would use other phrases together with 'risk' when they accounted for how they made such considerations. Consequently, all statements containing the words "risk", "threat" and "danger" were excerpted. To determine if a statement related to judgments of threat or control, each were analyzed by the author. The data were reduced by amalgamation of similar statements and the result was checked for internal consistency (no contradictions within the statements) and integrated to form a coherent model of threat and control in military decision making.

Results

The results show that two things determine the level of threat in a tactical situation: i) the enemy and ii) the level of uncertainty regarding the enemy. All respondents expressed that the enemy is the major threat determinant (9 of 9). When considering the enemy, two questions occupy the participants: what forces does the enemy have and what can the enemy do? As expected, the more forces the enemy have and the more capable the forces, the higher the threat. Further, the forces can be employed differently leading to more or less threatening actions.

The other threat driver is uncertainty. The results indicate that the respondents (6 of 9) regard uncertainty almost synonymously with threat . An uncertain situation is a threatening situation. As one of the lower experienced respondents put it "You often regarded different aspects of risk taking, what risks were acceptable, what uncertainties". When faced with uncertainty, as understood by some of the participants in this study (4 of 9), they deal with it by worst-case reasoning. This, however, gives a different bounding of risk than probability would give.

Consider the uncertainty about the enemy forces. Given no uncertainty at all, the enemy units that pose a threat, are known. Thus, the risk is equivalent to the threat posed by those units. As uncertainty increases, the more the decision maker tends towards worst-case reasoning. Consequently, risk is bound on the lower end by the threat posed by the known forces, and on the upper end by the threat posed by the worst plausible combination of enemy forces. The same reasoning goes for what the enemy can do. When uncertainty is zero the risk is equal to what the decision maker knows the enemy is going to do. As uncertainty increases the risk approaches the threat posed by the worst plausible enemy course of action. The following statements from two of the higher-ranking respondents serve as examples:

Let us say that you can get a decent understanding of what resources the enemy got, but what his possibilities are, how he thinks and ponders, that is not as easy. If you start to sort out, what are his resources? What kinds of ships are there, what kind of aircrafts, what other forces does he have?

And then you lay low and wait. You know that he can approach this area, and your mission is to prevent him from entering and doing something in this area. […] Then you must keep track of where he is and what the most dangerous thing he can do is, and decide how you can counter that. And yes, the difficult part is to know how big they are, how many they are, and how strong they are. That is what you are going to think about.

In the military context, threat is controlled by employing own units and by devising an appropriate own course of action. On this point all respondents agree (9 of 9). The number of own units and the types of own units deter-mines the control created by own units. The more own units, the higher the perceived control. The more capable the own types, the higher the perceived control. Following statements from two of the highly experienced respondents serve as examples:

What is it that has to be done? What does the threat look like? What enemy forces are in the area? What forces will I have at my disposal? In that situation the first thought is: Do I have enough own forces or do I need support from other units? Do I need recognizance aircrafts, attack aircrafts, surveillance helicopters, or support from other surface attack forces? A first feeling; do I have enough forces, enough capability to solve this mission?

I mean, what is level of risk you must be prepared to take? Of course there is a connection to the resources as I as tactical commander can use. And the difficulty is of course what resources I can get. What support can my mission [as tactical commander] get from the mission commander [the higher command]? There is a discussion about the supporting functions that I can get related to the level of risk. As an example: Can I get air support, costal missile batteries or something else as an additional strength. Or can I get submarine missions as support?

Control

Control is also achieved by devising/selecting an own course of action that subjects own forces to more or less risk. The control achieved by own course of action is consequently transitive. Consider following statement from one of the high experienced respondents:

It is embedded in this, the comparison of forces. How can I, so to say, protect my own forces and when can I strike, that is what it is all about. And if this comparison is to my advantage, which it seldom has through the years, it has always been an advantage to the enemy, both in numbers, size, resources, ranges, additional aircrafts and everything […] well yes, then I must, to protect my own forces as much as possible, utilize the protection I can get from maybe the terrain or similar, that is the archipelago, in another way than if we had an advantage of some sort in ranges. If that were the case, then you had been able to go out [on the open seal in another way.

The results indicate that the threat posed by an enemy force is a function of how large the enemy force is (how many units it contain), how capable it is (what kind of types of units it contains), what the enemy is doing (behavior), and the uncertainties regarding the number, types and behavior of the enemy.

Beginning with the properties of a unit, the threat posed by a unit is determined by its ability to destroy other units. To destroy another unit it must first be able to detect the other unit, and second, have a weapon that can be used to engage the detected unit. Thus, the threat or control posed by a unit is determined by the unit's ability to detect other units, together with the weapons carried by that unit.

Figure 2. Threat posed by a unit

Looking at Figure 2a, two identical ships with regard to armament and maneuverability are depicted. In this example the right ship will be considered as more of a threat since it can detect units (and consequently fire a weapon against them) at a further distance than the left ship.

If we continue to the weapons, a unit is perceived as more of a threat if it carries more powerful weapons. Figure 2b depicts two ships: a patrol boat (to the left) and a destroyer (to the right). The patrol boat carries a single gun while the destroyer carries two guns and six surface-to-surface missiles. In this case, the destroyer will be perceived as the higher threat due to its heavier armament. Furthermore, the range of the weapons carried by a unit also determines its level of threat. A unit with long ranged weapons will be considered more of a threat than the same unit with shorter ranged weapons. The reason for this is that a unit with long ranged weapons may fire that weapon outside the detection range of friendly units.

Yet another property that increases threat or control is a unit's ability to avoid detection, its ability to stealth. If a unit has a high ability to stealth, the unit has the advantage of coming into range with its own weapons and sensors without being detected by the opposing unit.
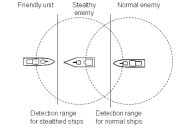

Figure 3. A stealthy unit is more threatening

Looking at Figure 3, three ships are illustrated: a friendly unit (left) a stealthy enemy (middle) and a normal enemy (right). Even though the stealthy and the normal enemy have the same weapons and sensors, the stealthy enemy will be perceived as more of a threat since it can detect and fire a weapon on the friendly unit without being detected. Consequently, a unit with high ability to stealth may pose a higher threat than a normal unit, even if the normal unit is equipped with better sensors and armament.

As said earlier, the behavior of an enemy unit also affects the perceived threat. In Figure 3 an enemy ship is moving north, its weapon and sensor ranges illustrated by the dashed circle. Now suppose that the enemy unit suddenly changes course. If the course change will bring the enemy closer to the friendly unit, the perceived threat will increase since the friendly unit runs risk of coming within range of the weapons carried by the enemy. On the other hand, if the course change will bring the enemy further away from the friendly unit, the perceived threat will decrease for the opposite reasons.
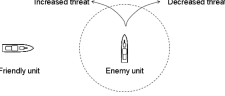

Figure 4. The behavior of a unit determines its threat

The capability of a force is determined in the same way as the capability of a single unit, by its ability to detect and destroy targets. But on a force level a procedure of target sharing can enhance those abilities. Once a naval operation is underway all units use their sensors to survey their immediate surroundings. All contacts are reported to designated units in the force, which compile the reports into a single, coherent view of the operation's area. This view is then distributed to the whole force. This procedure allows all units to become aware of all contacts held by the force, including contacts out of range by their own sensors.
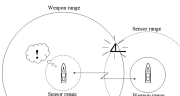

Figure 5. Target sharing within a force

How this procedure can enhance the combined effect of the force is illustrated in Figure 5. The right ship with the greater sensor range detects a target with its radar. As the target is outside the range of its own weapons the right ship cannot itself destroy it. However, by sending the target to the partner to the left, the partner also becomes aware of the target. The left ship has much greater weapon range and as the target is within that range, the left ship can engage the target. This simple scenario illustrates that the more capable a force is to detect targets, the more threatening will it appear. However, a force with superior surveillance capability is no threat at all if it does not have the capability to destroy the targets it has detected. Thus, the weapons it can employ also determine threat. The more powerful and the longer ranged they are, the more threatening the force will be perceived. On the other hand, the force is of no threat at all if it cannot detect any targets. Thus, to be a superior force it must have the upper hand both when it comes to sensor capability and weapons capability.

Figure 6 further illustrates the situation. To the left we see a force consisting of two ships of the same type. The inner zone, denoted by a dashed line, depicts the total area covered by the force's sensors. The outer zone shows the area covered by the force's weapons. The gray zone shows the area, in which this force can both detect and destroy targets; in this case it is the same as the area covered by sensors. If we now look at the right force we see that it consist of one ship and one helicopter. If we assume that this ship is of same type as the ships in the left force, we see that the area in which the right force has control is much larger than the left force's. This is due to the superior sensor range provided by the helicopter. If we now compare the threat perceived by the commanders in each force, the commander of the left force will probably perceive a higher degree of threat, despite the fact that he or she has twice as many weapons. This is quite evident since the right force can close in on the left force, use the helicopter to find the left force, fire its missiles at max range, without risking detection of the left force. Thus, the threat or control provided by a force is determined by its composition of the own force, in the same way as the threat posed by the enemy is determined by the composition of the enemy force.
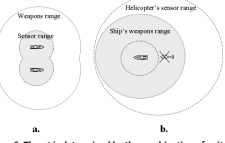

Figure 6. Threat is determined by the combination of units

As have been illustrated above, the control provided by own units was determined in the same way as the threat posed by the enemy. The second way to handle the threat was to devise an appropriate own course of action. How this can be accomplished is illustrated in Figure 7. The mission is to move the ship from Port A on the mainland to Port B on the island. Intelligence has reported that during the initial phases of the operation no enemy is in the area, but as the operation is underway the enemy will most likely try to prevent the transport. The commander concludes that if we move quickly we might get the transport to Port B without giving the enemy a chance to interfere. The plan is to move the transport ship at high speed across the open water, thus minimizing exposure time to the enemy threat. The friendly units will establish a protective screen.
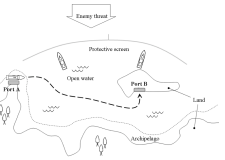

Figure 7. A simple escort mission

Now assume the operation is underway and the transport ship has reached a point on the open water between Port A and Port B. Suddenly, an enemy ship is detected and identified. Since the open sea does not provide any protection it is assumed that the enemy also has detected the transport ship. Figure 8 illustrates the situation. The enemy has a weapon range denoted by $r1$ and the friendly ship a weapon's range of $r2$. This means that the enemy ship cannot be allowed to get any closer than $r1$ to the transport ship, or else the transport ship runs risk of being sunk.
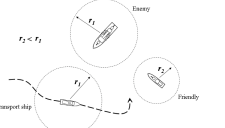

Figure 8. Zones of control

The commander can handle the threat in two ways. One alternative is to order the transport ship to head south and hide in the archipelago. This makes the transport ship difficult to detect and consequently difficult to destroy. The other option is try to sink the enemy ship, removing the threat altogether. However, attacking the enemy is dangerous since the own ship is inferior when it comes to weapon ranges ($r2< r1$). On the other hand, it may be worth the risk since a successful attack will lower the overall threat for the rest of the operation.
In this case the commander orders the transport ship to head south and seek cover in the archipelago. The idea is to let the transport ship move in the archipelago to the point on the mainland where the distance to the island is minimal. Once there, it will lay low and wait until the friendly units have cleared the route to Port B, as shown in Figure 9. Using same reasoning as before, the area that must be cleared is obtained by measuring the range of the enemy's longest ranged weapon and apply that distance perpendicular to the planned route. When the area is cleared the transport ship will rush out at maximum speed, giving the enemy minimum amount of time to act before the transport ship reaches Port B.

Figure 9. Zone that must be controlled

As pointed out, one of the most difficult aspects of military decision-making is the analysis of the enemy. Such analysis is made difficult because all information regarding the enemy is afflicted with uncertainty. The uncertainty regards three aspects of the enemy forces: (i) the number of units, (ii) the types of units and (iii) the behavior of the units. All these aspects affect the perceived threat.

This can be modeled in a tree structure (see Figure 10). The root node (S) represents the current scenario, i.e., the context in which the naval operation should be conducted. The intermediate nodes consist of the three aspects describing the enemy, where the first level represents the number of enemy units (n), the second level types of enemy units (t), and the third level the behavior of the enemy units (b). The value nodes (v) quantify the perceived threat of each branch in the tree.

When analyzing the own forces, the commander considers the same aspects as those of the enemy, the number of units, the types of units, and the behavior of the units. It is consequently tempting to model the own forces in a tree structure, similar to the enemy. There is, however, a difference. There is hardly any uncertainty at all regarding the own forces. When an operation is initiated the commander receives a mission statement from higher command. This statement contains the task to be solved, a roster of the forces assigned to the commander, and information about the enemy. When planning begins all these pieces are fixed. The commander can neither influence the mission assigned, nor the forces, nor the intelligence about the enemy.

The roster of the own forces made both the numbers of ships (n) and the types of ships (t) fixed. The only thing the commander can influence is the behavior of the own forces. As a consequence, the own force can represented similar to the enemy, as a single type-node that is then used as an argument when deciding how to solve the mission.

Figure 10. The threat can be modeled as a tree

Thus, the own behavior can be seen as a threat-altering function that given the own force influence the enemy's opportunity to pose threat to the own operation. Consider the situation described in Figure 8. When the transport ship heads south to take cover in the archipelago the negative value of being sunk is the same, however the probability that the enemy will sink the ship has been reduced. The alternative behavior, attacking the enemy ship and trying to sink it, will lead to that the probabilities of the number of enemy ships are altered.

The tree is generalized into the following formula for calculating the generalized expected threat:

$$T(S_i) = \sum_{i=1}^{n_1} n_i \sum_{j=1}^{n_j} t_j \sum_{k=1}^{n_3} b_k v_{ijk}$$

Given the threat in a scenario, the own course of action was regarded as a threat-altering function, taking the own force and the threat as arguments:

Definition: Given a scenario Si with the expected threat T(Si) and the own forces F(n,t) where n=number of ships and t=types of ships. Behavior Bj is a function such as:

$$B : B\big(F(n,t), T(S_i)\big) \rightarrow T(S_i)'$$

Current work

The results from the interview study made it clear that further studies had to be conducted in an experimental situation in which the decision maker had to take action in a situation of varying threat. To create such an experimental situation a simple war-game – Simple Surface Warfare Model (SSM) - was developed.
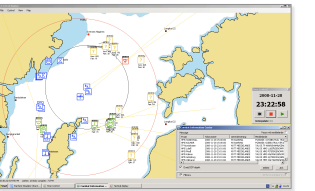

Figure 11. Main screen of Simple Surface Warfare Model

An scenario was developed in cooperation with a highly experienced retired officer and the scenario and system was tuned through several gaming sessions. The purpose of the experiment was to determine which aspects of naval command posed problems to the decision maker. The opponent cannot land any forces on Gotland before 1/12 but they have however some capacity to disturb our transport.

The experiment was conducted using "think aloud"-protocol, where the participant has to verbalize his or her thought processes. The session was recorded on video together with a screen-capture movie from SSM.

Background
It is 28/11 and the time is 1500. Reliable intelligence states that our opponent is preparing an attack towards the island of Gotland as part of an operation primarily aimed at another country in the region. To prevent this a mechanized brigade must be transported to Gotland from the mainland. The opponent cannot land any forces on Gotland before 1/12 but they have however some capacity to disturb our transport.
Task
You are the commander of task group 1 (CTG1). CTG1 transports the mechanized brigade from Swedish mainland to the island of Gotland. Available ports of debarkation are Visby and Klintehamn. The brigade must be unloaded no later than 301800.
Intelligence
Six enemy attack corvettes and one enemy radar surveillance helicopter operates in the eastern Baltic Sea with the objective to disturb any reinforcement of Gotland. Four are currently in the Bay of Finland and two are in the Bay of Riga. One enemy submarine has been reported west of Gotland.
Forces
4 Gothenburg-class coastal corvettes, 4 Ystad-class fast missile crafts, 4 Kaparen-class fast patrol boats , 1 radar surveillance helicopter, 2 anti-submarine-warfare helicopters, 3 Transport ships
Rules of engagement
No restriction
Figure 12. The experimental task

Initial analysis show that the participants have problem of keeping track of enemy units when they are outside the sensor range of own units. If there are much enemy activity in the north the participants "forget" the units in the south area which leads to that many participants are caught by surprise when they are attacked from the south resulting in loss of own units.

A support system to help the decision makers with this problem has been hypothesized. Whenever an unit moves outside the range of own sensors the decision maker must decide whether the system should keep track of the unit. If the unit should be tracked, the system calculates the area where the unit can be using the time that has passed since the last sighting and the average max speed of the unit. This area can later be reduced if own units use their sensors to survey parts of the calculated area. The system can be further enhanced by indicating own units or areas that are to be protected and the system can then keep track of which areas are critical, if there exists areas where the enemy can be and at the same time engage own units.
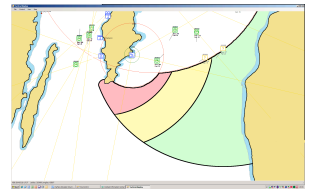

Figure 13. A hypothesized decision support