The Value of Information in War: Some Experimental Findings

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Abstract

A common assumption is that what matters in combat outcome is information superiority[1]. The absolute level of uncertainty about the situation in the battlespace is seen as unimportant. Is that true? Results obtained with a dynamic, chessbased wargame indicate that the answer to this question is no - the absolute level of uncertainty is important. More specifically the results show that as the absolute level of uncertainty increases, the value of having information superiority as well as the value of having superior strength decreases, whereas the value of having tempo superiority remains unaffected. Two conclusions are drawn. The first is that information superiority may be best created at lower levels of command where uncertainty is at its lowest. The second is that because uncertainty probably will continue to be a problem in war, tempo superiority may be a more viable alternative than information superiority or superior strength for winning.

[1] Information superiority is defined as knowing more than the adversary about the situation in the battlespace.

1.0 Introduction

Not even staunch believer in the potential of the new information technology believe that it will dissipate the "fog of war", and make command and control with perfect understanding of the battlespace possible.

> We will never have *perfect* understanding of a battlefield, our systems and weapons will never work flawlessly *all the time*, and the forces we ask to wage war will never do everything correctly *every time* [Owens, 1996].

There are a number of reasons why uncertainty will remain an important problem in warfare. First, modern technology can only detect what is observable, e.g. the enemy's position and strength. It can not reveal what cannot be observed e.g. the enemy's intentions [e.g. MCDP 6, 1996;Watts, 1996]. Second, there is the enemy. War is a struggle between opposing wills and the enemy will try his best to use various means of information warfare to prevent certainty [e.g. Van Creveld, 1985]. Third, to attain certainty one must have access to all the relevant information, but gathering and processing information takes time. This creates several problems [MCDP 6, 1996]. Knowledge in war is perishable: as time is used to gain new information, information already gained becomes obsolete. Time is also a valuable commodity. While information is collected the enemy may already be acting – thereby changing the situation into a new one. In warfare there will be attempts to get inside the opponents "decision-cycle" [Boyd, 1987] and postponing decisions may give an advantage to the enemy. The rapid tempo of modern operations also puts limits to the amount of information that can be gathered, processed and assimilated in time to be of use. Therefore a commander must find a balance between information needs and needs for quick action [e.g. Coakley, 1992]. Fourth, large amounts of information make it harder to sort out the reliable and valuable information [Van Creveld, 1985]. Technical solutions have been proposed to handle the problem but while technology has drastically reduced the time to collect and transmit information, the processing and analysis of this information has lagged behind [e.g. Dymek, 1998]. Humans will play an important part also in the future and there is only so much information that humans can handle in a given period of time. Fifth, events that may affect the success of an operation have not occurred until after the decision to act is taken [Watts, 1996]. Sixth, the complex and nonlinear nature of war entails that also rather small uncertainties can have serious consequences [e.g. Czerwinski, 1998; Alberts & Czerwinski, 1998].

The above list is not intended to be complete. Hopefully it is sufficient to elucidate why uncertainty is likely to be an important problem also in future warfare. That uncertainty cannot be dispensed with need not necessarily be a problem. A common view is that what matters in warfare, is to attain information superiority. The absolute level of uncertainty is unimportant [e.g. Watts, 1996].

Is that really true? Some experimental findings from the project entitled "The need for information in future wars" throw some light on this question. The experiments were concerned with the value of information in war and were carried out by means of a chessbased wargame.

2.0 A two-sided, chessbased, dynamic wargame

Chess is one of the earliest wargames. It is assumed to have evolved from an ancient Indian game known as Chaturanga. In this game the pieces represented the various components of the armies of the time: cavalry, elephants, foot soldiers, and so on [e.g. Perla, 1990]. What qualifies chess as a wargame is that it contains several features of warfare. A game of chess is a struggle between two opposing wills that are trying to defeat each other with the use of two "armies". Chess also contains the "basic elements of war" i.e. strike, move and protect [e.g. Leonard, 1994]. Warfare is an example of a dynamic decision task. According to Brehmer and Allard [1991] dynamic decision tasks have four distinguishing features:

- They require a series of decisions
- These decisions are not independent
- The state of task changes, both autonomously and as a consequence of the decision makers actions
- The decisions have to be made in real time.

Edwards [1962] originally coined the term dynamic decision making and the first three points constitute his definition. Playing chess thus is a dynamic task in the sense Edwards defined it. In a chessgame moves do not have to be made in real time. However, the effect of time is that the decision-maker cannot make decisions when he is ready to do so. He has to make the decisions when they are required by the way the situation develops. In modern chess this is partly replaced by the inclusion of a time limit. Real time also makes it necessary to make plans that include the time it takes to do things. In chess this feature is partly replaced by the necessity to plan the number of moves an operation takes. Operations must be carried out before the other player can carry out his operations. If an operation is postponed too many moves it may be too late. However, chess has one drawback. Unlike real war it does not contain uncertainty. To introduce uncertainty a new variety of chess was developed. It was made up of two chessboards and an in between screen which prevented players to see the other player's board. A game leader transfers the moves made by the players to the opponent's board. The set-up is shown in figure 1.

Figure 1. The figure shows the research set-up with two chessboards and an in between screen. From left to right: Joacim Rydmark; Tonie Fahraeus and Jan Kuylenstierna.

With this simple set up it is possible to play games of chess with information manipulated in various ways. Delaying moves can create uncertainty i.e. a player may be prevented from seeing the opponent's latest, two latest moves and so on. Instead the player will be shown the opponent's move preceding the most recent one, the opponent's move preceding the two most recent moves etc. Letting one player have more moves delayed than the other player creates information superiority. Forcing one player to play with fewer pieces than the other player creates strength superiority, and allowing one player to move more than one piece when it is his or hers turn, creates tempo superiority. Naturally, this new variety of chess has required modifications of the standard chess rules. Typically, in a game each player has a certain amount of time to his or hers disposal and the clock is running every time he or she makes a move. The game leader keeps track of the time, keeps track of the moves and adds up the results.

3.0 Overview of results obtained.

Experiments carried out with this game have so far resulted in three major findings. The first concerns the value of having information superiority as the absolute level of uncertainty increases. As pointed out above, what matters in warfare is to have information superiority over the enemy. This hypothesis was tested in an experiment by Kuylenstierna, Rydmark and Fahraeus [1999 a]. The factor varied in the experiment was the uncertainty about the situation on the chessboard and this factor had two levels. In each condition the participants were randomly subdivided into pairs and each pair played a duel made up of two games. In each game one player had information superiority and in the duel both participants played one game each in the superior position. In the first condition (0/1), the player in the superior position (0) made his moves with complete information about the situation on the chessboard. The player in the inferior position (1) made his moves without information about his opponent's latest move. Consequently, the player in the superior position had no uncertainty and information superiority equal to one move whereas his opponent had uncertainty as well as information inferiority equal

to one move. In the other condition (2/3), the player in the superior position (2) made his moves without information about his opponent's two latest moves. The player in the inferior position (3) made his moves without information about his opponents three latest moves. Consequently, the player in the superior position had uncertainty equal to two moves and information superiority equal to one move whereas his opponent had uncertainty equal to three moves and information inferiority equal to one move.
In both conditions then, the information superiority was equal to one move. The difference between the conditions was that the level of uncertainty was increased by two moves for both players in the second condition than for the players in the first condition. For each duel, performance scores for the players in the superior position were summed up and the means of these sums were calculated for each condition. The results showed that as the level uncertainty about the situation on the chessboard on both sides increased, the value of having information superiority decreased. This result refutes the hypothesis stated above, that the value of having information superiority is independent of the absolute level of uncertainty.

Clausewitz proposed superior material strength as a solution to the problem of uncertainty in war [e.g. Handel, 1996]. This possibility was investigated in an experiment by Kuylenstierna, Rydmark & Fahraeus [1999b]. The design and the procedure of this experiment were similar to the ones used in the first experiment with the exception that information superiority was replaced by superior strength. In one condition (0/0) there was no uncertainty and in the other condition (2/2) the uncertainty was equal to two moves for both players. Removing the queen, one bishop and one of the peasants for one player created superior strength. The results showed that the value of having superior strength decreased as the level of uncertainty increased. These results should not be seen as a refutation of Clausewitz's proposition. He was referring to overwhelming force and was probably had the opinion that increased uncertainty will rise the cost of winning [e.g. Handel, 1996].

The third finding concerns the value of having superior tempo as uncertainty increases.
A strive in war is to establish a tempo which is higher than the opponents tempo [e.g. Boyd, 1987]. What will happen to the value of a tempo superiority when uncertainty on both sides increases? This problem investigated in two experiments by Kuylenstierna, Rydmark and Fahraeus [2000]. The design and the procedure were similar to the ones used in the experiments described above. In the first experiment, moving two pieces per turn created tempo superiority. In the second experiment, the tempo superiority was lowered. This was accomplished by allowing only one piece to be moved for each third turn and by allowing two pieces to be moved in the other turns. Both experiments failed to demonstrate any effects of uncertainty on the value of having tempo superiority.
In neither experiment did the performance in the low uncertainty condition differ from the performance obtained in the comparable conditions in the other two experiments. Consequently, there is no reason to believe that the level of tempo superiority was any stronger than the superiority levels used in the other two experiments. Instead the results suggest that tempo superiority may be more resistant to uncertainty than both information superiority or superior strength.

4.0 Conclusions

Allowing for that the results are obtained with a chessbased wargame, they have at least two implications of concern for information superiority. First, according to many experts in the field, the level of uncertainty is generally lower on lower levels of command [e.g. Van Creveld, 1985]. Therefore, information superiority may be best created on the lower levels of command. Second, as pointed out in the introduction, uncertainty will continue to be a problem in war. The results presented above suggest that tempo superiority rather than information superiority or superior strength may be the winning formula for winning in battle.

5.0 References

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