PROCESS - ORIENTED MODEL OF INFORMATION WARFARE

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The evolution of Information Warfare (IW) concepts and doctrine has been considered in many publications.[1,2,4] Our core concept is that IW concerns human activities and judgements performed as part of the Command and Control (C2) process. It is our view that C2 is a universal human activity and that it is the battlefield on which IW occurs. Our objective in this paper is to analyze the C2 process in a structured way so that the result can be the basis for a coherent characterization of IW.

Statement of the problem

According to von Clausewitz, war is a continuation of national policy by other means. The national policy is extended to war when the outcome of diplomatic means is in doubt. Therefore, decision-making in war, specifically in C2, transcends the tactical situation. It is strongly and directly influenced by the national policy that is being executed. Wherever IW is applied, its purpose is to influence the outcome of the policy being executed. It does this by making friendly decision-making more efficient and adversary decision-making more difficult and uncertain.

It is commonly assumed that national policies are interactions between states. However, it is reasonable to ask whether IW applies and whether Information Operations (IO) are appropriate against (on behalf of) entities which are subordinate to a state or which are inter-state entities. It is also appropriate to ask how IW/IO applies during activities short of open conflict. In fact, is it possible to delay or prevent war by the use of appropriate IW/IO measures?

Another question is whether high levels of interoperability and security can exist in the same information space. As the common interests of nations are integrated, increased regulation is necessary. But is it possible to share information to our mutual benefit and still maintain the confidentiality required for national

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security? As the renowned Bulgarian leader Vassil Levsky once said: “We are within the time and the time is within us - we turn over it and it turns over us.” Paraphrased, we can replace the word “Time” with the word “Information” and the statement suggests that Information is a double-edged sword. It represents enormous potential benefits as well as dangers, perhaps not yet fully understood.

The objective in this paper is to present a C2 process model, which can be the basis for analysis of IW on several levels, and to develop strategy to manage the potential rewards of the information society for the benefit of all nations.

The C2 process as the IW battlespace

The OODA loop (observe, orient, decide, act) is a useful paradigm for the analysis of decision-making and planning activities like C2. However, we intend to develop the cognitive hierarchy further and integrate considerations of human-machine interaction and assessment/planning activities more explicitly. The cognitive hierarchy is a pyramid, starting at the bottom with data pertaining to the real-world and ending at the top with broad cultural aspects (Figure 1). The data becomes information when processed using existing knowledge. In turn, it adds to our store of current knowledge. The synthesis of knowledge enhances our understanding of the world in which we live, enabling us to make effective decisions. The ability to manage our environment by making effective decisions leads to a global understanding of broader and more sophisticated relationships which could influence and be directed by the culture in which they occur. Similar are the hierarchies in other disciplines such as Decision Support Systems (DSS) and large Management Information Systems (MIS).

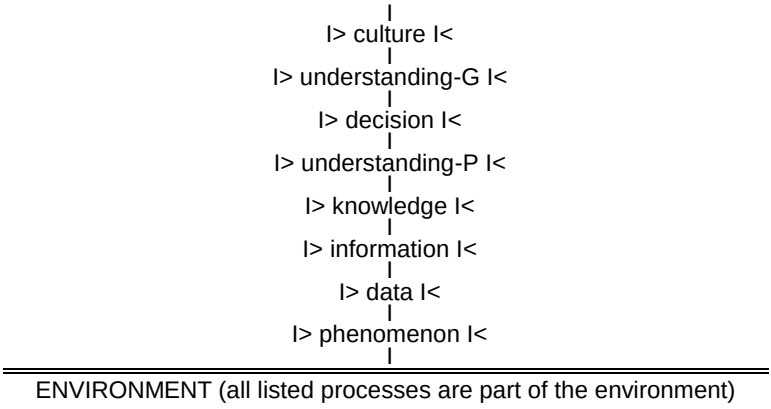

Figure 1: Refined cognitive hierarchy in C2 context
(I> - attack, I< - protection, I - conversion).

The elements of the hierarchy from data to Global understanding can be machine aided, in some cases, machine executed. In fact, some human decisions are made based on the bottom and top levels alone, without formal analysis or process in between. Accepting the fact that the cultural level will always influence decision-making to some extent, it is important to establish a balance between analytical and intuitive processes and between human and machine contributions.

We prefer a variation of the OODA model, which is closer to the military concept of C2 – the OAPE loop Observation, Assessment, Planning, Execution[1]. Observation produces Data. Assessment and Planning occur at every level in which the generalization of knowledge and understanding increase, up to the cultural level. Moreover, IW measures, Attack and Protect, are possible at every level.

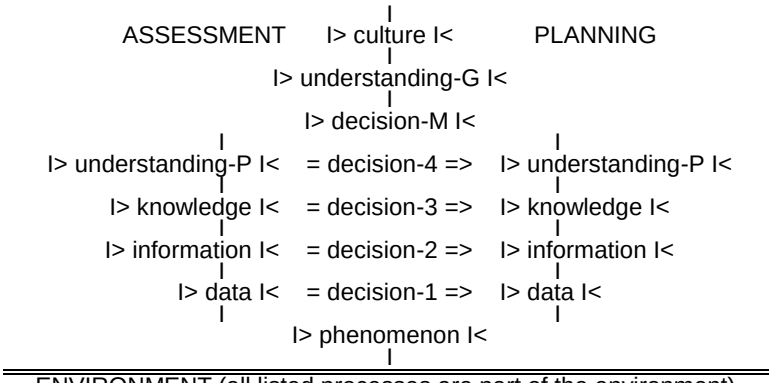

Figure 2: Refined cognitive hierarchy and OODA loop in C2 context
(I> - attack, I< - protection, I - conversion, =decision-?=> - short loop decision, maybe made without direct/real-time involvement of the human being).

The model suggests that planning can (sometimes must) be based on whatever level of assessment is available. To have a global understanding of all the factors influencing a situation before planning and executing is a luxury, which almost never exists in crisis or war. Figure 2 also shows that culture is outside the loop, but nevertheless plays a role in the larger loop of decisions. This model is more appropriate for the consideration of the balance between the Assessment and Planning branches and the Culture level.

Down the center of the figure are the different types of decisions based on data, information, and knowledge and understanding respectively. The highest level in the art of decision-making is decision M, based on intuition.

There are several types of challenge implied by this model. These are uncertainty, complexity, speed and scope of change. The way to deal with these challenges is to REDUCE the problem to the lowest level of decision making and to EXPLOIT technologies that enable faster and more precise processing of data and communication of information. A further challenge is to establish a balance between assessment and planning by establishing sufficient certainty to be the basis for planning with the minimum acceptable data set.

There are some results, which emerge from the analysis. One of these findings is that the model is open both at the top and the bottom. At the top, decisions may be made, not based on bottom up analysis, but rather on the historical record of successful decisions made in the past and recorded as understanding of the processes involved. At the bottom, the data used as the basis for decisions only approximates the phenomena occurring in the real world. The collection of data is selective and the process is noisy, i.e. imprecise. Moreover, it is unrealistic to think of automating the entire process. The correct balance between human judgment and machine decision-making is essential to achieve.

Machine implementation of the OODA loop is approximated by the middle four decision levels in our cognitive hierarchy. There may be many passes through these levels before the levels outside the loop at the top and bottom come into play. Ultimately, binding decisions are made at these external levels and retained as understanding (Genotypic) for future use.

The lower levels in the hierarchy are designed and maintained by the higher level functions. Specifically, the higher levels control and manage the allowable level of uncertainty from the lower levels. To do this, the higher levels use a type of meta-knowledge about the lower processes. Moreover, a certain amount of training and exploitation of appropriate technology is needed. To illustrate, consider a radar parameter collection system, which performs statistical analysis of the radar environment, maintains the existing data base and re-programs systems that identify radars without human intervention. These low-level functions are only possible because a higher level with more sophisticated understanding performed a detailed design and implementation task.

Lower level processes are not free-running for very long. Monitoring is required. This occurs at the decision-M level in the hierarchy where understanding-G constraints and controls are applied.

Several lower level processes in the hierarchy run concurrently. Results of these processes are aggregated and passed to the next higher level. Evaluation at each level is critical to the success of the global process. Uncertainty and errors at

lower levels can have a multiplier effect and cause cataclysmic results when higher level decisions are applied.

A final pitfall to be mentioned is that the requirements for the output at each level must be correctly determined and clearly stated. Otherwise, the right decision could be made for the wrong problem. For example, when an Operations Analysis study of the USAF C5 transport was done, its performance was found to be inferior to that of the existing C-141. This is impossible, because the C5 is a manifestly superior aircraft. The reason for the false conclusion is that it was assumed that the C5 would fly the same routes and make the same refueling stops as the C-141. When the framework of the study was corrected, the results were as expected and the C5 superiority became clear.

Definition of command and control (C2) and information warfare (IW)

Having described the cognitive hierarchy, which is the basis for our study, we are in a position to state definitions of the core concepts:

C2 is the set of processes used to assess the environment, make decisions based on this assessment (guided by culture) and to plan/direct activity to influence the environment according to these decisions.

IW is the application of superior methods to develop information from data and decisions from understanding in order to degrade the adversaries attempt to develop understanding from information.

Information strategy to cope with challenges of IW

In order to discuss strategies[3], we need to develop some subordinate concepts, essential for understanding IW activities.

The *Goals of IW* are to process data more efficiently and to make effective decisions at the highest level, while degrading the capabilities of the adversary to develop understanding and to use it as the basis for good decisions. Data is only noise in the absence of knowledge, so careful study of allies and adversaries alike is a pre-condition for effective application of IW methods.

The *IW adversary* is any agent who attempts to degrade our decision making by attacking our collection, movement, storage and/or use of data to generate information and to develop understanding as the basis for decision making.

Allies are any agents with whom we have a common understanding (Phenotypic and Genotypic) to a certain extent. Nurturing a common understanding with as many potential agents as possible makes allies of strangers and is a deterrent and

preventive measure to IW. For example, there are two NATO members on the Southern Flank with very different cultures and perceptions of the world. Indeed, there has been open conflict between these nations in the past. A common perception of the threat has become part of the national consciousness of these two nations and has enabled them to cooperate as members of the defensive alliance. Their understanding has something in common and it has been absorbed into their respective cultures.

IW tasks are the *collection, movement and storage* of data and its *use* to develop information and understanding. *IW procedures* are used to carry out these tasks. For example, an airborne platform with wideband and frequency selective receivers *collects* radar parametric data. The parametric data is downlinked (*moved*) to a ground processing station where it is *stored* in a data base after pre-processing. Eventually, it is used to generate a radar classification algorithm which is used in an aircraft defensive system. All this activity is performed according to a set of certain rules.

IW tools are the technologies and systems, organized in a *IW force* element used to carry out IW tasks. Each of the tasks could be carried out by a large number of different systems depending on availability and/or the specific requirements of the task. For example, the electromagnetic environment could be sampled by systems in an aircraft, satellite receivers, a fixed ground station or a suitcase transportable receiver.

The *IW Concept of Operation* consists of forces, systems and established procedures used to carry out IW tasks or to implement attack and/or protect measures at any level in the cognitive hierarchy.

Conclusions

It is possible to imagine that, in the information age, nations can advance upward in the cognitive hierarchy to a more common genotypic understanding and an increased level of cultural commonality. If this occurs, the perceived reasons for armed conflict will diminish or disappear.

To promote this more-nearly-ideal world, one of the key efforts must be in Research and Development / Education and Training which promote interactive connectivity between nations and agents within nations. This will result in more widely shared core values and less reason for conflict. A second prerequisite will be timely and reliable international early warning and rapid reaction capability subject to international controls and discipline.[5]

Among the trends that could facilitate greater international understanding is the increase of commercial-off-the-shelf (COTS) components which make interoperability easier to achieve. Another is the emergence of international certification programs in fields critical to Information processing and dissemination. This trend will enable shared information assurance and less opportunity for misunderstanding leading to conflict.

There are now other participants in Information Operations Other Than War (IOOTW). The emergence of Non Governmental Organizations (NGO's) is a very positive element in the progress toward common understanding. NGO's are taking their places alongside national representatives in discussions of issues of global importance. Since they are inherently international in orientation, this can only be a positive development. The fact that the world's money markets are now virtually integrated is another positive development. No nation or business entity can afford to be ignorant or misinformed about understanding and cultural orientations in other nations.

Our purpose in this paper has been to portray Information Warfare and Information Operations as an opportunity rather than as a threat. It is a fact that the information revolution is changing the course of history. It may be that, instead of using information as a destructive tool, we will be able to use it to promote common understanding among nations. If that is the case, we may be seeing the beginning of a golden age of harmony and prosperity. Instead of preparing for conflict, we can actively promote a peace based on common perceptions of goals and mutual aspirations.

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