19th ICCRTS

"Enterprises as Inquiring Systems with Implications for Information Warfare"
Paper #031

Topics:
1: Concepts, Theory, and Policy
2: Organizational Concepts and Approaches
3: Data, Information and Knowledge

Corresponding author:
Gregory A. Miller
Naval Postgraduate School
Systems Engineering Department
777 Dyer Rd.
Monterey, CA 93943
(831) 656-2957
gamiller@nps.edu

Ronald E. Giachetti
Naval Postgraduate School
Systems Engineering Department
regiache@nps.edu

Abstract
This paper incorporates what is termed an inquiry model into a model of information warfare. An inquiry model describes an organization's belief system, often unarticulated, about how they process information and make decisions. The paper takes the position that different organizations have different inquiry systems, and effective information warfare operations requires one to tailor actions to exploit the adversary's inquiry system. Different inquiry systems are vulnerable to different types of misinformation or actions. Moreover, information warfare actions that are effective against one type of inquiry system may not be effective against another. The paper contributes to the literature on information warfare by describing a means to incorporate the adversary's worldview into the analysis of what is effective. The paper describes the model and discusses its application to information warfare.

1 Introduction and Background

The primary role of military command and control (C2) is to decide on a course of action that will best achieve a unit's mission. That decision is based on information at hand, knowledge of the unit's goal, and a comparison of several alternative actions. One way to degrade an adversary's C2 is via information warfare.

Information warfare seeks to corrupt a competing enterprise's knowledge-creation and decision-making. It is about encouraging incongruency: inconsistencies between an enterprise's decisions and its goals. Misalignment may not guarantee failure, but it makes success much more difficult.

Organizations and the people in them have worldviews or *Weltanschuuang* that describe how they perceive and process information about the world around them. The worldview shapes how they design their command and control processes, how they operate them, and how they make decisions. Understanding the worldview of your adversary should inform how you conduct information warfare operations. Knowing how your adversary processes information, interprets information, and makes decisions is important knowledge that can be used to create vulnerabilities and exploit them while conducting information warfare.

This paper looks at inquiry models as a description of an organization's worldview. We incorporate inquiry models into the Dynamic Model for Situated Cognition (DMSC) to explain command and control. Recommendations for tailoring information operations for each inquiry system are presented. Finally, a case study demonstrates the utility of the approach.

2 Inquiry System Models

In 1973, Mitroff and Turoff suggested applying C. West Churchman's characterization of Western epistemology, which was born in the tradition of the philosophy of science, in the business world [Mitroff & Turoff 1973]. They contend that every company is an inquiry system: a set of interrelated components for producing knowledge on a problem or issue of importance. That is, like an individual, a team or group gathers information, processes that information by transforming raw data into knowledge for action, and checking the validity of the inputs, the outputs, and the processing itself. Every inquiry system has four main components, shown in Figure 1. They are the inputs, an operator, the outputs, and the guarantor.

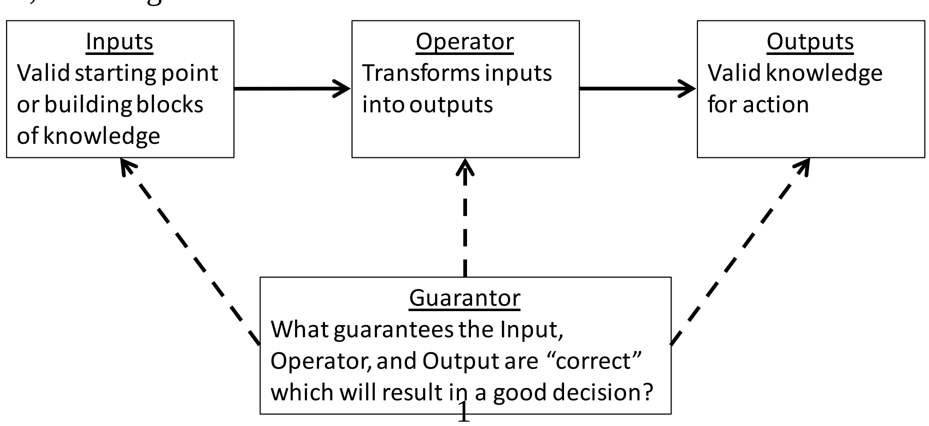

Figure 1. An inquiry system, from Mitroff & Linstone [1993, 31]

The inputs are the raw data from the outside world. They are not just any data or all the data, but are those entities that a particular inquiry system recognizes as valid. The inputs that one inquiry system deems legitimate are not necessarily recognized by others [Mitroff & Linstone 1993]. This is more than just differentiating between what is relevant to the issue at hand and what is not. It is not the result of filtering all raw data, but recognition of what *is* data. The definition of valid data is determined by the guarantor – the philosophical foundations for acceptable knowledge creation.

The operator is the mechanism that transforms the valid input into knowledge. It could be arithmetic functions, formal logic, or more complicated algorithms or heuristics [Mitroff & Turoff 1973]. Other rules might be specified, like time duration, type of feedback, and number of parties involved.

The output is what the system regards as valid knowledge. It could be the numeric result of an arithmetic operation or a verbal recommendation. The distinction between process (operator) and its result (output) is not surprising, but will take on some importance in the discussion of the role of the guarantor.

The most critical part of this system is the guarantor. It specifies what legitimate input data is, what particular operator is acceptable, and what kind of output is regarded as knowledge [Mitroff & Linstone 1993]. In some instances, direction for the operator could include who or what does the processing. One can see the criticality of the guarantor because it is not just a "traffic cop" directing flow, but the executive that makes the most basic determinations about everything in the system. Discussions about the validity of an inquiry system are really about its guarantor. It defines the most basic precepts like objectivity, expertise or experience, measures of performance, formality of problem statement, nature of the output, intended consumers of the output and what types of problems are best suited for it [Mitroff & Linstone 1993]. It always exists, but is generally not explicitly considered. For an enterprise, it is the result of that enterprise's culture and the personal philosophy of the people making decisions.

There are only a few inquiry systems that can be observed. Their labels come from the European philosophers whose epistemology they most closely resemble.

2.1 Lockian Model

The Lockian model bases reasoning on experiment and consensus. Empirical information is gathered from external observations and used inductively to construct a representation of the world. The inputs are elementary observations. The process is assigning labels to those inputs and communicating about their relationships. The output is a taxonomy or a general rule set describing the relationships. It is also capable of self-reflection and backward tracing of labels to the most elementary inputs. Agreement and consensus on the labels and taxonomy form the guarantor. This inquiry system can be called Inductive-Consensual because it attempts to infer a general conclusion based on particular observations and then seek agreement on both the observations and induction [Mitroff & Linstone 1993]. An example is the Delphi method. In Delphi, several subject matter experts participate by making observations that appear relevant to the issue at hand, and make a decision or prediction. The individual results are presented to the group, and another round ensues. In most instances, all participants start to approach one answer, thus achieving consensus. There are several assumptions here. First, that observations are all objective and that the result (truth) is singular (also objective). The truth content is associated with empirical content; data justifies theory [Mitroff & Turoff 1973].

2.2 Leibnizian Model

A Leibnizian inquirer is a closed system based on elementary axioms that are used with formal logic to generate more general information. The generalization is based on new hypotheses extending the axioms. Once a new hypothesis is shown to be consistent with the entire set of axioms through logic tests, it is also accepted as truth. The output is a set of fact-nets and new truths. The guarantor is internal consistency and comprehensiveness of generated facts. If the correct set of axioms is chosen and the correct logical equations are applied, success is guaranteed. Theory comes before data (not the other way around as in the Lockian system). Logic, reasoning and mathematics are more important than empirical observations. This inquiry system can be called Analytic-Deductive [Mitroff & Linstone 1993]. Unlike the Lockian system, theory precedes observation. Like Lockian, it provides a singular result. This approach is very common. Einstein's thought experiments and Euclid's geometry are examples of its power and universality. Virtually every decision-support methodology seeks to reduce all problems to a formula or recipe that represents human values as weighted utility scores. In many cases, observations are replaced with a model (logic and math generate "data inputs"). This system is mechanistic and reductionist, but applied in almost all decisions because it is considered "objective" and logic is "better" than intuition.

2.3 Kantian Model

The Kantian system is something of a mixture of Leibnizian and Lockian. The system is open, like that of Lockian. It generates hypotheses on the basis of inputs received. The unique feature of the Kantian system is that the theoretic aspect allows an input to be interpreted in different ways. Alternative world views (alternative axioms and logic) are maintained. The fact nets generated are tested against which is the "best fit" for the data. The guarantor is the degree of model-data agreement. There is feedback implied here, as well. That is, a new theory will inform what is "relevant" data input. It seeks to prove or disprove alternative fact nets by gathering new observations that were not made on the first pass. If a model is not producing satisfying results, it can be discarded or modified. General theories are built up from data, but data collection presumes some theory. The truth content is thus located in both its empirical and theoretical components [Mitroff & Turoff 1973]. The guarantor is the fit between fact-theory net models and data collected based on those theories. This can be called the Multiple-Realities inquiry system because several different models (theory-axiom sets) can be compared to data; there is not *one* way to define a problem [Mitroff & Linstone 1993]. An example is when the decision-maker is an active participant in the inquiry process and he does not apply purely formalized mathematics in his approach. To really be useful, uncertainty is embraced, many different world-views and approaches are considered, many channels of information are used, and the results are presented with the underlying assumptions built in ("if we accept the problem really is X and assume A and B, then approach Z would be good enough, but not always optimum").

2.4 Hegelian Model

The Hegelian system is like the Kantian in that there is more than one theory or model. What is does differently is to gain knowledge through the conflict of ideas. The operator is the process of one player constructing a thesis while another constructs the antithesis. Both seek supporting data and theories then present their positions to a neutral player who can form a "bigger" view of the problem itself before seeking a solution. The guarantor is conflict (why this inquiry system is also called Dialectic) and the resulting synthesis. The role of data is to help uncover "intense differences in the background assumptions between two or more divergent positions" [Mitroff & Linstone 1993, 74]. It is good for surfacing issues for management. However, a strong-willed senior decision-maker must be able to force opposing sides avoid becoming entrenched in their positions. A good example is the use of Red Teams and Blue Teams in war-gaming. If both sides are truly free to maximize the resources of the role they play and minimize their adversary's advantages, new strategies and tactics can result. An example of entrenchment would be deadlocked negotiations between organized labor and management or even a legislature with an even mix of two opposing political parties.

2.5 Singerian Model

Finally, the Singerian system is based on two premises. First, it requires the establishment of standards of measure that specify conflict resolution within a community. The measure of performance reflects the degree to which differences of opinion can be resolved. A key feature of the measuring system is that it can replicate results consistently. The second premise is the strategy of agreement. When models fail to explain a phenomenon to the satisfaction of different members of a community (because they have different educations and experiences), new variables and theories are swept in to provide guidance and overcome inconsistencies. However, the initial disagreement is valued and even encouraged. This promotes sharing different perspectives and open discussion of their capabilities and limitations because each perspective "reveals insights about a problem that are not obtainable in principle from the others" [Mitroff & Linstone 1993, 98]. This is why this inquiry system is also called Multiple Realities. Its foundation is acknowledged interdependence of the participants. Some sub-teams on the Apollo space program used this approach to present the problems they were facing in different representations. It was through examination and comparison of conflicting models that they progressed [Mitroff & Linstone 1993]. Systems thinking and holism are accepted. This system requires a multidisciplinary team that recognizes value in the seemingly valueless (not everything is about what one group deems important) and can identify when nontraditional and anti-reductionist approaches fit best. Unfortunately, this inquiry system assumes participants have high intellectual maturity, exercise great tolerance and are open-minded. It also assumes an almost child-like innocence and optimism that we can all just get along and drive the community forward. The real power is the integration of social and technical aspects of an issue, promoting viewing the world as an interconnected whole.

2.6 Inquiry System Model Summary

The real issue is whether the philosophical system of inquiry that underlies information-processing is sound and appropriate for the situation at hand. The structured approaches of Lockian and Leibnizian systems will not work with unstructured problems. Similarly, it would be inefficient and unnecessarily complicated to apply Kant or Hegel to a well-structured problem in which there is consensus on the nature of the problem and how to judge a singular solution. The character and culture of the enterprise are strong influences, as well. It would take a strong, but open-minded decision-maker to take full advantage of a Hegelian system. And, one would not want to use a Singerian approach with a group composed of people from a single profession. Further, categorizing an enterprise based on its inquiry system helps one understand the deeper workings behind its decision-making like what input data is relevant, the basis and rigor of making sense of that data, the nature of output knowledge created, and how the system exercises quality checks to assure itself of the validity of its new knowledge.

3 Enterprises and Decision Making

"Decision making is the process of making decisions and includes the activities to identify problems, understand the problem, generate alternatives, and select the best alternative" [Giachetti 2010, 357]. Enterprise design requires designing the organization decision process. This includes developing means to gather information on which decisions will be based, designating the person or position with the authority to make what kind of decision, and establishing policies on how decisions will be made [Giachetti 2010]. Comparing this to the general inquiry system model indicates the gathered information is the input, the result of a decision is the output, and process with policies and decision-authority assignment compose both the process and guarantor, respectively.

Considerations for who makes decisions can revolve around centralization. In a military operation, traditionally, emphasis is placed on centralized direction (and decision-making) with decentralized execution. Network-centric principles run counter to that because of the tenets of ubiquitous access to appropriate information and shared commander's intent. This allows decision-making at the edge of an organization, making it better suited for those situations requiring agile responses. The environment and the enterprise culture influence determination of centralization for decision authority. Environments in which change is slow, non-routine decisions only involve strategic direction and external information is readily available are a good fit for a centralized decider. Similarly, in a culture in which too much creativity and a "flat" organizational structure are considered counter to consistency and quality of the enterprise's product, high centralization would be better. Edge-empowered or decentralized decision-making works better in fast-changing and unpredictable environments and in organizations that value creativity and independence of their smaller business units.

Processes for decision-making can be very precise and didactic, establishing simple rules for routine decisions. They can be more complicated for non-routine decisions. In those cases, the emphasis is not placed on the decision itself or the conditions driving a simple choice among few allowed options. Rather, the focus is about who in the organization should be involved, how (or if) consensus should be reached, and the time limits on which a decision must be reached. The rules may be formal and well-documented or completely unwritten [Giachetti 2010]. The type of problem at hand should help an enterprise engineer with these kinds of issues. For well-defined problems which require a singular answer, the Lockian or Leibnizian approach is best. These are problems in which the result can be obtained through formula or simple algorithm. When relevant data is easily obtainable, it is a case for Locke. When we must rely on modeling and simulation, we look to Leibniz. However, most enterprise problems are messes or "wicked problems." Reductionist and mechanistic approaches will not work. The inherent ambiguity and uncertainty of the problem itself and how we would judge the efficacy of a solution mean search for clarity and precision lead us further from the answer. In those cases, a Kantian or Singerian approach is best. But, again, the culture of the enterprise itself must be considered in process design.

And, that leaves the issue of information – the 'right' information is necessary to make informed decisions. How does one decide what is 'right' based on quantity, quality, and timeliness? Additionally, information flows via information technology, which means it must be designed to be congruent with the decision-making organization and process [Giachetti 2010]. Further, reliance on automated decision aids espoused by proponents of net-centricitiy means there is both a technical and social aspect. Enterprises, after all, are socio-technical systems by definition.

4 Information Warfare with Socio-Technical Considerations

Enterprise design to support good decision-making is well understood. However, there has been little said about applying enterprise concepts in information warfare. This is somewhat unexpected because the U.S. Department of Defense official definition of information operations explicitly includes socio-technical aspects. According to Joint Publication 3-13 *Information Operations*, information operations is defined as the "integrated employment of the core capabilities of electronic warfare, computer network operations, psychological operations, military deception, and operations security, in concert with specified supporting and related capabilities, to influence, disrupt, corrupt or usurp adversarial human and automated decision making" [Joint Pub 3-13 2006, GL-9]. There are a few key points about information operations here:

- They apply across the spectrum of adversarial relationships, from competition to full-scale conflict.
- They focus on adversaries' socio-technical military enterprise.
- Their purpose is explicitly to influence or hinder decision-making.[1]

[1] The definition was revised in the 2012 version of JP 3-13: "integrated employment, during military operations, of information-related capabilities in concert with other lines of operation to influence, disrupt, corrupt, or usurp the decision-making of adversaries and potential adversaries while protecting our own" [Joint Pub 3-13 2012, GL-3]. In the authors' opinion, the 2006 definition is superior because it explicitly includes technical and social aspects of operations. The change does not materially affect this paper.

Figure 2 shows the 2007 extension of the Dynamic Model for Situated Cognition (DMSC) [Miller & Shattuck 2004; Miller *et al*. 2007]. The center oval, labeled number 1, is the ground truth in the battlespace. The left side shows the red forces' collection of data and interpretation of that data, and the right side does the same for the blue forces. A technological system for data collection consisting of sensors and other technologies will collect an imperfect subset of the actual data (Oval 2). It will be imperfect in that it will be incomplete and there will be inaccuracies due to technical limitations, environmental conditions, or activities by the adversary to defeat the data collection. The collected data is processed by C2 support systems (Oval 3) and leads to a further reduction in quantity and possibly quality. At this point, the information is processed by the decision makers (Oval 4-6). The bounded rationality [Simon 1991] of human decision making along with cognitive biases,

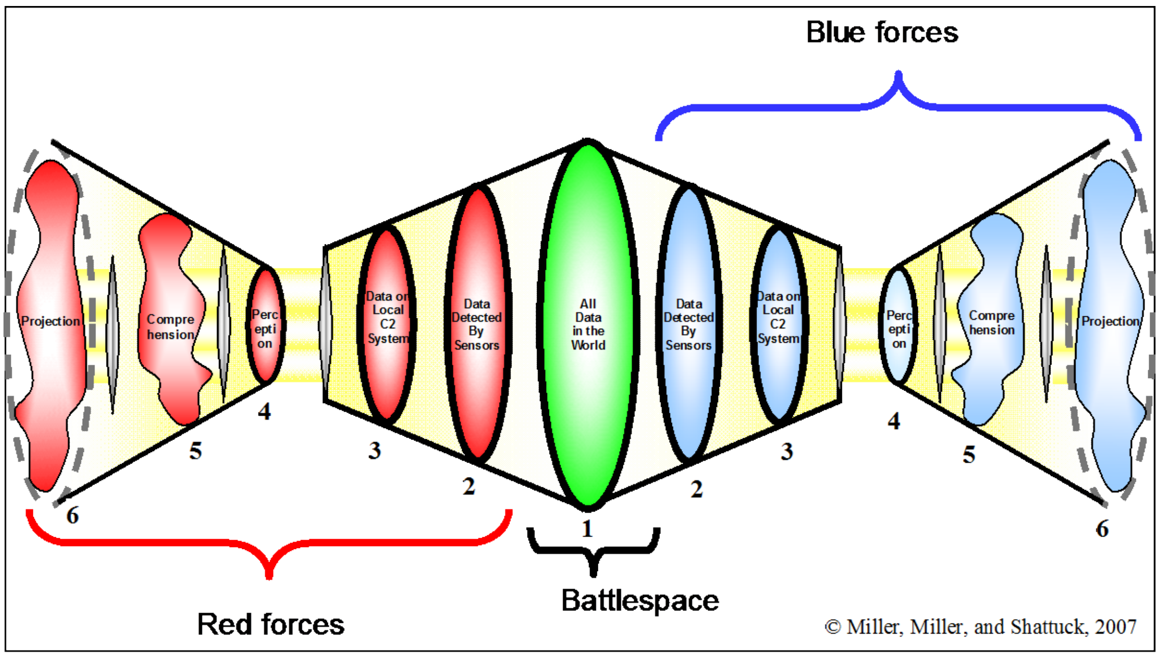

Figure 2. DMSC including Blue and Red forces [Miller, et al. 2007]

It is important to note that Oval 1, Ground Truth, is the actual battlespace and forms the one common element in the center of this extended model. This is the true physical domain of conflict in which traditional forces engage each other. Additionally, Red force decisions are implemented through the feedback control he exerts on his own forces, sensors and networks. A decision maker's actions include providing direction to his own physical forces and management of his own sensor and network resources. Of course, other feedback includes adjustments to his OPORD and local doctrine. He also seeks to reduce distortions of his lenses and make his own forces more effective.

If we have specifically included the comprehension and perception of the Red forces, the next logical step is to include offensive information operations (IO) against him. The goal is to reduce the enemy's ability to gather and manage valid information he seeks about the battlespace and make decisions based on that information that will influence the outcome of the total conflict. Arrows were included in the model to represent offensive actions as shown in Figure 3. The arrows do not represent specific means to affect the flow of information, but the influence of the action on the content of the affected ovals.

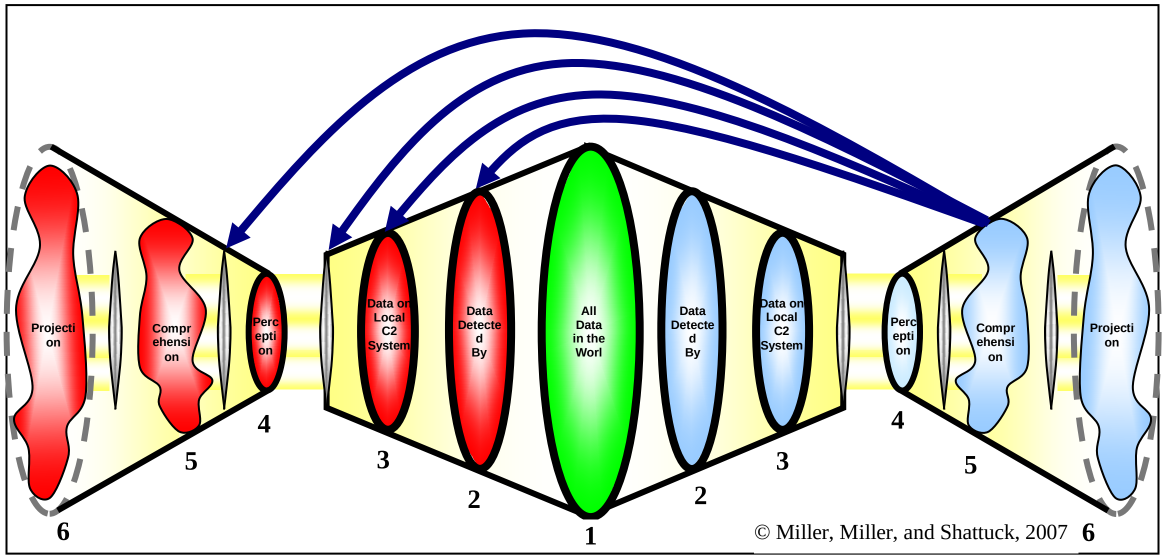

Figure 3. Offensive information operations [Miller, et al. 2007]

Counter-sensor warfare is aimed primarily at degrading the quality and quantity of information at Oval 2. It includes classic electronic warfare such as jamming intended to deny the proper operation of sensors and deception intended to introduce false signatures. The common element here is an attempt at reducing the quality of data detected by technological systems. As such, one would expect actions to be technologically-centered vice human-centered. Similarly, electronic warfare aimed at disrupting communication links and networks degrades the quantity and quality of information available at Oval 3. That is, the information gathered by the sensors (Oval 2) is made available to human operators, and Blue forces want to impact that process. The value of representing both Oval 2 and Oval 3 in this context allows the designer of a complete information campaign to consider the potential interaction between the two. However, one should not try to separate IO planning elements from the overall operational plan. If Blue introduces false signals and decoys, he would want that to propagate to Oval 3 while not allowing the propagation of information in Oval 2 that might reduce the effectiveness of such deception [Miller, *et al*. 2007]. And, of course, we include operations aimed at Red force lenses of doctrine and OPORDS to introduce distortions in perception and comprehension (also explicitly included in Figure 3). The entire spectrum of deception, psychological operations, and all means to impact human-centered aspects of cognition can be mapped into this model [Miller, *et al*. 2007]. It should be noted the discussion has mentioned specific mechanism to introduce invalid information, but the model is intended to be solution-neutral. Those specifics were included as exemplars only. More detail on the ramifications and application of the extended DMSC (such as counter-communication activity, measures of effectiveness, decentralized operations, and target nomination) are available in the original work [Miller, *et al*. 2007].

Information operations are part of a larger campaign or strategy. Therefore, operations against decision-makers should be congruent with other actions, and considerations for effects-based planning and execution are necessary. This also means we should think about tactical versus strategic decision-making. Executing offensive information operations at the strategic level must be consistent with and supportive of similar operations at the tactical level. In some instances, it may be hard (or even counterproductive) to draw a distinct line between the levels. This closes the loop on congruency within an enterprise. Introducing incongruency into an adversary's enterprise decision-making requires congruency of one's own information operations.

5 Implications Based on Inquiry System Models

An effective information operations campaign must be tailored for the targeted decision-maker. In our case, that decision-maker is an adversary's command and control enterprise. Modeling such an enterprise as one of Mitroff's inquiry systems should lead to some insights into what kinds of operations would be effective based on an understanding of the capabilities and limitations of each. We should not just "throw" misinformation at an opposition's sensors or obscure everything from their view. Instead, we must determine which inquiry system is most like the targeted enterprise. Then, we can decide what misinformation the guarantor will recognize as valid and be processed in such a way to achieve our goal. Of course, we should assume the inquiry system and enterprise design are consistent with each other. If that were not the case, and an adversary is trying to make decisions with an organization or with processes not designed to support each other in the context of its environment and organizational culture, it is likely to make bad decisions on its own, obviating the need for information warfare.

5.1 Operations against a Lockian system

First, the Lockian system is based on experiment and consensus. The participants are successful if they reach consensus on observations and the implications of those observations. If the goal is to slow or confound decision-making, presentation of different and inconsistent data would be effective. The participants would be presented with different views of ground truth and then reach their own conclusions based on those views. However, they would be unable to reach consensus simply because each sees a different world and it would be very difficult for them to resolve the differences, if at all. If the goal is to obscure ground truth or to misrepresent reality, the participants must be presented with the same input data (other than ground truth) via different channels and that data must be consistent within itself. The belief in empiricism to uncover truth backfires – their senses deceive them. If the decision-makers are geographically dispersed, we should consider technical aspects of the enterprise – the communication infrastructure that connects the dispersed nodes. Interrupting those lines of communication would have a deleterious effect. Without communication, consensus cannot be reached.

5.2 Operations against a Leibnizian system

The Leibnizian system is based on elementary axioms and formal logic. Introducing any input is difficult. Instead, one can seek to provide information that would call into question the logic itself or disprove the models on which predictions and comparisons are made. One could also take advantage of the reliance on and confidence in those models.

This is one instance in which a purely technical approach seems acceptable. Modifying a computer-based model to provide erroneous or misleading output is possible. The Leibnizians are so confident in the logic of their models and distrustful of empirical data, they may not question that output. Resulting decisions would cause them to commit any number of tactical or operational errors. A Leibnizian system is heavily reliant on standard operating procedures and formal doctrine. Given a particular condition or trigger will automatically result in the appropriate programmed response. This means one can elicit a response that may be counter to the enterprise's goals, if the standard procedures are known.

5.3 Operations against a Kantian system

With a Kantian system, care must be taken to present input data that is consistent with the theory and axioms already accepted. Confirmation bias can work for us here. That is, people believe what they want to believe – to see data that confirms what they already suspect. From a technical perspective, they believe what their sensors are presenting to them to be an absolutely correct representation of ground truth if it confirms a pre-existing concept or prediction. The built-in "if this, then that" statements that form the output can be leveraged if the "this" part must be believed, even if it is not correct. The results of actions taken and decisions made are also monitored closely by a Kantian system: outcomes form part of the data input of a new cycle of decision-making. Therefore, the results as captured by his sensors and as communicated between the participants may also require manipulation to ensure the original decision is not called into question.

5.4 Operations against a Hegelian system

The Hegelian system can be confounded if the opposing sides within the targeted enterprise take up the wrong issue or approach it from incorrect perspectives. The issues uncovered by the opposition and explored through the resulting conflict would be irrelevant to the true issues at hand. The trick, then, is to present information that appears to be relevant and allows opposition positions to form with some support for each. The resulting decisions would be ineffective because the conflict-generated knowledge would have little to do with the actual truth of the situation. We could also use the technical aspect of the enterprise to isolate the executive by disrupting his communication channels. This might leave opposing parties entrenched. It would be like a legislative body hopelessly deadlocked, unable to reach a clear majority and without a strong leader to break the tie. No decision could be reached in a timely manner.

5.5 Operations against a Singerian system

A Singerian system presents more of a challenge. The organic ability to consider many different perspectives to determine valid input means that misinformation would be identified as such quickly and obscuring truthful data would be almost impossible in the long run. In the short term, decisions can be delayed if we can present misinformation at a rate or volume that result in "analysis paralysis" on the part of the decision-makers. There could be so many different perspectives to consider that it takes too long to analyze each one. A decision is deferred past the time at which action is required. Still, the Singerian system would be resistant to such a situation over a longer time interval. Mechanisms other than introducing misinformation or misinformation-overload would be more effective. The pre-requisite for trust relationships among the participants makes them somewhat vulnerable. The foundation of acknowledged interdependence itself should be targeted. If one can introduce reasons for the participants to distrust each other, the system will fail to produce good decisions. They spend time second-guessing each other, looking for hidden motives, trying to identify traitors that may or may not exist. The optimism and open-mindedness devolves into distrust and hoarding valuable information or perspectives. If a cascading failure can be induced, the enterprise ceases to be functionally viable.

5.6 Operations summary

The above discussion focused mostly on IT and automated decision support systems (the technical side of a socio-technical system) where it was necessary to explicitly consider the channels of introducing misinformation, defer the receipt of valid information, or to interrupt information flow between participants. The human aspects of decision-making really form the basis of the inquiry systems models, and it is those aspects the authors were seeking to explore.

6 Illustrative Example

As a short example, we examine the case of Operation Bodyguard, the denial and deception operations designed to support Operation Overlord, the Allied invasion of Normandy in World War II (our description of the intelligence operations leading up to the invasion of Normandy is based on Holt [2004], Dunnigan & Nofi [1995], Lloyd [1997], and Eldridge [1990]). Operation Bodyguard was actually a series of related operations. The larger elements were Operation Fortitude North, intended to convince the Germans that major land operations would begin in late spring of 1944 in Norway, and Operation Fortitude South, intended to indicate a minor operation would take place at Pas-de-Calais in France with any activity at Normandy being a feint. The details of all the activity in support of these operations is beyond the scope of this paper, so a very brief summary is provided.

To deceive the Germans that a landing in Norway was imminent, a fictitious landing force was “stood up” around British General Andrew Thorne in Edinburgh, Stirling and Dundee in Scotland. A small group of radio specialists at the three locations transmitted radio messages that indicated the buildup, movement and training of the troops. Newspapers and the BBC carried stories about sporting events between the fictitious units and even marriage engagements between local women and soldiers. Dummy landing craft on the east Scottish coast were put into place in full view of reconnaissance aircraft. Double agents reported the arrival of a Soviet officer to coordinate Red Army operations in support of the Norway landing. And Air Vice-Marshal Thornton paid a visit to his old acquaintance, the Commander-in-Chief of the Swedish Air Force, to ostensibly secure some support (recall that Sweden was officially neutral during the war) just so that German agents would report his activity there. The result of the combination of these different, but complementary pieces of information, presented via different venues, resulted in the Germans believing the major Allied land operations would commence in Norway and they kept over 300,000 troops there through the summer of 1944.

In the south, a similar tactic was employed: the fictitious First US Army Group (FUSAG) was established under US General George Patton, with imaginary units in Essex and Kent whose landing was to be at Calais. The same false radio activity and newspaper reporting of local marriage engagements used in Scotland were repeated here. Armored vehicles and aircraft made of plywood or inflatable rubber were presented for aerial reconnaissance (and even moved around overnight). Additionally, on the night before the actual invasion at Normandy in early June, Royal Air Force aircraft flew at low altitude across the English Channel and deployed a series of chaff clouds in precise patterns. German radar operators detected the clouds and identified them as large surface targets – amphibious ships moving toward Calais. At about the same time, half-life-size dummy paratroopers were dropped in the fields nearby along with noise-makers simulating small-arms fire. The result was not only that the German forces were prepared for a landing at the wrong location; they were kept there, away from the real fighting, for weeks after the actual Normandy landing.

The German Army staff can be considered a Kantian inquirer because it received inputs (and actively sought new inputs) to generate hypotheses on the basis of those inputs. Additionally, unlike the Lockean inquirer, the German approach sought multiple, different interpretations via different intelligence analysts examining different inputs. This is characteristic of the Kantian inquirer system. The theoretical component of a Kantian inquirer allows different alternative models of the world, and tests those alternatives to see their fit with the input data. Also, the Kantian inquirer modifies the alternatives to account for any new data. The guarantor is the degree of model-data agreement. The result is a fact net of knowledge resulting from revising and validating models. The means of gathering input data were intercepting and decoding radio message traffic, using aerial photography, monitoring the local media coverage, and even a network of spies or human-based sensors (run by *Abwehr*, German military intelligence). Intelligence analysts and senior officers come to an understanding of the initial data (for instance, a single intercepted radio transmission indicating increased troop activity in Scotland) and propose a reason or model explaining that activity (the Allies are building a force to invade Norway). Based on the model, more input data are sought (can other radio transmissions or aerial photography confirm or deny such a plan). It is the acceptance of more input and testing or revalidating of the models that make such a system strong. The Allied Operations Fortitude North and Fortitude South were quite successful because they presented several different pieces of misinformation over time that were consistent with each other. Erroneous data was presented via different venues (all introduced at Oval 2, data collected by sensors) – radio, air reconnaissance, media and spies. Because there were several different inputs gathered via several kinds of sensors, the Kantian inquirer's model was reinforced: the actual landing at Normandy was a feint.

7 Summary & Conclusions

This paper reviewed Mitroff's inquiry system models in the context of enterprise design and decision-making. Several aspects of enterprise design with regard to organization and information processing in support of decision-making were discussed. A socio-technical model representing adversarial information operations was reviewed. A consideration of the strengths and weaknesses of the inquiry systems led to a discussion of the effectiveness of different methodologies against each. Finally, an illustrative example was presented in which we demonstrated how the attributes of an inquiry system can be exploited with a tailored approach. A key conclusion is that no decision-making enterprise modeled as an inquiry system is immune to information operations. Their weaknesses can be exploited, and their perceived strengths can be used against them. Further, any military command and control organization can be considered an enterprise. People rely on each other and on systems to come to an understanding of a situation, make projections and reach decisions. Therefore, a systems thinking approach that considers the socio-technical aspects of organization, processes, and IT support enables information operations planning and execution.

This paper represents an initial exploration into these topics and how they are related to each other. Further work could include: the detailed aspects of planning and executing information operations tailored to each inquiry system, and modeling and simulating command and control activities with a tool like POW-ER or VDT.

List of References

James F. Dunnigan and Albert A. Nofi. 1995. *Victory and Deceit: Dirty Tricks at War.* William Morrow and Company, Inc.

Wentworth Eldridge. 1990. "Biggest Hoax of the War: Operation FORTITUDE: The Allied Deception Plan that Fooled the Germans about Normandy." *Air Power History,* Volume 37, Number 3, pp 15-22.

Ronald Giachetti. 2010. *Design of Enterprise Systems*. CRC Press.

Thaddeus Holt. 2004. *The Deceivers: Allied Military Deception in the Second World War.* Scribner.

Joint Publication 3-13, *Information Operations*, 2006.

Joint Publication 3-13, *Information Operations*, 2012.

Mark Lloyd. 1997. *The Art of Military Deception.* Leo Cooper.

Gregory Miller, Nita Miller and Larry Shattuck. 2007. "Red Force Interaction in Situated Cognition." *Proceedings of the 12th International Command and Control Research and Technology Symposium*, Newport, RI.

Nita Miller and Larry Shattuck. 2004. "A Process Model of Situated Cognition in Military Command and Control." *Proceedings of the 2004 Command and Control Research and Technology Symposium*, San Diego, CA.

Ian Mitroff and Harold Linstone. 1993. *The Unbounded Mind.* Oxford University Press.

Ian Mitroff and Murray Turoff. 1973, "Technological Forecasting and Assessment: Science and/or Mythology?" *Technological Forecasting and Social Change*, Vol 5.

Herbert Simon. 1991. "Bounded Rationality and Organizational Learning." *Organization Science,* Volume 2, Number 1, pp 125-134.