Influence Net Modeling for Strategic Planning: A Structured Approach to Information Operations

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Introduction

In earlier writings, the authors introduced an approach to investigating the human decision cycle, called *Influence Net* modeling.[1,2,3,4] Benefits of this user-oriented approach have been evidenced through successful operational use by analysts in the intelligence community and senior level decision makers.

More recently, Information Operations staff members have recognized the applicability of Influence Net modeling in their planning and resource allocation cycles. This structured approach accounts for the multi-faceted nature of information operations. It assists analysts and planners in identifying and modeling the societal motivations, military factors and economic and political influences as relevant in specific situations.

Although people may define the term Information Operations (IO) differently, all personnel involved in preparing for such activities agree that traditional planning approaches are insufficient. Successful IO does not depend exclusively on the *capabilities* to conduct missions, which have been the focus of decades of simulation and modeling research and development. Whether focused on affecting an adversary's information and information systems, or defending one's own, successful IO plans require a thorough understanding of the behavior and rationale of decision makers.

In this article we present an overview of key difficulties in planning for IO activities, the structured process afforded through collaborative *Influence Net* modeling, and an example to illustrate how the modeling process implemented through our decision support software tool, **SIAM**, facilitates IO planning.

The next section provides a discussion of the characteristics that make IO decision-making highly complex and difficult to plan. We note that these characteristics apply equally well to other areas of decision making in the 21st century. Subsequent sections introduce readers new to *Influence Net* modeling with a brief discussion of terminology and, through an historical example, how the construction and analysis tools included with our **SIAM** software application facilitate the structured approach. [5]

The Need for Structured IO Planning

As we enter the 21st Century, our world continues to become more interconnected — socially, economically and politically. As a result, US decision makers need to understand underlying motivations of individuals, multi-national organizations and governing bodies. Such motivations lie at the heart of military actions, whether they are the traditional force-on-force campaigns or the increasingly evident terrorist attacks on civilian populations.

At the same time, our ability to forecast events is hindered by increasing uncertainty about our allies, adversaries and third parties. Furthermore, the uncertainty of today's situations is not the only parameter that defines US security concerns. Budget realities also require the national security community to reduce its infrastructure. Combat forces, both the size of US forces as well as the numbers available from our traditional allies, will diminish. Additionally, the planning and intelligence communities are also undergoing a reduction in force. Similar financial constraints upon our allies are reducing the likelihood that "host-country basing" will be available when regional crises arise.

These considerations indicate the need for a structured process for strategic planning. In this context the term "strategic" implies a long-term approach with expected results over a time interval measured in years, rather than months. Furthermore, recent events have shown that advanced military capability, when used in the absence of detailed knowledge of the multi-dimensional decision making process, is not always an effective deterrent. Therefore, strategic planning for improved force structure and technology research and development must be combined with a strategic planning process to understand and influence the decision making process itself. Once the decision process is reasonably understood, the strategic and operational planners must determine complementary courses of action, which map near- and long-term objectives to the implementation of associated tasks and actions.

Such planning requires not only fact-based information gathering of historical and current events for traditional military campaign planning, but also knowledgeable inference of intentions and motivations of key influencing actors. All aspects of this structured process are focused on a single goal — the prevention or containment of instability through long-term application of information operations to influence the motivation and behavior of adversaries, allies and third parties.

In some cases, the planning process examines an individual decision maker who has monolithic power in determining the fate of entire populations. However, in most situations, the decision making process involves a governing body of leaders or, perhaps, the population itself. In such cases, our ability to positively influence the ultimate outcome is determined by the identification of critical events and actors that will have long-term, broad-based effects. There are two sides to these effects:

- Generation of a majority opinion, if not consensus, among the decision makers that agrees with our ultimate goal; and,
- Creation of a split in opinion among the decision makers that completely hinders the opponent's ability to counter our ultimate goal.

The former effect is called a *seam* in the strategic planning process, and the latter is called a *fissure*. Identification of critical seams and fissures is the key to determining an effective strategic information operations plan.

Characteristics of Complex Problems

As illustrated by the example presented in the following sections, *Influence Net* modeling assists in identifying seams and fissures that define an IO problem. Additionally, the construction and analysis tools described below assist the IO planners in determining the optimal courses of action that influence these critical events and actors.

The operational problem faced by IO planning staff, while considerably different than traditional military campaign planning issues, is not unique. Throughout history, analysts from diverse fields of study have employed various methods for analyzing human motivation and behavior. These methods have typically fallen into one of two categories of investigation:

- Seminars, workshops and informal communications that are aimed at extracting subjective, but valid, knowledge from subject matter experts; and,
- Mathematical and computer-based models/simulations that attempt to estimate current and future states of "physics-based" phenomena.

The former category has provided reasonably good results for "one-time-only" issues that are not subject to rapid change. However, the complex issues involved in anticipating human motivation and perception are highly dynamic over short time frames and subject to change from a wide array of possibly conflicting influences.

The second category of investigation has been used quite successfully for traditional logistics and production planning. In these situations, vast amounts of data regarding observable and repeatable processes are known and stored. In such cases, the process is either deterministic or sufficient data exist to make valid statistical estimates of key measures of performance. However, for situations where the measure of performance is a human's perception of the environment, little or no "hard data" exist. That is, the events and relationships that define a decision making process are burdened with uncertain and missing data.

Therefore, when we attempt to understand complex problems faced by planners responsible for understanding human decision making, we must address three key characteristics:

- ***Diversity*** of the factors and influencing relationships that have both direct and indirect impacts on the process;
- ***Uncertainty*** in both the strength of the influencing impact between factors, as well as the likelihood that the factor exists; and,
- ***Dynamic*** nature of any list of significant factors and inter-relationships.

Advances in the fields of operations research, mathematics and computer technology are united in our *Influence Net* modeling technique to address these characteristics. However, mathematics and computer software cannot solve complex problems alone. A fundamental principle of the *Influence Net* modeling approach is that humans, and only humans, are well suited to estimate human inference patterns. As such, pivotal to this structured approach is the real-time collaboration of subject matter experts.

The success of this structured approach lies in the early identification of events and inter-relationships that have great potential to influence the ultimate outcome of a situation. Such identification is possible through an iterative approach to model construction and analysis that encourages experts to create, refine and maintain models of the situation that can be used to determine effective courses of action.

Influence Net Modeling — Terminology

To facilitate communication among the experts and the decision making consumer, *Influence Net* modeling encourages the experts to create "influence nodes." These influence nodes depict events that are part of cause-effect relationships within the situation under investigation. The experts also create "influence links" between cause and effect that graphically illustrate the causal relation between the connected pair of events. This cause-effect relationship can be either reinforcing or reversing, as identified by the link "terminator" — an arrowhead or a circle. The resulting graphical illustration is called the *Influence Net*'s "topology;" a sample topology is pictured in Figure 1.

This topological structure of the *Influence Net* model is a point of departure for, and a significant product of, the discussion among subject matter experts as they investigate the situation. In addition, decision makers require a capability to examine courses of action that have the potential to prevent, mitigate or contain crises. In order to provide a real-time analytical capability for situations fraught with uncertainty, a rigorous mathematical foundation, such as Bayesian inference networks, is re-

(See **INFLUENCE NET,** *p. 37)*

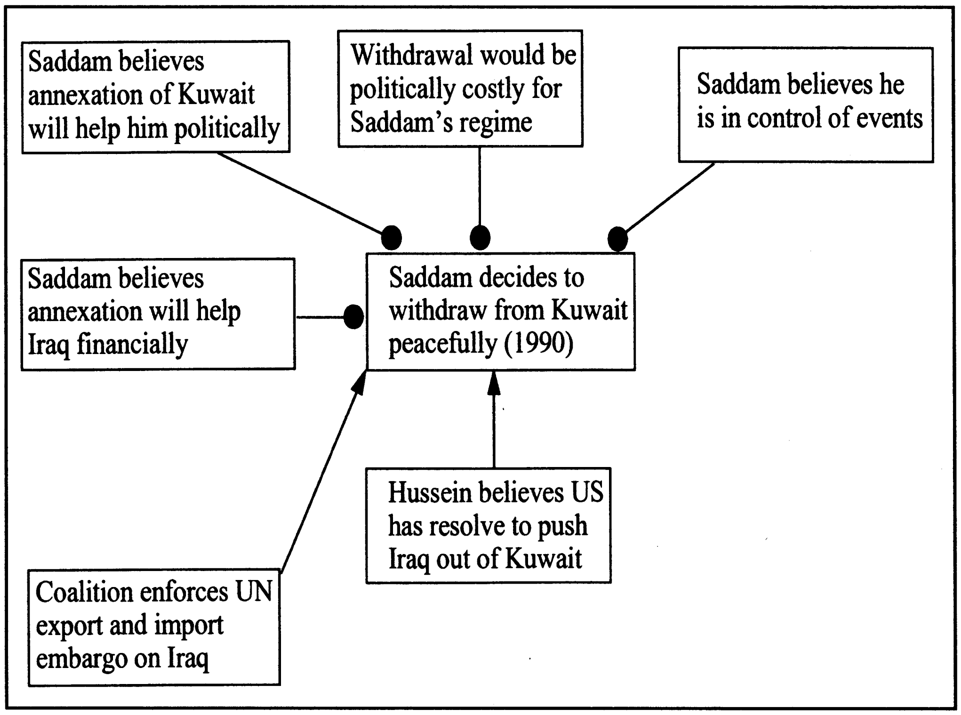

Figure 1. Sample Influence *Net* Topology

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(continued from p. 7)

quired.[6,7,8]

The amount and accuracy of information required to construct the traditional Bayesian inference network is far too excessive for modelers and planners of human decision-making. Specifically, the observable, repeatable measurements required to postulate the contents of the complete conditional probability matrix are not available for the subjective decision making process.

In order to address this lack of information, the authors, in conjunction with members of George Mason University's C3I Center for Excellence, developed an evolutionary approach to model construction — Causal Strengths (CAST).[9] The CAST algorithm allows users to assign expert judgments to the likelihoods of initial-state events and the strengths of the influencing relationship between cause and effect. These parameters are then employed in the standard forward belief propagation to compute the cumulative impact of all causes (direct and indirect) on each event in the model's topology.

SIAM — A Decision Support Application for Influence Net Model Construction

Using simple writing instruments, subject matter experts and planning staff can discuss and identify the key factors and their influencing relationships. Such cooperation is a good starting point when investigating complex problems. However, once the influence model is constructed, several important questions must be examined before a successful plan of action can be developed:

- Which of several selected causes has the greatest impact on the identified effect?
- Of all the factors included in the model, which one (or two or three) has the greatest potential to change the situation, assuming other factors remain the same?
- What if the chance that a factor will occur changes as the situation evolves? How is the desired outcome affected?
- If I apply an influence to one or more factors, what are the unintended side effects?

Experts who are comfortable discussing problems with scope limited to their domain of knowledge may be capable of answering such questions based on their experience. But analysis of the diverse, dynamic and uncertain problems described in the previous section is beyond the capability of human analysis. Therefore, we employ the **SIAM** software application to facilitate analysis of *Influence Net* models.

To construct an *Influence Net* model, users of the software application simply click-and-drag from a control panel to create a node that represents an influence factor. Essential for analysis is the node's current "belief" parameter. **SIAM** also provides several parameters to support documentation and auditing of the model. For all but initial-state events, **SIAM**'s implementation of the CAST algorithm automatically calculates this belief from all the factors and relationships that influence the node. For initial-state nodes, the current belief is manually assigned by the expert through the belief slider bar; see Figure 2. Moving the slider bar to the left of center reflects the degree of certainty that the influencing factor will not occur. Moving the slider bar to the right of center reflects the expert's certainty that the factor will occur. In addition to this quasi-quantitative cue for a factor's likelihood, the node graphic will be displayed with a corresponding color.

Once influencing factors are created, the causal relationship, or link, connecting a cause-effect pair is considered. Again, **SIAM**'s easy to use click-and-drag technique allows subject matter experts to include all significant causal connections. Of particular note when considering links between cause-effect pairs is the notion of "what if." When working with influencing relationships, we are not concerned with the current likelihood of the factors. Rather, we are modeling the situation to understand what the potential pressure points for change might be. Therefore, as illustrated in Figure 3, two causal strength parameters are requested:

- In a future where the influencing factor were ***true***, would the effect be more or less likely to occur? Or perhaps, a status quo would be created, with no appreciable impact on the effect.
- On the other hand, in an alternate future where the influencing factor were ***false***, would the effect be more or less likely to occur?

Another benefit of the **SIAM** software implementation is the capability to partition complex problems into more manageable "bites." That is, within the software, distinct but inter-dependent sectors of influence can
(See **INFLUENCE NET,** *p. 38)*

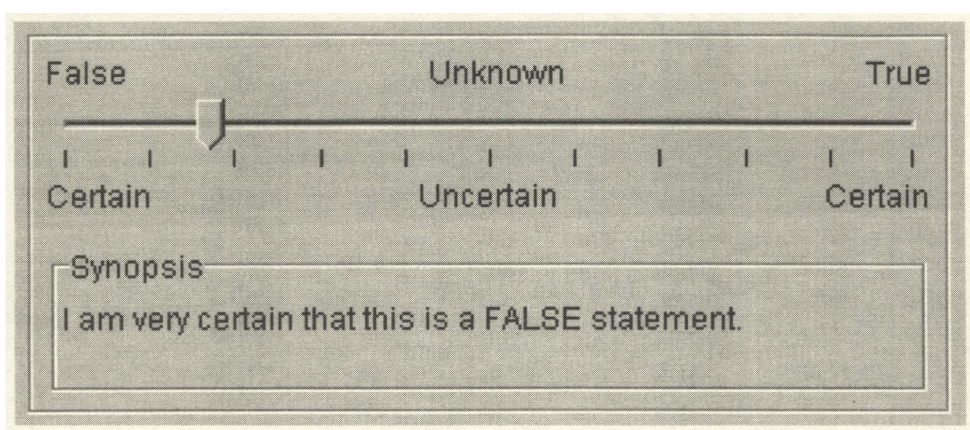

Figure 2. SIAM's Node Belief Slider Bar

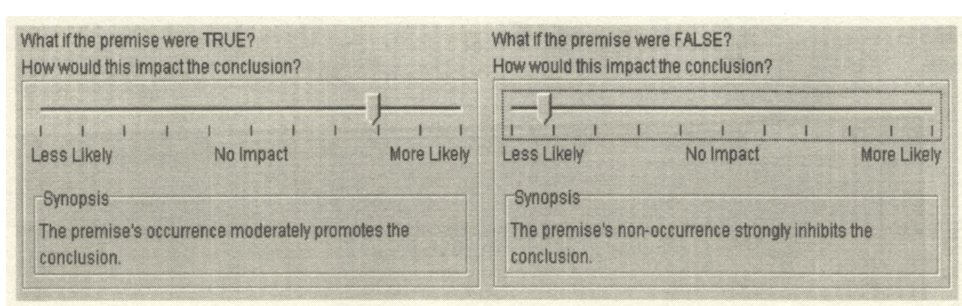

Figure 3. SIAM's Link Strengths Slider Bars

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be represented on separate "pages" of the whole *Influence Net* model. This technique is referred to as "embedding a subnet" within the larger model. In addition to the obvious visual benefit of a less cluttered image, the software implementation easily accounts for highly complicated multi-path influencing chains.

SIAM's Analysis Techniques

Since **SIAM** includes a mathematically complete forward propagation algorithm, users can examine the results of postulated alternate futures by simply changing the beliefs of corresponding influencing factors, and refreshing the display. This technique provides one method of pinpointing influencing factors that have significant and desired effects on the situation's outcome. This technique will also identify undesired or unexpected effects. For example, humans — even subject matter experts considering a subset of factors and relationships in a highly complex situation — might have an incorrect intuitive "feel" that an influencing factor holds little importance on the overall outcome. But by including all significant factors from diverse sectors of influence, the automated algorithm can uncover overlooked or forgotten paths of influence. Results of the algorithm will also indicate whether several paths of weak influence combine to produce an unexpected outcome.

SIAM's automated assessment tools also include comparative analysis techniques. Such analysis provides modelers with real-time feedback on the consistency of their judgments and intuition, as well as the completeness and accuracy of the constructed model. The analysis results also assist the user in identifying critical "pressure points" of influence. Pressure points are those events that have the greatest potential to alter the outcome.

One of the more critical reasons for implementing a structured approach to planning and decision making is the lack of resources. These resources might include money, labor or time. Whatever the constraining element, it is beneficial to determine if a subset of influences is sufficient to achieve the desired outcome. **SIAM**'s impact analysis technique allows users to identify whether or not a single "silver bullet" exists. And if not, then is there a subset of the influencing factors that might not provide a reasonably sufficient impact?

Figure 4 illustrates the results of **SIAM**'s impact analysis on the outcome of the **Saddam Hussein** example depicted in Figure 1. The influencing factors listed on the left side of this figure are the immediate causes of the selected effect. These causes represent the culmination of several subsets of influencing factors: domestic economy, international trade, military presence/resolve, psychological profile and political considerations. Using the assigned strengths of the link connecting each factor to the selected outcome, the displayed rank ordering is determined.

Subject matter experts can use such results as a "sanity check" of the validity of the *Influence Net* model. For example, if the group of experts found a glaring inconsistency between these results and evolving real-world events, then the corresponding

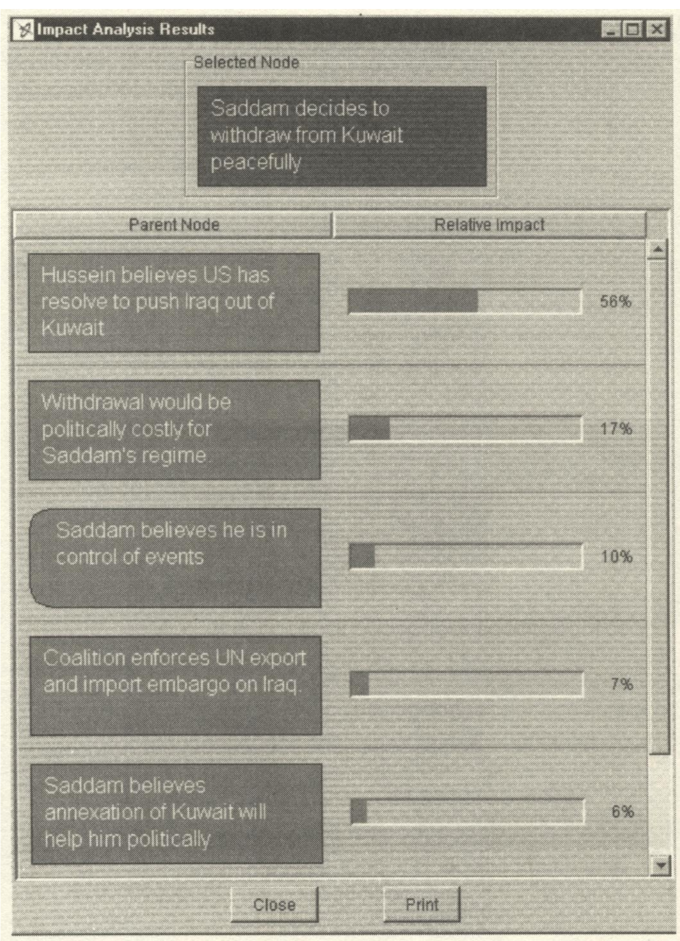

Figure 4. SIAM's Impact Analysis

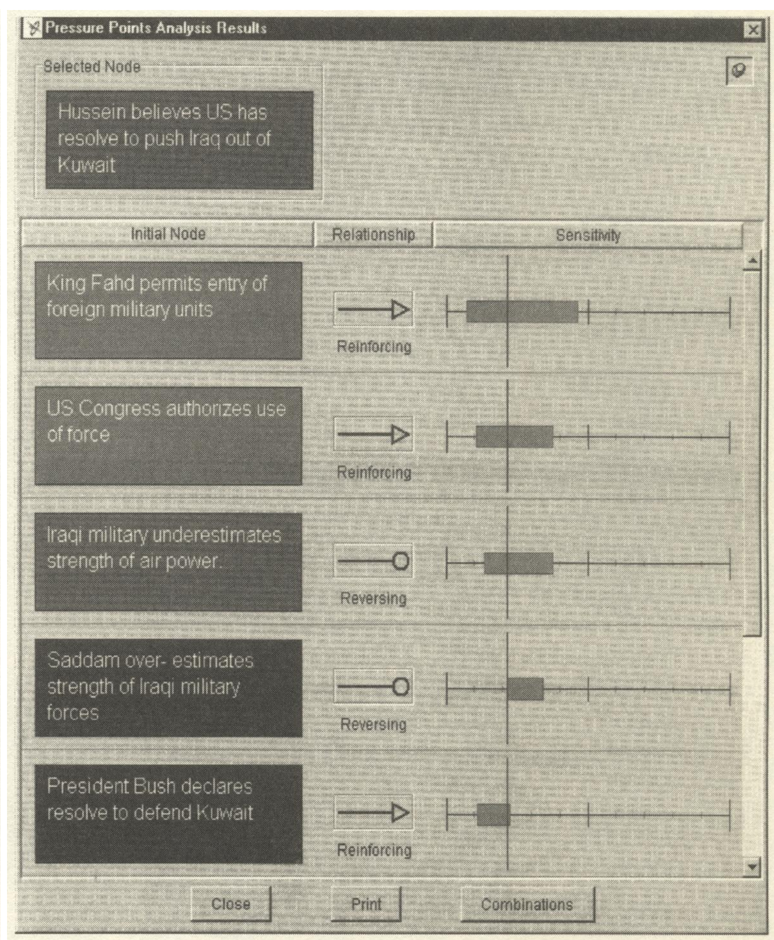

Figure 5. SIAM's Pressure Points Analysis

set of link strengths become the focus for model refinement. The results illustrated here indicate that any successful course of action should address multiple components of Saddam Hussein's decision-making process. Nevertheless, the military component appears to present the best opportunity for change. This can be further examined through **SIAM**'s sensitivity analysis techniques.

Figure 5 illustrates the results of **SIAM**'s "pressure points" sensitivity analysis for the military component. Specifically, the influencing factors identified on the left of this figure are the initial-state nodes that have at least one chain of influence culminating with the selected outcome — Hussein's belief that the US leadership has the resolve to deploy military forces against him. The direction (reinforcing/reversing) of the overall effect of all paths of influence between the initial factor and the selected effect is displayed in the second column. The vertical bar within the shaded regions represents the current belief of the selected effect; this likelihood, in turn, additionally depends on all of the expert-assigned link strengths and initial node beliefs.

The results of any of **SIAM**'s sensitivity analyses are used to determine influencing factors with great *potential* to alter the selected outcome. The width of each shaded bar reflects the relative sensitivity of the selected effect to the corresponding influencing factor. The wider the shaded region of the bar is, the more sensitive the (possibly distant) causal relationship. This sensitivity depends on several parameters of the *Influence Net* model, including: (i) the degree of multi-path connectivity between the influencing factor and the selected outcome; and (ii) the expert-assigned strengths of each pair-wise cause-effect link. Moreover, the relative potential to improve or degrade the situation over its current state is depicted through the portions of the shaded region to the right and left of the vertical bar. Such analysis provides the planner with actionable events upon which to apply effective pressure in order to minimize potential risks (degradation) and maximize potential benefit (improvement).

Furthermore, if a critical pressure point is unknown (gray color coding), then the decision maker is provided with a ready-made list of information requirements to be met prior to proceeding with the detailed planning process.

SIAM also allows users to analyze and compare:

- Sensitivity of a desired effect to combinations of influencing factors;
- Sensitivity of a desired effect to selected factors as influencing relationships change over time; and,
- Sensitivity of a desired effect to selected factors as alternate future scenarios, called excursions, are triggered.

Summary

In this article the authors have presented the fundamentals of *Influence Net* modeling, an approach to understanding complex problems. This approach is fundamental to a structured planning process that has been used successfully in strategic planning. The same approach can benefit IO planners who face complex problems in their everyday planning cycle. Our experience with this modeling technique and structured planning approach indicate that the working relationship developed between members of the intelligence community and the operations staff participating in the workshops helps to cement a collaboration that is essential if future planning is to be successful.

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Biographies

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***Wayne L. Smith** has been a Senior Engineer at Science Applications International Corporation for 10 years. Currently, Wayne serves as lead engineer for projects involving SAIC's* Influence Net *modeling process and software applications. Prior to the initiation of the* Influence Net *modeling efforts, Wayne worked in the area of simulation and analytic modeling of underwater warfare. Support has included modeling and analysis of submarine mission effectiveness, bistatic LFAA system effectiveness, sonar systems performance, target localization techniques, and weapon system effectiveness. He holds M.S. and B.S. degrees in Mechanical Engineering from the Rensselaer Polytechnic Institute.* ✪

MORS tentatively plans to hold a workshop on IO in the Fall of 2001.
Watch for details.