Team 10: Peace Support Operations Model

TEAM 10 MEMBERS

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INTRODUCTION

As the focus of the United States military shifts from conventional warfare toward irregular warfare, interest has grown in the development of models that can simulate social behavior as it pertains to military operations. The contemporary operating environment, as reflected in Iraq and Afghanistan, shows the critical role the population portrays in modern combat. Populations, whether broken into smaller social groups, granulated into individuals, or studied as an aggregate of social groups, are often the determinate of success in modern combat. Therefore, the military's interest in modeling social cognition has grown out of necessity. The military uses models for course of action analysis, training and rehearsal, and evaluation for acquisition. If these models are not indicative of contemporary operations, they are not only lacking in utility, but are potentially harmful.

One new model which combines conventional warfare with the modern focus on the population is the Peace Support Operations Model (PSOM). PSOM is a simulation-based war game which portrays the populace and displays the effects military and political actions have on the populations. During preliminary use, PSOM has shown potential as an analytic and training tool; however, to date the model has not been taken through any sort of VV&A process. This can prove detrimental due to the tremendous risk inherited from using a model that has not been thoroughly evaluated. Our working group quantifiably analyzed PSOM using data farming to measure the limitations and constraints of the model.

Methodology

- Our goal for IDFW 18 was to use quantitative analysis to explore the capabilities of PSOM. Because the parameter space in a campaign level model such as PSOM is quite large, the basis of our work was to leverage high performance computing and efficient design of experiments to run the model many times. This process allows for the exploration of a very large parameter space in a limited amount of time. Efficient design of experiments and statistical analysis permit us to determine which parameters and interactions are significant in PSOM.

The scenario used to test the model is the ongoing war in Iraq as of 2004 (figure 3). This scenario was developed by DSTL in 2008. For the workshop we focused primarily on those regions of Iraq which are inhabited by the Sunni Population. This limits the focus to about 30% of the population, 37 coalition combat maneuver battalions, and the faction of the Sunni Nationalists. The designs of experiments focus on the underlying assumptions about the Iraqi population, the capabilities and attributes of coalition and insurgent forces, the operational courses of action taken by coalition forces, and the systematic settings of PSOM. The responses analyzed are primarily the changes in security in the nation and the population's consent towards its own government and coalition forces (when needed, other outputs are taken into account). The resulting statistical analysis is then used to gain insight into the vast space of possible PSOM inputs and their resulting outputs.

Factor	Level 1	Level 2	Level 3	Level 4	Description
Coalition Stance	Combat Units Attacking Sunni Nationalists–Sub Stance Clear	CBT Units Securing Sub Stance Patrol	CBT Units Providing Humanitarian Aid – Sub Stance Build Infrastructure	CBT Units Withdrawn	37 Coalition maneuver BN's in Sunni inhabited regions take this stance.
Sunni Nationalist Stance	Attacking U.S. Sub Stance Ambush	Attacking Iraqi Government Sub Stance Destroy Infrastructure	Withdrawn		75 Sunni Nationalist Units (AQI and Militia) in Sunni inhabited regions take this stance.
IGO Stance	Withdrawn	Provide Humanitarian Aid			47 IGO's throughout Iraq take this stance
Coalition Shares Intelligence with Sunni Nationalist	Yes	No			Determines if the coalition and Sunni Nationalist share information

Table 1. Categorical Factors Explored

Factors explored

During the International Data Farming Workshop we chose a set of parameters from the scenario file of PSOM. These factors represent many of the assumptions specific to the scenario being simulated. For this experiment these factors are applied to either the coalition forces, Sunni nationalists, or the Sunni population of Iraq. Table 1 displays the categorical variables manipulated in the DOE. Table 1. Categorical Factors Explored

Table 2 is an explanation of the continuous variables used in the experiment.

Factor	Experimental Range	Description (Jon Parkman, 2008)
Coalition ROE Level	1-5	1 (Loose) and 5 (Tight) representing the degree to which the unit is willing to cause civilian casualties in order to complete its task.
Coalition Force Protection Level	1-5	An integer between 1 (Low) and 5 (High) representing the degree to which the Unit is willing to suffer its own casualties in order to complete its tasks
Sunni ROE Level	1-5	See above
Sunni Force Protection Level	1-5	See above
Sunni Political ideology	0-100	This is a value between 0 and 100, which give the Faction's Ideology based on its views on Personal freedom, through the Nolan chart system, as shown below
Sunni Marginal Gains	0-1	These values, one for each Good Type, control the level of importance that the Group places on the provision of that Good Type
Sunni Marginal Gains Security	0-1	This value controls the level of importance that the ethnic group places on Security
Sunni Initial Consent Coalition	2-8	These values set the initial levels of Consent towards each Faction that are possessed by the generated Agents at the start of play
Sunni Initial Threat toward coalition	2-8	This value sets the initial level of threat that a population agent feels toward each faction
Coalition Casualty tolerance	0-100	Casualty Tolerance value, which controls how many casualties the unit will bear each turn before the Deterrence function begins to have an effect.
Coalition Leadership	0-100	The level of competence in the leadership of the Unit
Coalition Experience	0-100	The level to which the Unit is trained and experienced in conducting operations in a PSO type situation
Coalition Reputation	0-100	The degree to which the Population perceives that the Unit is unwilling to conduct offensive operations against them

Table 2. Continuous factors explored.

Description of Scenario

The scenario is Iraq 2004+ created by the developers of PSOM. Figure 3 is a general Description of the population and anti-Iraqi force lay-out used in the scenario.

Design of Experiment and Metrics

We used a full factorial design for the categorical variables crossed with an NOLH for the continuous variables resulting in a DOE with 3120 design points covering a multitude of possible combinations of the factors. We then ran each excursion 5 times in order to account for the very limited stochastic influence within PSOM.

The resulting design points were then analyzed using quadratic least squares regression models with two way interactions where the response variables are either the mean Sunni Population's consent toward the coalition or the mean Security across Iraq.

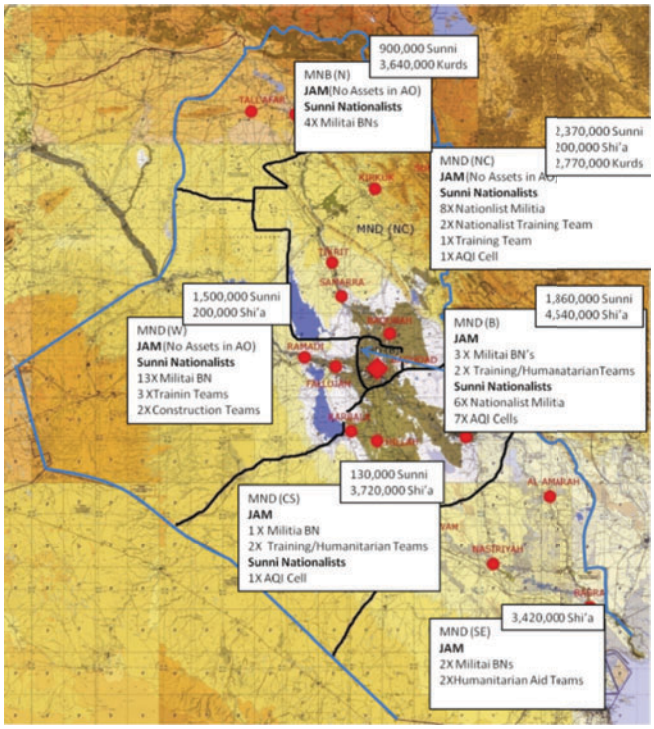


Figure 1. Iraq Scenario

Results and Analysis

Our resulting meta models proved accurate enough for further analysis. (Figure 2)

Summary of Fit	
RSquare	0.938032
RSquare Adj	0.937792
Root Mean Square Error	0.588595
Mean of Response	-4.03833
Observations (or Sum Wgts)	3120

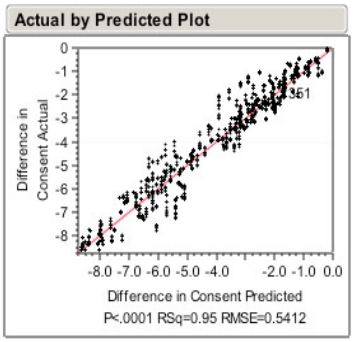


Figure 2. Consent toward coalition meta-model.

Looking at the scaled effects we found that the initial value for consent and the parameter Sunni Marginal gains for Security are the most significant factors examined in

determining consent. The contour plot (Figure 3) shows the significance of these factors with respect to consent.

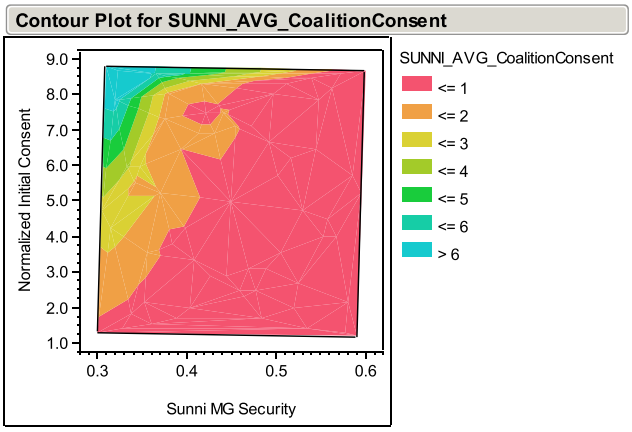


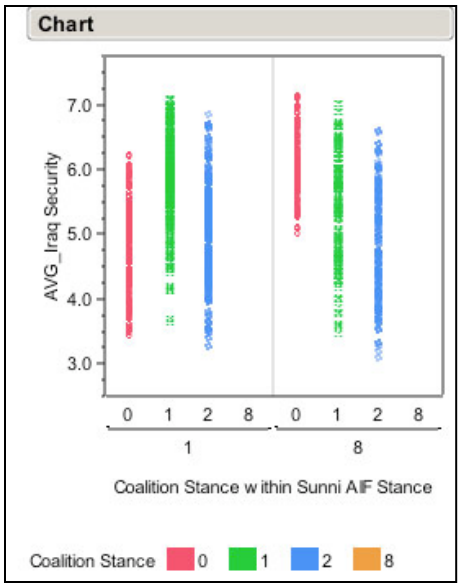
Figure 3. Contour plot of Sunni consent toward coalition with respect to Marginal Gain Security and Initial Consent.

We also found that coalition stance is a significant factor in respect to Sunni Consent for the coalition.

Looking at the response of security we had similar success with our meta model. With an R squared of .76 we found the Rules of Engagement setting for factions to be particularly significant toward security. We also found that the factions' stances and the interactions of the stance of competing factions is particularly significant in the model as can be seen in figure 4.

Conclusions

The team's main objective was to jointly agree on a set of parameters within PSOM which should be interesting and then use data farming to determine which of these factors truly are influential to both the consent metric and the security metric within PSOM. Our hasty analyses conducted during the last day of the workshop proved positive toward PSOM potential uses. Clearly the underlying assumptions about the population have tremendous implications on the model. Also, we gained tremendous insight about the effects player decisions have toward both security and consent. We clearly met our main objectives and in doing so have displayed the power of data farming in regards to the VV&A process for contemporary combat models.



Stance
0 - Provide Humanitarina Aid
1 - Attack
2 - Provide Security
8 - Withdrawn

Figure 4. Line chart showing effects of stance with respect to security.