Using Cognitive and Systems Dynamic Approaches to Model Potential Individual and Societal Reactions to US Actions

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Gaining insight into the attitudes and intent of leaders and populations can expose potential reactions to specific US initiatives, their subsequent cascading effects, as well as broaden the sphere of influence options.

The phenomena that maintain or transition dictatorship and democracy have recently become understandable enough to pose dynamic (testable) hypotheses amenable to simulation [1]. As such, the ability to address intervention dynamics and unintended, higher order consequences is key focus of this work. The objective of the described work is to develop a systems-level, capability that will allow analysts to better assess potential actions and counter-actions of individuals interacting within a country of interest before, during, and after a U.S. initiated event (see Figure 1). Specifically, the assessment will address the dynamics that drive stability and instability within the country of interest. The intent is to (1) assess adversarial choice options that allow analysts to pose "what-if" queries concerning hypothetical policy and/or military initiatives to help determine how and why a population may react to a specific event, leader, or operation across time; (2) assess potential blind spots by providing analysts with the ability to better understand 2nd- and 3rd -order interaction effects between leaders and local societies and how allegiances are formed and changed over time; (3) perform risk analysis by hypothesizing and testing the limiting assumptions and unknowns for the successful outcome; and (4) perform risk management by establishing whether there are delayed consequences that will require mitigation or adjustments to planning.

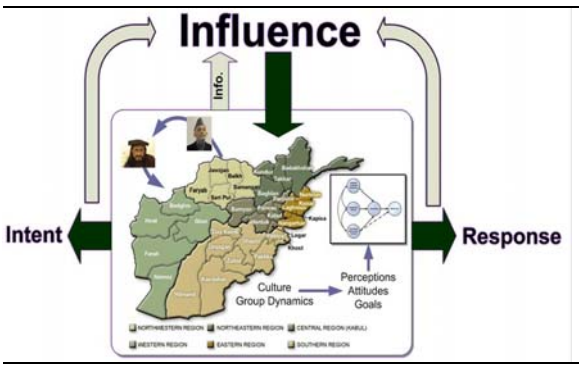

Figure 1. Simulating how influential behavior affects intent and responses, while intent and responses can influence behavior.

To accomplish this, Sandia is utilizing its technical expertise in Modeling & Simulation (M&S) to create a social simulation platform that couples High-Definition Cognitive Models (HDCM) with a cultural, economic, and policy-based simulation [2]. The HDCMs are designed to computationally represent the mindset of specific individuals, including their cognitive perceptions, goals, emotion states, and action intentions [3]. The actions of one HDCM can affect the mindset and actions of others, as well as the general mindset of the society in which they are situated. The society, computationally represented by Sandia's Systems Dynamics-based Aggregate Societal Model (SDASM) can, in turn, affect the actions of the HDCMs. Using a hybrid of theory of planned behavior, cognitive dissonance, and qualitative choice theory as the psychological basis, SDASM includes logic for detailed intra- and inter-regional

interactions, as well as aggregate rest-of-world feedback dynamics.

While the HDCM is focused on individual or small-group level of analysis, the SDASM is focused at an aggregate level social, economic, and cultural level of analysis. These models are integrated to provide a single psychological framework that can simulate interactions among individuals, groups, and societies (Figure 2). This high-fidelity, scalable assessment tool can produce outcome distributions that can be used to investigate attitudinal and behavioral reactions to US policies for a given country, group, or ethnic region.

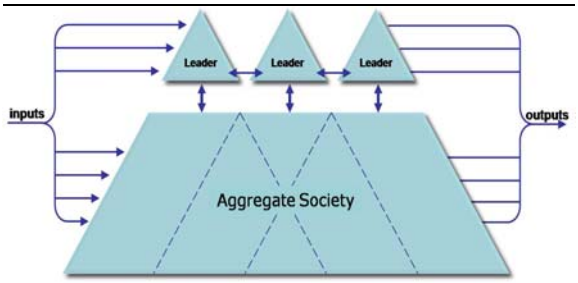

Figure 2. Sandia's High Definition/Aggregate Societal Framework uses system dynamics to simulate causal feedback interactions among and within leader and societal entities.

The data used to condition the model can originate from a large spectrum of sources including previous studies, expert opinion, surveys, observations, and public media. Characterization of the uncertainties in this data can be through standard statistical methods. Once the uncertainty is characterized and quantified, methods to propagate this uncertainty through computation models is well established at Sandia [4]. An important component of the present work is the identification and quantification of data induced uncertainties associated with model parameters, expert opinion, and survey/poll data. The formal analysis of these uncertainties on simulation output will characterize model confidence and robustness of what-if policies and actions.

This prototype societal assessment capability developed for DoD reveals (1) potential actions, as well as the psychological processes behind those actions, for specific individuals of interest and (2) potential societal actions in response to the actions of individuals of interest as well as exogenous variables. When fully implemented, it is believed the combined interactions will capture the necessary dynamics, secondary effects, and potential unintended consequences required to better assess/develop interventions and regional-stabilization conditions.

References

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