

# Threat Anticipation Project Overview



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## **Threat Anticipation Project – Overview**

### **Background**

The varied threats against the United States and its interests are real and immediate, but also not fully understood or recognized. The Defense Threat Reduction Agency within the Department of Defense (DOD) has a specific mission to reduce the threat of weapons of mass destruction, including weapons of mass effect, against the U.S. and its interests. This is a mission of critical importance for DTRA, the DOD, the interagency, and the American people. The mission of DTRA's Advanced Systems and Concepts Office (ASCO) is to anticipate future threat reduction needs and develop advanced systems and concepts that will satisfy those needs. In this vein, as a result of the September 11 events and the consistently changing global security environment, the Director of DTRA directed the formation of a Threat Anticipation Project (TAP) to support the DTRA mission.

Since its inception in 2002, ASCO has initiated TAP projects to explore productive areas of threat anticipation including workshops to identify and acquire relevant expertise from the social science, computational science and other communities; development of conceptual computer models to better understand and anticipate asymmetric threats; and staff activities involving networking with universities and other federal and private sector organizations to survey the current thinking on these issues and leverage outside expertise. TAP has produced a variety of concepts, computer and theoretical models, workshop proceedings, and reports of value to the future mission needs of DTRA. It is extremely important to have these products preserved, validated in some practical sense, and more widely used within the larger national security community. Threat anticipation by computational and social sciences is rapidly gaining recognition for potential utility; hence TAP can become a major contributor to the DOD, other federal agencies, universities, and other organizations in this area.

### **Current Efforts**

Research efforts under TAP have been selectively chosen to investigate a broad range of applicable areas including workshops and modeling efforts. The primary efforts are summarized below.

#### Joint Threat Anticipation Center

In FY04, DTRA established the Joint Threat Anticipation Center (JTAC), operated collaboratively by the University of Chicago and Argonne National Laboratory. The goal of JTAC is in part to provide DTRA with the combined capabilities of Argonne National Laboratory and The University of Chicago to enhance the effectiveness of the TAP. The program has four primary objectives:

- Expand and promote research in the art and science of anticipating threats, a new field of study.
- Establish a center located at the University of Chicago that will become a recognized "center for excellence" of threat anticipation expertise, promotion, and products.
- Develop a repository at Argonne National Laboratory for models, publications, and institutional memory of threat anticipation for interagency use
- Provide the services that can assist DTRA with focused TAP activities and contacts that facilitate interagency participation.

Recent results from JTAC include: (i) a successful workshop designed to foster relationships between social scientists and computational scientists and identify key problems in threat anticipation; (ii) successful research on the underpinnings of suicide terrorism (recently featured in a New York Times op-ed piece, and additional articles in the Washington Post and Washington Times); (iii) establishment of a core team of interdisciplinary scientists to develop a common language for computational and social scientists engaged in threat anticipation studies.

#### Cultural Simulation Model

The goal of the Cultural Simulation Model (CSM) is to develop a methodology for interpreting information from different perspectives, points of view, and/or cultures. From that interpretation, the model displays the vast amounts of complex data and interactions in a usable manner. The core of the CSM is the “cultural construct” and is built using content from primary source documents and subject matter experts to provide contextual information to an issue or situation. The cultural construct is dynamic, as it is regularly updated as new information becomes available. Instead of trying to eliminate bias in the interpretation of information (e.g., a news article), the CSM attempts to capitalize on the incorporation of numerous points of view in the cultural construct to provide a multi-dimensional view on a situation or circumstance. This methodology allows the CSM to identify threats, goals, and when different group’s perspectives change or align with one another. Additionally it allows the user to identify gaps in information required to adequately assess a situation. This modeler is in the prototype phase.

#### Threat Anticipation Project Multi-Agent Simulation

The anticipation of terrorist threats requires understanding of the dynamics of terrorist social networks and actions. In this new security environment, there have been major shifts in how terrorists operate. For example, there has been a decrease in the use of mostly well-organized, state sponsored, localized groups and an increase in the use of loosely organized, international networks of terrorists to carry out operations or activities. Understanding these new paradigms can benefit from a “bottom-up” analysis. That is, using a “bottom-up” agent-based simulation approach that captures individual’s resources, goals, and desires, the dynamics of terrorist social networks can be analyzed providing valuable insight into anticipating the most-probable macroscopic trends. Agent-based simulation allows for examination of how individual interactions at the micro-level can affect overall behaviors at the macro-level. Agents follow mathematical rules for local decision-making and learning. Different agents have access to different information may follow different rules. Agents are not required, and usually do not, have access to the global information set of all other agents – although the agent decisions can be driven by environmental conditions (economics, war, poverty, relative social status, disease, etc.).

The Threat Anticipation Project Multi-Agent Simulation (TAPMAS) uses this approach to model the interaction of organizations and formation of social norms with conflicting constraints and objectives.

#### **Future Efforts**

Both the CSM and the TAPMAS are in the final stages of Phase III. They have successfully shown proof-of-concepts for their respective approaches and are now ready to be further developed based on requirements of their end users. ASCO will continue to promote their utility to the appropriate agencies and groups. However, future efforts pursuant to TAP will be focused on furthering efforts at JTAC. The philosophy and general research directions for the future are outlined in this section

#### Structure and Directions for TAP

Discussions with computational modelers, social scientists, and Government Officials have led the modeling portion of TAP to be organized in three overlapping phases that are necessarily dependent on one another. They include:

- I. Organization and compilation of data;
- II. Assessing the current state;
- III. Forecasting from the current to establish and assess future threats.

Future work in these areas will require fundamental research in social modeling and should include:

- a. Study of the relevant scales on which the model is useful;
- b. Validation and verification of theory and models
- c. Enhance interactions between social scientists, mathematicians, statisticians, computational scientists, modelers, and end users (i.e., analysts, and policy makers).

In order to provide more useful information to analysts and policy makers, future research efforts in the previously mentioned areas should emphasize distributions of events rather than single possibilities. For example rather than trying to predict a specific event, it is more realistic to forecast a range of likely behaviors and events.

#### *I. Organization and compilation of data*

Given the rapidly increasing volume of information and intelligence collected on future threats to the U.S. and its allies, there is a need to be able to rapidly process, assimilate, and distribute it in relevant formats for the varied users. It is anticipated that information and intelligence will vary substantially in format; it will include news outlets, interviews, independent assessments, audio, video, and others. Systems that can accomplish this daunting task, both in terms of organization and distribution of data, include, but are not restricted to, knowledge management systems and large database systems. It will be critical that future systems focus on flexible infrastructures that will be able to consolidate, organize, and distribute information in real time.

#### *II. Assessing the current state*

Typical premises of modeling require knowledge of the current state of the system that is being modeled. This is because time-evolved forecasts use knowledge of the current state to constantly refine their forecasts by updating the initial conditions (the initialization of the model) with the latest and most relevant information. It is well known in the modeling community, that in even relatively simple models, it is possible to have small errors in the initial or current state lead to large errors within a relatively short period of time. Thus, it is anticipated that methodologies and techniques that improve assessments of the current state of a system will lead improvements in forecasting future events.

While much work has been done in the modeling community to develop techniques to make high quality assessments of physical systems from limited observations in order to initialize models, there has been little discussion in the social modeling community. Due to the complexity of social models and the limited set of observations, methods to estimate the current state will depend heavily on the real-time collection, organization, and distribution of high quality data.

#### *III. Forecasting from the current to establish and assess future threats*

The forecasting and assessment of future threats against the U.S. and its interests will require the development of new modeling efforts that will depend heavily on collaborative efforts between social scientists, computational scientists, mathematicians, modelers, analysts, and policy makers. Few programs exist that provide a forum for these diverse fields to interact; yet this is critical to

achieving the overall goal. Furthermore, it will be essential to maintain close ties with the analysts and policy makers since they remain the primary customer and end user of the tools

In order to provide analysts and policy makers with a more accurate perspective of the future threats, it is essential that distributions of likely events be provided and ranked.

Below include several research directions that are anticipated to be critical to future modeling efforts.

*a. Study of the relevant scales on which the model is useful*

Models are typically designed to capture dynamics of a particular scale. For example, the local (faster) scale would be models of psychology and on the global scale (slow) scale would be culture. Current models tend to show predictive skill over a narrow range of scales. With regard to social modeling, there is a need for a fundamental understanding of how social elements interact on multiple scales. In particular there is a need to understand how perturbations or anomalies in social behavior on one scale percolate to social behavior on other scales. For example, there may be ranges of times when small changes on the psychological level (e.g., advertising) will result in rapid changes on the cultural level. However, there may be other time ranges when no levels of modification the psychology will result in a change to the culture. As history has shown, attempts to modify behavior may result in non-intuitive results. Understanding of the complicated relationships between scales is critical to strategies involving intervention.

*b. Validation and verification of theory and models*

Models are tools to identify, isolate, and conceptualize key components of a natural process or phenomena. Once a model has been designed, it is critical to determine that the model is free of errors in implementation and hence, does indeed “do what it was intended to do”. This step is known as *verification*. Similarly, another salient issue is if the model represents any form of reality; this is known as *validation*. The relationship between the model and reality involves a number of subtleties that complicate matters. These include: identification of the minimum number processes and interactions that are necessary to adequately represent reality (producing the simplest model), limited abilities to initialize the model, poor data quality, sensitivity to initial conditions, etc. To further complicate matters, physical systems that can be considered “unmodelable” do exist (these are called unshadowable systems). For a model to be “useful” to the end user, the user it needs to do what is intended to do, and represent the reality of the situation needing to be analyzed, as close as possible.

*c. Enhancement of interactions between social scientists, mathematicians, statisticians, computational scientists, modelers, and end users (i.e., analysts, and policy makers).*

In order to develop the next generation of models it will be essential to provide a forum for consistent interaction for the relevant communities that are expected to contribute to this effort. Critical to this are the needs of the end users: analysts and policy makers. Increased efforts should be focused on understanding the end users’ needs.

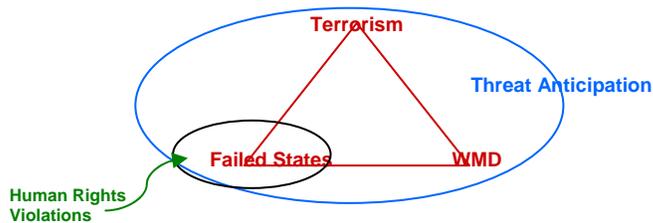
Guidance for JTAC

The previous discussion pertains to how both JTAC and TAP will be organized to execute in future efforts to anticipate varied threats through a variety of “new” and creative means. The general objectives for JTAC are summarized below:

- I. JTAC will be an academic center of excellence on for the study of issues related to the anticipation of threats to the United States and its interests. The center must provide the

United States Government (USG) with access to the highest quality community of academicians that can provide guidance, tools, and context in the broadly defined area of anticipation of threats. Key to these efforts will be synergistic activities in the social sciences, physical sciences, and computational sciences. The center must be an honest broker, and strive for excellence and intellectual honesty. The center must provide guidance to other institutions that are responsible for the engineering and implementation of operational systems developed from the research conducted by the center.

- II. Graduate students and postdoctoral fellows will act as a conduit to facilitate communications between the social sciences, physical sciences, and computational sciences; they will be steeped in the new field of computational social science; and provide a link between basic researchers and those that implement the research.
- III. JTAC will seek to identify grand challenge problems for the emerging field of computational social science. It will be crucial for the center to identify future areas of research, emerging technologies, and directions relevant to threat anticipation. Future areas of exploration include:
  - a. Reaching out to disciplines that can contribute to JTAC's mission. These fields should include areas such as mathematics, physics, financial engineering, theology, public health, human rights, economics, psychology, sociology, political science, anthropology, etc.
  - b. Use multimedia platforms for a source of information dissemination related to threat anticipation studies to include an email list-serv and a website which includes links to relevant publications.
  - c. Explore possibility of supporting a regular seminar series on threat anticipation.
  - d. Host a workshop aimed at increasing the visibility of the Center to the USG and establishing itself as a known, respected resource to those that are seeking outside expertise.
  - e. Engage in expand research on the relationship between weapons of mass destruction (WMD), terrorism, failed states, and human right violations. WMD, terrorism, and failed states are typically statistically modeled as singularities (rather than trends) with low probabilities and human rights violations such as genocide, forced migrations, and torture are trends that may be precursors to WMD use, terrorism, or state failure. Additionally, this effort will expand reach of expertise into human rights community, thereby expanding the pool of experts that have traditionally contributed to threat anticipation. A combined effort between these varied communities will increase the collective expertise available to anticipate threats to the U.S, and our interests.



- i. JTAC will solicit research concepts, proposals, and directions of the higher caliber. Furthermore the research directions should have a clear component of computational social modeling.

**Contact Information**

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