Avoiding 21st Century Societal and Regional Conflicts through Advanced Technologies for Understanding, Anticipating and Shaping

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Abstract— Largely as a result of Cold War era concerns arising from the existence and actions of the Soviet Union, strategic technology development was focused on developing offensive weaponry such as high-yield warheads and delivery vehicles, as well as C^4ISR defensive systems designed to provide warnings of impending or likely military strikes. Today, however, a radically different threat has arisen from the residue of failed and weak states, and terrorist groups who have a very different world view. This paper describes an effort, called Pre-Conflict Management Tools (PCMT) program, to develop technologies to address this new threat.[1,2] In support of this description, the technologies comprising the PCMT effort are overviewed, a synopsis of the programs results provided, and future – related-- efforts considered.

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1. INTRODUCTION

The U.S. strategic technology focus during the Cold War was largely centered on the Soviet Union and nuclear deterrence – the three most important technological features being nuclear warheads, their various delivery systems, and defensive early warning C4ISR systems. Today, however, a radically different threat has arisen from the residue of failed and weak states, and terrorist groups who have a very different world view. These threats are not concerned with international order, stability, and prosperity. Rather, they seek to disrupt existing international norms and institutions, and pursue personal, ethnic, or religious gain. In the case of failed or weak states, government leaders may have little control over their own security and intelligence institutions.

Meanwhile, terrorist groups and transnational ideological movements claim historical interpretations that cast their members as victims who must rebel and overthrow existing political systems, both domestic and international. In both cases, strong motivations exist to acquire WMD, missile, space, and other advanced military capabilities for promoting individual and group prestige and the accomplishment of political and military objectives.

Identifying and assessing the new threat is a major challenge. Enemies are often indistinguishable from the local civilian population; they are not organized as a conventional military force but rather are a complex web of networks based on tribal, familial, religious, ideological, or other ties. They have complex and dynamic organizational structures that anticipate and respond to our detection measures and countermeasures; they conduct military or quasi-military operations using instruments of legitimate activity such as the internet, cell phones, the press, and critical infrastructures like transportation, communications, and financial systems. Furthermore, as evidenced in the growing incidence of insurgency attacks and suicide bombings, they are willing to accept high degrees of risk, destruction and casualties to achieve their objectives.

The focus of this paper is to describe a research program at National Defense University called Pre-Conflict Management Tools (PCMT).[1] The PCMT project focused on the development of analytic tools and policy planning processes for dealing with the treats posed by weak and failed states, and violent non-state actors. Implicit in its design was the belief that it is possible to marshall and coordinate national strengths beyond just the military, e.g. diplomatic, economic and philanthropic. During PCMT's proof-of-concept phase, the project identified numerous requirements for the development of analytic and planning tools needed to confront new threats, as well as explored the efficacy of analytic collaborations to deal with these new challenges and threats. Moreover, PCMT laid the groundwork for deploying an initial capability to Combatant Commanders for use in their areas of responsibility (AOR). This paper concludes with a discussion of the PCMT's

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transition to operational use, and the design of a new research and development effort focused on technology gaps identified by the PCMT project being undertaken by DARPA.

2. THE PCMT APPROACH

The PCMT program consists of several components that combine to form a coherent system for data collection, model based analysis, and policy analysis and simulation.

long intervals, such as once every five years. Moreover, aggregated national level data obscures many of the most important and revealing distinctions between regions or groups with a state. Because intrastate features and distributions provide the earliest indications of state weakness and failure, valuable opportunities for social, economic, and military intervention go unrecognized until they manifest nationally.

In order to deal with the problems of sparse reporting and a sub-national analytic emphasis, PCMT needed to move away from highly structured, traditional social science data
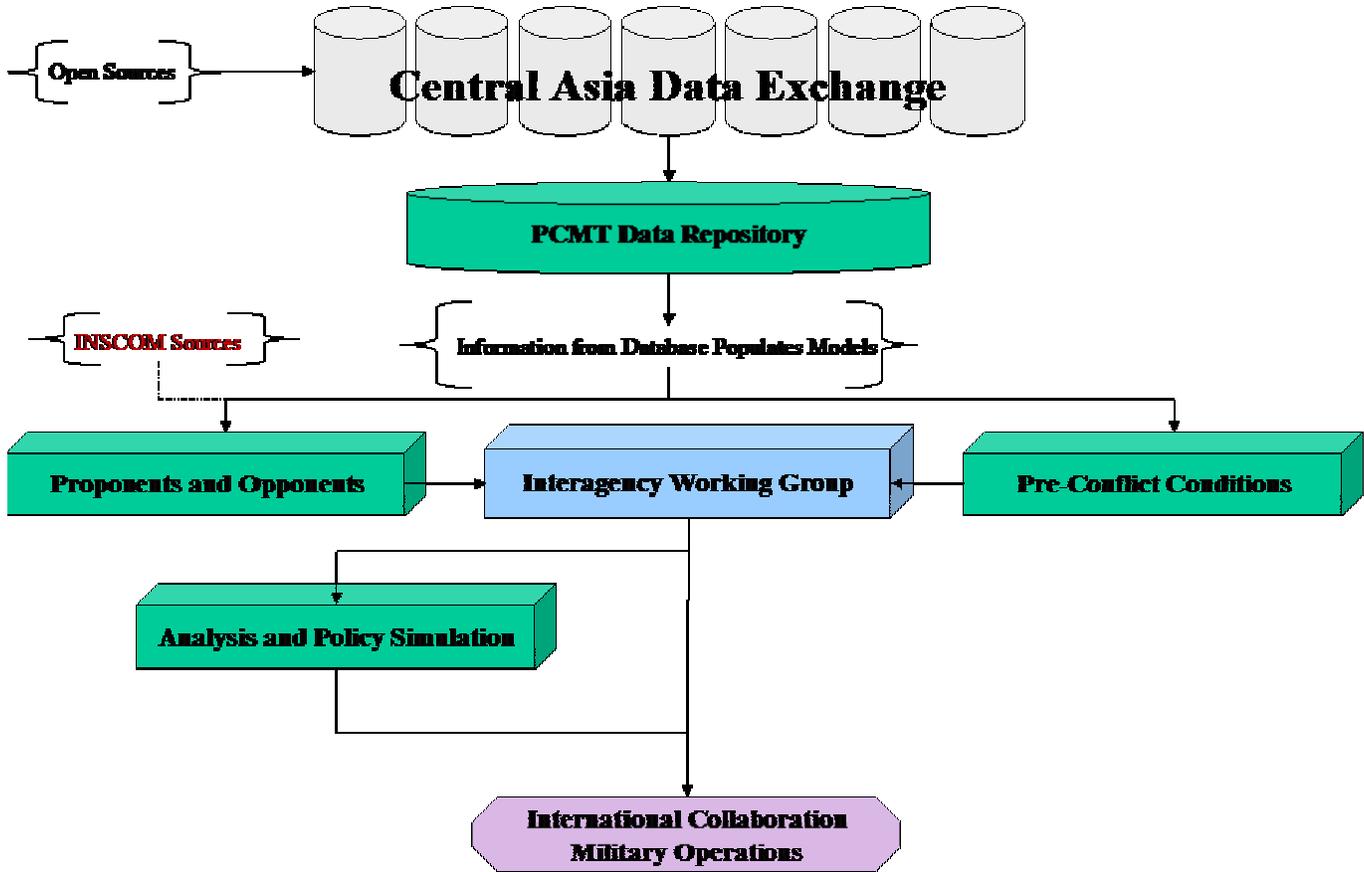

Figure 1: PCMT Architecture & Process

This system of components is illustrated in Figure 1, Each of these components, and their associated subcomponents, will be discussed below.

Data Collection and Organization

The collection of data on weak and failed states marked the first challenge that the PCMT confronted. Because weak or failed states lack strong governing institutions, their ability to collect and catalogue data about their own population, geography, economy, and military is substandard when compared with stable states. Efforts to augment the data collection capabilities of national government through international programs, such as the United Nations or World Bank, provide valuable national level data, but only after

sets, and rely on a broader, unstructured corpus of text. This created a new set of challenges for which technology played a crucial role in addressing. Because PCMT depended on non-traditional sources of data, existing databases were of little value analytically. Instead, two infrastructures were created in order to collect local level and disaggregated data. The first infrastructure, which was also exercised during the PCMT experimentation phase, was the creation of software agents that collected data from English language news sources on the region of interest. The second infrastructure was the creation of an online data-exchange and repository. This data-exchange is a peer-to-peer information exchange where users can submit and extract information regarding the region.

Working from disaggregated and unstructured data created new challenges for analysts. News reports written to professional journalism standards provide a semi-structured data format that can be used to support social modeling efforts after a reasonable degree of manipulation. However, the range of models that these texts can support is limited due to the intricacies of natural language processing. Moreover, dropping the requirement for highly structured social science data, the universe of available information and documents was greatly expanded, creating new problems for data validation and the control over the quality of individual pieces of information.

By employing agents and a data exchange system the amounts of information available to PCMT's analysts was overwhelming. As automated document collection and data-coding tools came on-line and improved, analysts were able to shift their attention from sampling available documents to filtering all available information. As a result, analysts were no longer starving for data – they were drowning in it. This new problem required new methods and technologies.

First, computational linguistics were employed to extract event and content information from semi-structured news reports. Second, a highly reconfigurable database was developed to store data extracted from the available documents, along with metadata regarding document source, publication date, location on the web or in the exchange, and other features, e.g., expert assessments of validity or accuracy. The reconfigurable nature of the data allowed for different models to reconfigure the database as needed, resulting in an ontology free data-structure that could simultaneously be interrogated by a variety of models and model types, and enable analysts to plug-and-play new models in the future without being constrained by institutionalized standards for the classification and representation of social phenomenon.

Data Analysis

Once PCMT has collected and organized data, the analytic suite automatically uses it to populate multiple models of social vulnerabilities. As part of the proof of concept study, two nearly orthogonal models were employed in the analytic suite. These models included the a variant of the Conflict Assessment System Tool called mini-CAST, and an instantiation of the econometric theories posited by Paul Collier of the World Bank. In addition to these two models, the PCMT social vulnerability suite made use of an expert solicitation Excel model. The intent of comprising the suite with multiple models was to provide a more effect means of "reasoning" about deeply uncertain situations.

Mini-CAST was based on conflict assessment framework developed by the Fund for Peace and is called the Conflict Assessment System Tool (CAST). [2] [3] The full-version of the CAST model has been used by government agencies for regional assessment and planning for more than a decade. The second model is derived from Paul Collier and his colleagues at the World Bank Group, and has been used for estimating the risks associated with country loans, and determining the consequences of development on conflict. Each of these models are focused on estimating the likelihood of civil war or state failure, yet their methodological approaches and underlying theory are quite different. The excel model provided a means of assessing the impact of policy "levers" on measures of long-term interest, i.e. this model coupled short-term actions to long-range objectives. [4]

The CAST model is a computational model that forecasts a state's risk of failure. The general theory that the model instantiates is based on the idea that conflict is a process that begins with the decline of a state's governing capacity. In the CAST model, as governing capacity declines, the state's ability to deal with demographic, economic, security, environmental, and public health problems diminish. As a result, competing groups form, each seeking to provide the services that the government has failed to provide. While such groups may signify a strong civil society that can provide services at a grass roots level, if there is a high degree of competition between them and questionable legitimacy, conditions for factional conflict may grow. Additionally, competition over natural resources, the influx of cash, arms, and ideology from diasporas, or the provocations of foreign governments may all encourage violent escalation. Thus, CAST views civil conflict as a process with distinct decision points or branches, indicating future conflict trajectories and opportunities for intervention in order to reestablish order and bring warring parties to peaceful terms. The Mini-CAST variant is a computational instantiation keyed for operating in the computational reasoning environment employed in the PCMT system.

The Collier model is a quantitative model that has been employed to understand and articulate the relationship between development and conflict. [5] The model is based on the work of Paul Collier and his colleagues at the World Bank Group. The Collier model is actually a collection of statistically similar linear models that relate different drivers of civil conflict to a dichotomous dependent variable of conflict. In one case, the model is based on the notion that civil wars result from political or social grievances within the population, suggesting that such conflicts are political in character and motivation. In another case, the model is based on the notion that civil wars are driven by greed, and profit and rent seeking activities by elites within the state. From this perspective, the drivers of conflict are economic, and tend to be clustered around resources or other economic assets.

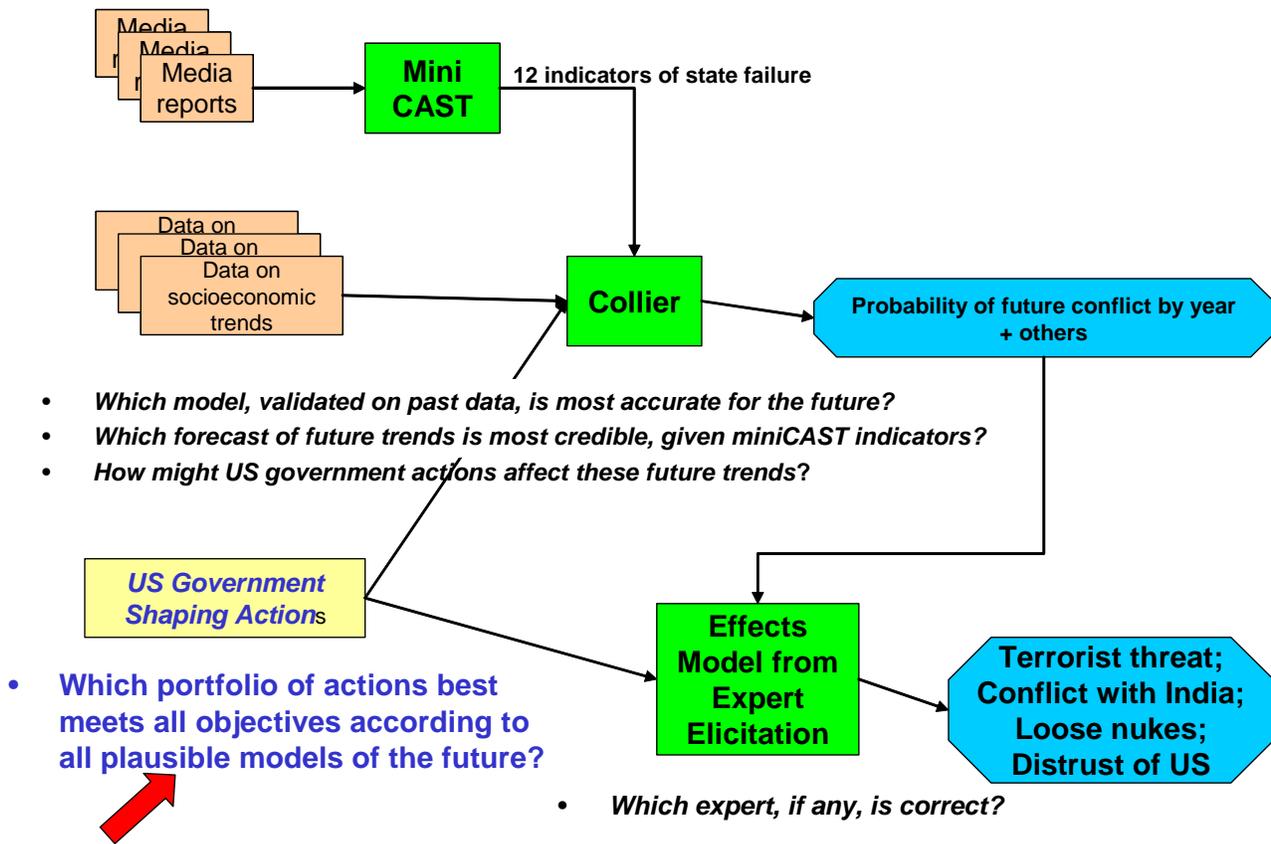# Tools Allow Reasoning Over Multiple Models

Figure 2: PCMT approach for "reasoning" about societal instability across multiple models and simulations.

Each version of the Collier model, both greed and grievance, indicates that civil war is development in the reverse, and tracks important development indicators such as mortality rates, infrastructure, and foreign investment before and after conflict. A crucial finding of the model is that civil wars are self-reinforcing and likely to recur due to their economic, political, and social legacies.

The Collier model instantiated in the PCMT system uses the logistic regression methodology in association with data on 161 countries over the period between 1960 and 2001. The regression equation calculates the probability of civil war breaking out in a given country based on the categorization of variables into three groups. The first group is the most recent set of country indicators – GDP, commodity exports, population characteristics, etc. The second group of variables is from the preceding time period, and is used to calculate change over time, e.g., the growth or decline of per capita income. The final group of variables refers to structural factors that do not change over time, or change slowly over generations.

PCMT's macro models discussed above each provide competing views of national stability, and differing explanations for the sources of stability and instability. Outputs from these models support the exploration of impacts and consequences that may propagate as a result of

actions taken by the United States government. The excel spread sheet model that captures expert based insights generates the relationship between actions and goals. [6]

These macro-level views of national stability are complemented by the analysis of elite dynamics. The inclusion of elite dynamics into PCMT's analytic suite serves three distinct purposes. First, it enables an understanding of what policy options are viable based on existing relationships within the region, i.e., the regional microstructure. Second, observations of elite dynamics reveal leading indicators of events or emerging issues within a society before they manifest in standard indicators such as GDP or demographic figures. Finally, elite structures can be employed as indications of policy success or failure, serving as a measure of effectiveness for national strategy and international action. PCMT's use of elite dynamics rests atop a large literature and practice of thinking about states and leaderships as a system of interconnected parts. Elite dynamics can be understood as a means for observing how societies extract and mobilize mass resources, and how hierarchies of decision-makers emerge in formal governmental, and informal political organization.

The examination of elite networks, and the relationships between information flows, whether between individuals or

organizations, issues, and the unfolding of events has been used to depict and understand politics, and open up the traditional black boxes of party, race, gender, class, nation, and other aggregate levels of analysis. While such levels of analysis provide a useful mechanism for arranging a system into its constituent elements, these blocks assume uniformity of their members and do not account for their relational properties and consequences of micro-level interactions and processes. The analysis of elites helps explain the methods by which political, social, economic, and military resources are extracted, concentrated, and deployed within a society, and how the mass mobilization of people, for or against a particular policy, occurs. In addition, network analysis methods, are critical for developing alternative models of the international system that go beyond the examination of regional blocks and viewing nations as unitary actors. This is important for understanding the construction and dynamics of a post-Westphalian world, where groups may form and dissolve dynamically depending on opportunities and threats, and how collections of actors arrive at consensus about abstract issues or concerns for which no empirical or objective criterion for evaluation exist.

Policy Analysis and Simulation (Model Exploitation)

PCMT's employment of social science models provides users with a method for gaining situational awareness. However, for that awareness to be more than a store of generic knowledge, it must inform the decisions of policy-makers and the actions of organizations. PCMT employs a decision-making approach based on the search for robustness, as measured by the search of actions that produce the least regret across a variety of plausible scenarios generated by the modeling suite. As a result, policy analysis, that is the articulation and assessment of policy options, is performed via the computational simulation of PCMT's social vulnerability models.

Robust policies mark an important departure from the traditional search of for optimality, and fare better in situations where deep uncertainty reigns and a priori assertions of utility or probabilities make little sense. In cases such as the current, highly volatile international system, policies or strategies are regarded as robust if they perform well across a variety of different models of the international system, even if they may not be ideal or optimal given a particular model.

PCMT achieves robust decision-making by allowing users to conduct a dialogue with a variety of models simultaneously. By enabling the mapping of various strategies against changes in structural model parameters instantiated in the model, as well as the input stream used to generate the model parameters, the effects of a given course of action can be simulated. Comparing how policies or strategies fare across all models and ranges of initial conditions allows for alternative approaches to be

systematically compared. Those that perform well across a variety of models and initial conditions and allow for adaptation as new information becomes available are regarded as robust. (Figure 3 illustrates output used to support simulation and exploration of policy actions and longer range outcomes.)

PCMT's analysis and simulation tools reside in the hands of a variety of users representing the interagency planning process. The character of political instability makes interagency and international planning, collaboration, and operations crucial. While military operations have a clear role to play in countering the treat posed by failed and weak states, terrorist operations, WMD, and the proliferation of advanced military technology, effectively dealing with the social, economic, and political conditions that motivate intra and interstate conflict requires a broad set engagement options.
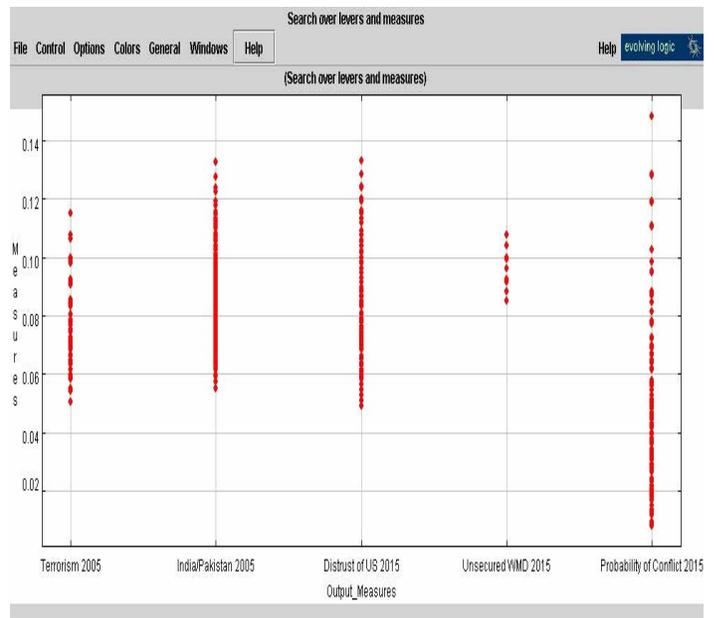

Figure 3: PCMT approach can suggest actions which meet near-term objectives consistent with long-term goals.

While PCMT's technological and analytic tools seek to incorporate the current state-of-art in their respective fields, the issue of interagency coordination and collaboration remains a compelling and timeless issue. Historically, new governmental missions or the desire to address complex, multi-faceted problems challenge bureaucracies and institutionalized organizational structures. Efforts to reorganize existing bureaucratic structures, create new offices, or create single points of focus for the purpose of eliminating duplication appear logical, but have consistently failed to produce desired results. More often they produce additional offices that complicate the management of complex problems, or irrelevant an ineffectual oversight bodies that are disconnected from operations or too poorly resourced to affect behavior.

PCMT's infrastructure and modeling suite is designed to facilitate interagency – even international collaboration – in order to bring a diverse set of resources and perspectives to bear on complex problems. Traditionally, collaborative processes begin with a period of establishing definitions, terms of reference, norms of behavior, and other activities that determine the way the group represents problems and bounds the solutions they consider. PCMT deliberately employs competing models in order to foster and facilitate analytic debate. This approach allows participants to use whatever models best represent their personal, institutional, professional, or other interests and concerns. Thus, diverse groups need not be forced to accept models or terms of reference they object to, encouraging their sustained interest and participation in collaborative planning and action. This pluralistic view of complex problems allows for greater and deeper exchanges between agencies.

PCMT is capable of transforming interagency planning and coordination, but it will only do so if policymakers embrace it. Such demands run the gamut from technical features, such as user interfaces and communication speed, to the more organizationally salient, such as incorporating models or theories that organizations consider credible into the analytic suite.

PCMT's Research Results and Future

Since beginning in April 2003, PCMT has rapidly developed. At this time, individual technologies show promise, and early results demonstrate the utility of each of the components as well as the uniqueness and power of the larger process that links them together. At the conclusion of the eighteen-month proof of concept study, PCMT has proven to be a successful research effort, and is currently transitioning towards an operational capability; however such results do not fully reveal the future trajectory of the project.

PCMT's experimentation program, which was exemplified by an aggressive demonstration effort managed by the Joint Forces Command, identified several areas where additional development is required before a robust operational capability becomes reality. The demonstration plan examined the performance of the PCMT approach in individual countries in the Central Asia region and across regions comprised of multiple nations and border areas. At this time, an initial operational capability is anticipated for summer or fall 2005, with a sustained effort to improve PCMT based on user feedback. Particular targets of post-deployment development efforts include improving the underlying document analysis and automated scoring mechanisms, expanding the number of countries included in the database and analytic suite, adding additional social vulnerability or conflict prevention models, and developing additional data collection agents to cover a broader range of information sources. Also of interest is the development of a community of local-level data contributors in an attempt to more effectively assess non-national level phenomenon.

3. CONCLUSION

In addition to its accomplishments, a number of other agencies and institutions have taken an interest in the set of issues that PCMT is focused on. Of particular note, DARPA is launching a new program that targets the technology gaps and technical problems that were beyond the score of PCMT to address. The Pre-Conflict Anticipation and Shaping (PCAS) program at DARPA, identify and develop approaches to understand and anticipate the emergence or development of societal/regional threats capable of disrupting global and international order. These technology-derived insights will support the formulation and evaluation of strategies that allow for shaping a Combatant Commander's area of responsibility (AOR). PCAS adopts a systems concept that exploits advanced technologies such as self-sustaining analytic databases, computational social science, and modeling, simulation & gaming (MSG) approaches as a means of better understanding and anticipating societal conflict and regional instability. The PCAS system also incorporates technologies that support the formulation and evaluation of shaping strategies capable of reducing the likelihood of conflict and instability. The approaches being pursued in the PCAS effort are based on advanced planning and decision-theoretic tools, evolutionary computation, massive multi-player on-line gaming (MMOG) environments, and visual analytics that support collaborative interaction.

The systems approach implemented by PCMT reflects a major innovation in addressing future security threat. The integration of advanced IT, of computational social science, and modeling, simulation, and gaming techniques is providing a unique approach to threats at the level of the individual agent and sub-national region as opposed to the nation-state. Subsequent systems that emerge from the initial efforts of PCMT will further exploit the aforementioned technologies, along with others, in dealing with the most likely threats of the 21st century.

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BIOGRAPHY

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