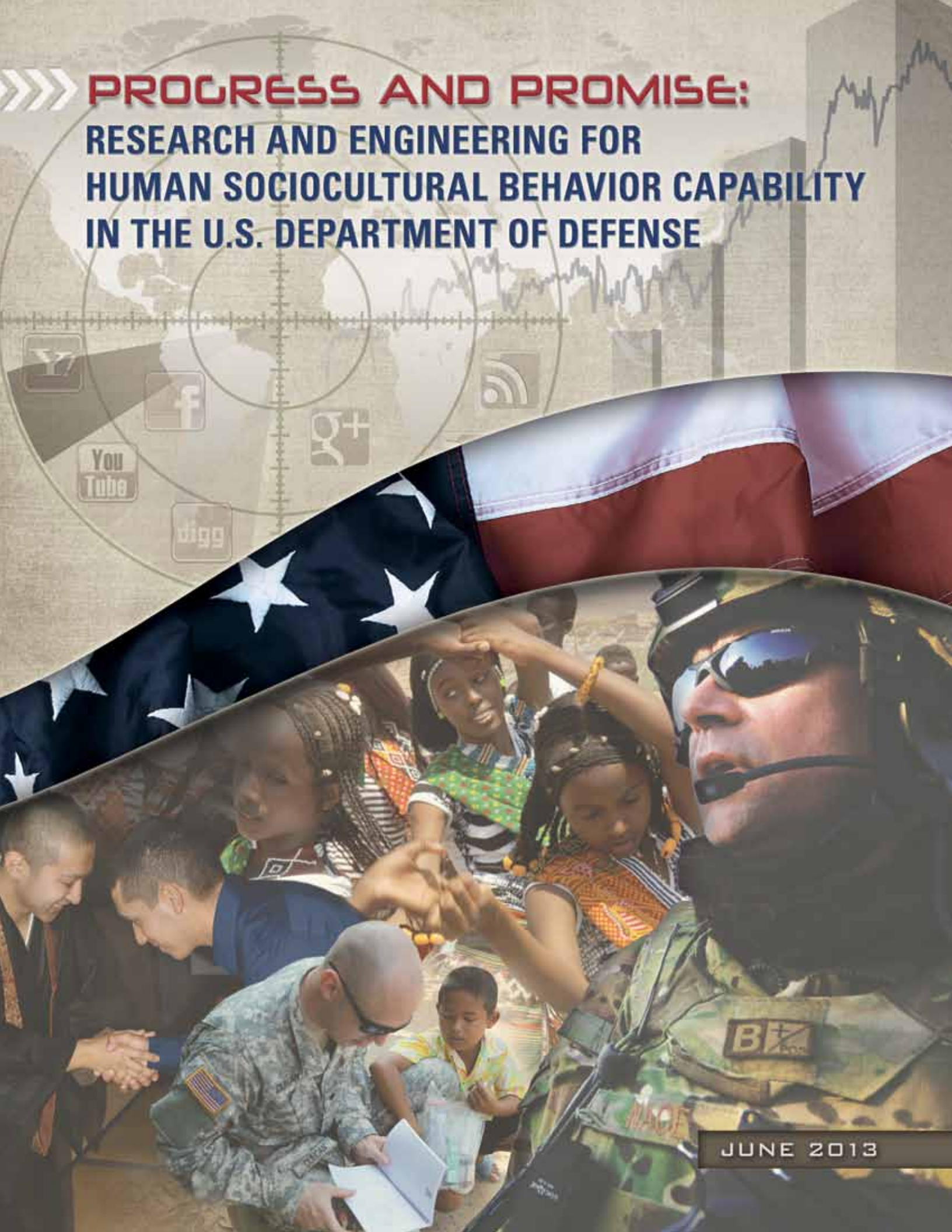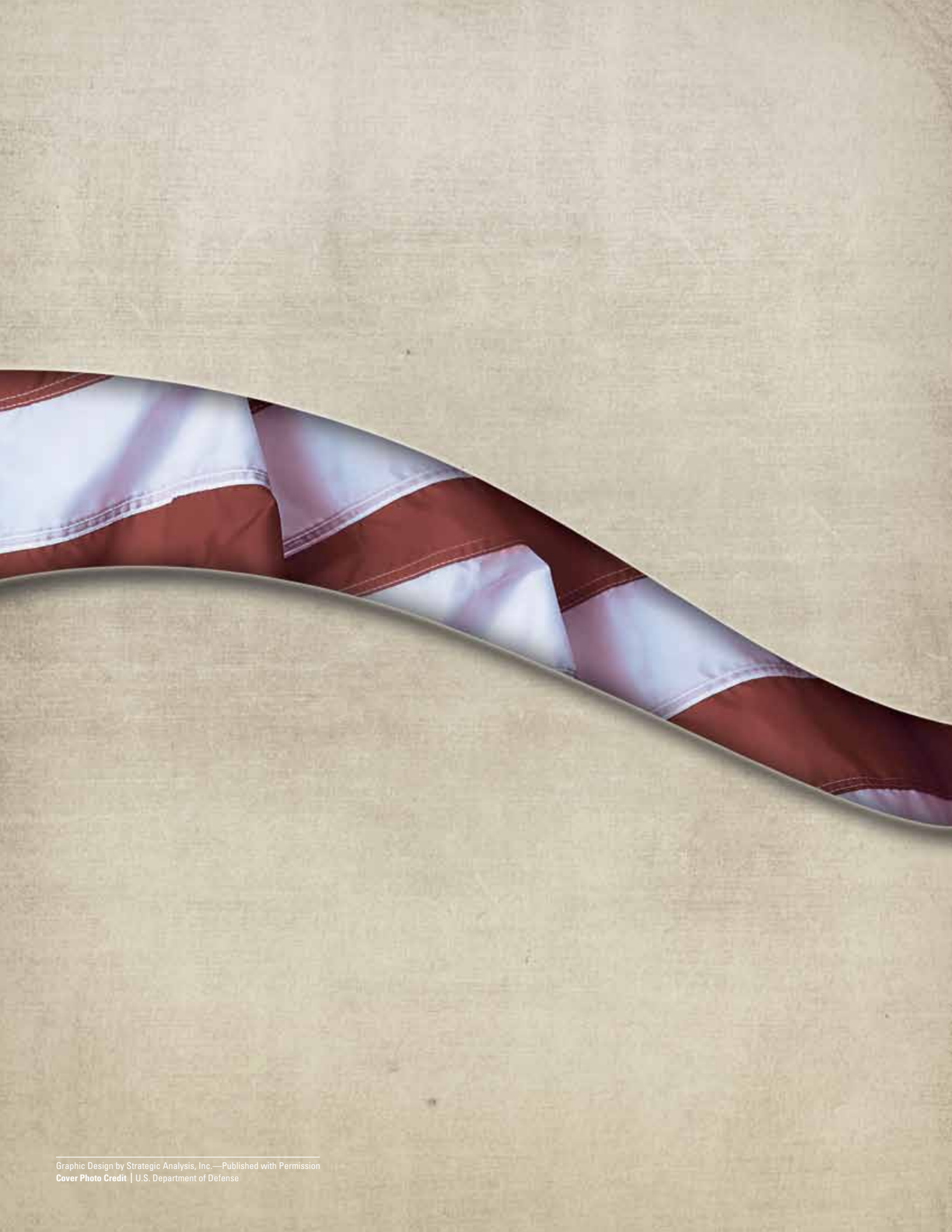# PROGRESS AND PROMISE:

RESEARCH AND ENGINEERING FOR HUMAN SOCIOCULTURAL BEHAVIOR CAPABILITY IN THE U.S. DEPARTMENT OF DEFENSE

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14. ABSTRACT

Progress and Promise is an update on defense-sponsored sociocultural behavior modeling science, technology, and technology transition from 2008 through 2013. The point of reference for this document is the Strategic Planning Guidance (SPG) 2008-13 report on human social cultural behavior modeling. Released in 2006, the SPG report identified major capability gaps and recommended substantially increased investment, particularly in the areas of Applied Research, Advanced Technology Development, and Advanced Component Development and Prototypes. Progress and Promise gives particular attention to the activities, accomplishments and impacts of the Office of the Secretary of Defense (OSD) HSCB Modeling Program, given that it was the primary response to the SPG report. The origins, funding, staffing and range of performers within the HSCB Modeling Program are described, and significant research findings and program transitions are highlighted. Additionally, this document summarizes other major initiatives across DoD and highlights accomplishments and impacts of relevant programs and projects. Finally, it discusses current and expected future national security challenges, outlines a long-term vision for sociocultural behavior capabilities, identifies research thrusts to enable those capabilities, and offers programmatic recommendations to move forward.

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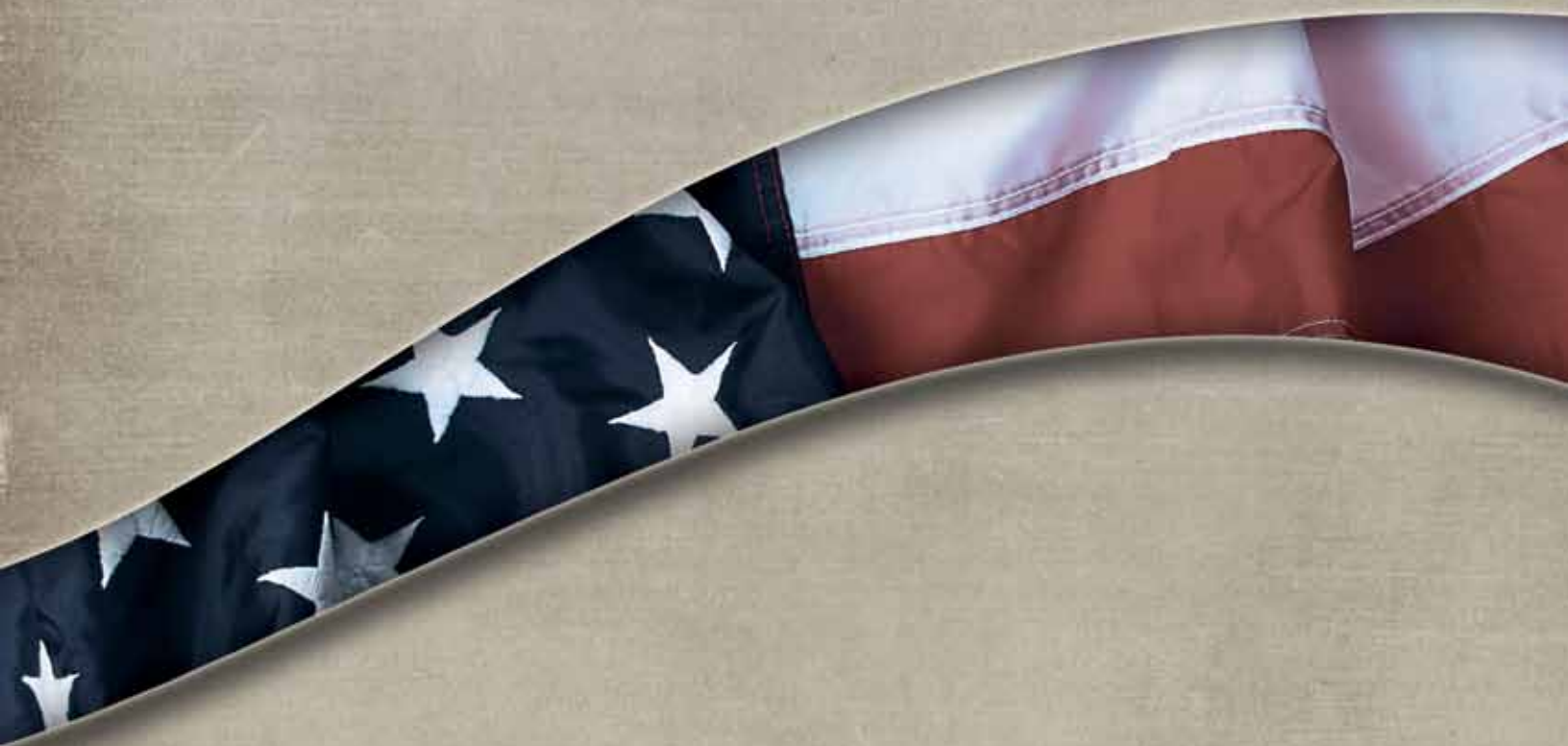
FOREWORD

Progress and Promise is an update on defense-sponsored sociocultural behavior modeling research and engineering from 2008 through 2013. It was prepared by The MITRE Corporation in its role as systems engineer for the Office of the Secretary of Defense (OSD) Human Social Culture Behavior (HSCB) Modeling Program led by Captain Dylan Schmorrow, USN. CAPT Schmorrow served as the HSCB Program Manager from 2008 through 2013.

The point of reference for this document is a 2006 OSD report on human social cultural behavior modeling research and capability. The report identified major capability gaps and recommended substantially increased investment, particularly in Budget Activities 2 through 4 (Applied Research, Advanced Technology Development, and Advanced Component Development and Prototypes). It also recommended more centralized governance of relevant research across the Department of Defense (DoD).

Progress and Promise gives particular attention to the activities, accomplishments, and impacts of the OSD HSCB Modeling Program, given that it was the primary response to the OSD report. This document also summarizes other major initiatives across DoD and highlights accomplishments and impacts of relevant programs and projects. Finally, it discusses current and expected future national security challenges, outlines a long-term vision for sociocultural behavior capabilities, identifies research thrusts to enable those capabilities, and offers programmatic recommendations to move forward.

Many individuals contributed time to review and comment on various drafts of this manuscript, or responded to requests for information as it was being compiled. Special thanks go to Mark Maybury, Maris Vikmanis, Michael Young, Laurie Fenstermacher, Joe Lyons, John Salerno, Charneta Samms, Liz Bowman, Jessica Gallus, Elizabeth Lyon, LisaRe Babin, Rebecca Goolsby, Gary Kollmorgen, Harold Hawkins, David Combs, Jim Frank, Marc Morin, Kerry Buckley, Rob Layden, Barry Costa, Gary Klein, Jill Egeth, Les Servi, Eric Hughes, and Lynette Hirschman. Special thanks as well to the many research teams sponsored by the HSCB Modeling Program who provided material necessary to summarize their work in Section III and the Spotlight features.

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EXECUTIVE SUMMARY

Years of non-conventional conflicts spanning multiple operational phases in culturally complex and unfamiliar terrain in Iraq and Afghanistan left the U.S. military with a newfound appreciation for the importance of sociocultural understanding. Success in these conflicts depended on close, effective interaction with an array of actors, including local populations, governments and military forces, allies, and non-governmental groups. This experience led an increasing number of military leaders, including Major General Freakley, Commander of Afghanistan Combined Joint Task Force 76, to articulate the need for enhanced capabilities rooted in social and cultural factors to understand and influence behaviors. "We must develop the ability to understand the complex human factors and must incorporate them into all facets of operations." [1]

Many across the communities supporting the warfighter concluded that the Department of Defense (DoD) lacked access to mature data, models, and tools for understanding, representing, forecasting, and influencing sociocultural behaviors. As part of the strategic planning process for Fiscal Year (FY) 2008–13, the Secretary of Defense tasked the Director, Defense Research and Engineering (DDR&E), now ASD(R&E), to evaluate the investment in and status of research and development (R&D) in the area of human sociocultural behavior modeling. In September of 2006, DDR&E delivered the *Report on Human, Social, and Cultural Behavior (HSCB) Modeling.* The study identified major capability gaps in this area and recommended increased investment in science and technology (S&T), in product maturation and transition, and management of sociocultural behavior modeling as a Joint Portfolio.

The most significant response to the report's recommendations was the establishment of the Office of the Secretary of Defense (OSD) Human Social Culture Behavior (HSCB) Modeling Program in FY2008. Under the direction of CAPT Dylan Schmorrow, the HSCB Modeling Program has supported a wide range of research and advanced technology development. Much of *Progress and Promise* discusses and reviews the Program's activities, accomplishments, and impacts. The DDR&E report also spurred activity across the DoD enterprise. In particular, the Services currently sponsor a wide range of relevant work through programs such as Minerva and the Multidisciplinary University Research Initiative. Overall, in the last six years the defense community has built its science and technology foundation for examining sociocultural behavior, improved its capability for understanding behaviors driven by social and cultural variables, and is now better positioned to pursue effective courses of action in the full range of military operations.

Yet much remains to be done to evolve and adapt sociocultural behavior capabilities to play a vital role in additional missions. Recent, rapid, and profound shifts in the geopolitical context have brought renewed attention to challenges such as hostile non-state

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1. MG Freakley, in Operational Needs Statement, 1 February, 2006.

actors who may be pursuing weapons of mass destruction, nation-state instability driven by drug economies and transnational criminal issues, humanitarian and disaster relief, and cyber threats. Continued sociocultural behavior research can make significant contributions to all of these missions.

Cutting across these many challenges are relatively recent, large-scale shifts in global information flow. The increasing pervasiveness of accessible wireless networks across the globe along with the immediacy and enormous scale of open source media cause many to view this media as a potentially rich source of information to enable the understanding of foreign populations. In this era where mobile communication technologies are nearly ubiquitous, individuals and groups can rapidly gain a voice, develop influence, and fuel change very rapidly and on a large scale. Tools and methods are required to support effective operations in this dynamic environment. Lieutenant General Michael Flynn, Director of the Defense Intelligence Agency, has argued that we "must develop a sensory capability to better detect the precursors to political change, a 'social radar' with a level of granularity, understanding, and confidence that enables policy leaders to make informed decisions that maximize national influence left of bang."[2]

Experience to date suggests an exciting future where global information, applied research, and analytics are fully and dynamically integrated. However, DoD and the nation are far from that desired end state. DoD should maintain momentum created by the HSCB Modeling Program and others by supporting promising research thrusts that will enable the capabilities most relevant to future national security demands.

Finally, innovative ideas for research, science, and technology are essential to long-term success in building DoD sociocultural behavior capabilities. However, those ideas can only be realized if appropriate programs and processes are in place. The recommendations that follow are derived from the experience of the last six years, including an understanding of current commercial technology and research efforts underway in this domain.

1. DoD needs a robustly funded research and engineering program to address the range of capabilities users demand. The area of applied sociocultural behavior research and engineering is still relatively young, specified requirements remain relatively limited despite widespread acknowledgment of needs, and the Services provide primarily Basic Research that is oriented to their particular priorities. There remains a need for a program and processes that can help mature Basic and Applied Research into software and tools that may be transitioned and sustained. Planned levels of approximately $50 million per year for the HSCB Modeling Program were not unreasonable, and experience with that Program suggests that resourcing under $20 million annually is not likely to be effective.

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2. Flynn (2012), p. 14.

2. The Services should prioritize S&T for sociocultural behavior capabilities, building on some of the innovative work already underway. This needs to be supported by specification of sociocultural behavior-related capabilities and associated requirements. These should be derived through coordination across the Services to maximize leveraging opportunities and minimize inefficient redundancies. With the joint requirements as drivers, each Service should then sponsor Basic and Applied Research tailored to the needs of their respective warfighters' missions.

3. To maximize the success of the first two recommended actions, DoD needs to intensify coordination across the sociocultural behavior research space. Using mechanisms such as the OSD Human Systems Social, Cultural and Behavioral Understanding sub-area group, DoD should increase coordination both horizontally (across the Services and at any given level of research) and vertically (from Basic through Applied and on to Advanced Technology Development and Prototyping programs).

4. DoD should identify a center of excellence for sociocultural modeling integration and analysis, focused on application of technology to user needs, transition to users and Programs of Record, metrics, data interoperability, model validation, and model reuse and generalizability. This center should emphasize identifying and supporting operationalization of sociocultural behavior tools. This could include helping to identify and develop resources and best practices for training, experiments with end users, requirements development, and rapid fielding.

SECTION I. BEGINNINGS: THE STRATEGIC PLANNING GUIDANCE REPORT

INTRODUCTION

The 2006 report "Strategic Planning Guidance (Fiscal Years 2008–2013)," issued by the Office of the Secretary of Defense (OSD), tasked the Director, Defense Research and Engineering (DDR&E) to evaluate the investment in and status of research and development (R&D) in the area of human sociocultural behavior modeling. In response, DDR&E delivered the *Report on Human, Social, and Cultural Behavior (HSCB) Modeling.* The study identified significant capability gaps in the modeling of sociocultural behavior and recommended increased investment in science and technology (S&T), as well as in product maturation and transition. This section summarizes the method, findings, and recommendations of that report (hereafter referred to as the SPG report), which provided a vital impetus for the next six years of Department of Defense (DoD) sociocultural behavior research and engineering (R&E) activity.

STUDY METHOD

To prepare the SPG report, DDR&E convened a working group of subject matter experts (SMEs) representing the DoD S&T community and stakeholders in relevant R&D. The SMEs included senior scientists and/or research program managers from DoD, as well as contributors from the Departments of State, Justice, Commerce, and Homeland Security, and the Central Intelligence Agency. Within DoD, participants included the Office of the Under Secretary of Defense for Personnel and Readiness, the Defense Threat Reduction Agency (DTRA), Defense Advanced Research Projects Agency (DARPA), Office of Naval Research (ONR), Army Research Laboratory (ARL), Army Research Institute (ARI), U.S. Army Corps of Engineers – Engineering Research and Development Center (USACE-ERDC), Air Force Research Laboratory (AFRL), and the Air Force Office of Scientific Research (AFOSR).

The study began with a "quick look" assessment that identified relevant work sponsored or conducted by DoD, non-DoD work that could be leveraged, and the alignment between ongoing work and strategic vectors in policy and technology. The S&T programs covered in the study focused primarily on individual cognition and lower fidelity group models that aggregate behaviors. To take the scope of future military operations into account, the study also included any research that sought to extend the state of science underlying HSCB models for individuals and groups. In parallel, the study assessed relevant research and technology aimed at means and methods: computational models, simulations, and automation technology tools for effects-based operations at the tactical, operational, and strategic levels.

The initial assessment of the relevant technologies and required knowledge led the SMEs to group technologies into six main domains: (1) Data and Knowledge Generation, (2)

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Data and Knowledge Management, (3) Theory and Understanding of HSCB, (4) Analytics and Modeling, (5) Visualization, and (6) Training. The SMEs categorized the first three domains as "foundational knowledge," while the last three were considered "output."

The second step consisted of breaking each domain area into essential capability areas that corresponded to required technical capabilities or foundational knowledge directly supporting the domains. The SMEs identified 75 capability areas spread across the domains: 7 in Data and Knowledge Generation, 11 in Data and Knowledge Management, 8 in Theory and Understanding, 21 each in Analytics and Modeling and Visualization, and 7 in Training. They then evaluated whether investments in each area provided substantive and/or sustained coverage of a capability, and used this information to determine the status of each capability area given then-current and planned DoD projects.

FINDINGS

SCOPE OF ACTIVITIES

The SPG report concluded that the DoD lacked a core human sociocultural behavior capability, as well as data and collection methods to support understanding, models, and development of useful tools. No Research and Development Descriptive Summary identified during the study specifically called for sociocultural behavior modeling capabilities. None of the modeling or technology work included planned technology transition. Furthermore, none of the 58 projects spanning Budget Areas (BAs) 1–3 had allocated adequate funds needed to mature products or provide risk reduction efforts.[3] All BA2 and BA3 project managers interviewed for the study reported a lack of adequate funding to inform and update their models and tools.

The number of projects funded by DoD rose sharply in FY06 following little or no investment in prior years, but the study predicted that the high level of activity would subside by FY08–09, when most projects were scheduled to end. A large majority of projects clustered in the "output" domains of modeling, visualization, and training. Examples included the development of geospatial visualization tools, training/mission rehearsal support, and modeling/simulation algorithms to support training and experimentation. By contrast, very few projects fell within the core/foundational areas of data/knowledge generation, data management, and theory/understanding, which are essential to drive tool development and ensure the robustness of the modeling and toolsets. The largest gaps occurred in areas of data acquisition and development of robust relationships between sociocultural factors and military operations.

Among the capability areas identified, only two received "Green" ratings, indicating substantial and sustained investments in the area. The SMEs rated 14 areas as "Yellow,"

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3. Department of Defense Research Development Test and Evaluation (RDT&E) budget activities (BA) are broad categories reflecting different types of RDT&E efforts. BA1 designates Basic Research, BA2 Applied Research, BA3 Advanced Technology Development, and BA4 Advanced Component Development and Prototypes. Corresponding funding for these BA designations are 6.1, 6.2, 6.3, and 6.4. Collectively, BA1-3 activities may be referred to as "Science and Technology."

2

with some sustained and substantial investments, and the remaining 59 capability areas as "Red"—including all of the capability areas within the Data Generation and Knowledge and Data Management domains. Moreover, no individual capability areas had ongoing efforts in all three S&T levels (BA1–BA3) across the 2007–11 Future Years Defense Program (FYDP), highlighting the failure to link basic science to prototype development. Research and interviews showed that none of the BA2 and BA3 HSCB project managers involved in the study had planned for life-cycle updates to their products.

The temporal profile of the projects revealed a near-term focus on support for current military operations rather than efforts to build and demonstrate a sustained capability. The largest investment focused on near-term deliverables to meet field capability gaps. Most FY06 projects centered on near-term deliverables such as geospatial tools or intelligence/influence operations software to give an initial capability to forces in Operation Enduring Freedom/Operation Iraqi Freedom. Few of the results from these projects could be generalized, integrated with existing information systems, or maintained to accommodate new information. Furthermore, there was no coordination with Programs of Record (PORs) for transition and maintenance of research products. A small number of programs, such as the Army Engineering, Research and Development Command's (ERDC's) geospatial work, had identified customers, but none of the BA2 or BA3 projects had transition agreements or BA4 funding in place. Instead, organizations used Operations and Maintenance (O&M) or BA3 funds to deliver technologies to the field.

R&D INVESTMENT

The DoD invested $36 million in human sociocultural behavior projects during FY06, and a total of $193 million was planned for the period FY06–11. The planned investment for FY08–13 (Program Objective Memorandum [POM]08) amounted to $118 million. The BA1 investment was $9 million in FY06, with a POM08 investment of $24 million; BA2 investment was $19 million in FY06, with a POM08 investment of $61 million; and the BA3 investment was $8 million, with a POM08 investment of $33 million.

The bulk of the investment and projects clustered within three organizations: ERDC, DTRA, and AFRL. The AFRL's investment in two application areas—Intelligence, and Influence Operations—represented almost half of the projects and funding for the entire DoD investment. Project investments and scope varied considerably; some organizations invested an average of $2–3 million per year in a specific, focused technology that applied to a single capability area, while others invested a small portion of their overall project budgets in preliminary assessment of the sociocultural areas relevant to an ongoing larger experimentation project.

The DoD investment in the FYDP 07–11 addressed only half (38/75) of the human sociocultural behavior capability areas, with the bulk of the investment due to end in FY08. The SMEs estimated that a similar investment would be needed to close all of the identified gaps across the POM08 timeframe, at a cost of approximately $70 million annually ($420 million across FY08–13). The SPG report authors estimated that this would provide the Services with full foundational data collection methodologies and foundational theories

within the HSCB modeling area, as well as sustainable models and toolsets that could be transitioned to support operations, training, and experimentation.

Little funding was available to support technology push to legacy programs or to provide new capabilities not tied to major acquisition programs. The FY06 budget for the sociocultural behavior-related programs allocated no resources for BA4. To estimate the resources needed for sociocultural behavior modeling, the SMEs estimated BA4 needs to be $1 million per project, and assumed a BA2 transition rate of 50% and BA3 transition success rate of 75%. Using the actual number of efforts in the FY06 project lines (21 for BA2 and 11 for BA3), this yielded an estimated annual average cost of $18 million across the POM08 FYDP.

The SPG study concluded that the projected FY08 FYDP for R&D in human sociocultural behavior modeling (spanning the range from Basic Research to Advanced Component Development/Prototypes) was inadequate, and that the DoD should support more projects in foundational areas to feed into a coherent set of major acquisition projects. To remedy these shortcomings, the SPG working group estimated that DoD should allocate $420 million to cover needs for FYDP 07–11: $302 million in BA1–3 and $99 million in BA4. Given the actual planned allocation of $118 million, this left an unfunded balance of $302 million.

The working group postulated that the funding shortage could be filled by a combination of internal DDR&E direction of resources and Program Budget Decision reallocations. The DDR&E direction of Multidisciplinary University Research Initiative (MURI), and Small Business Technology Transfer/Small Business Innovation Research (STTR/SBIR) program resources could cover $138 million of the BA1–3 shortfall, leaving $164 million to be reallocated. The MURI accounts could be executed through the Service component MURI process, with direction from DDR&E. The STTR/SBIR efforts would be executed through existing OSD and Service SBIR process, including issuance of Broad Agency Announcements (BAAs) by the appropriate program office. All $99 million for BA4 would require reallocation.

GOVERNANCE

Despite the high priority accorded to Theater Security Cooperation Program (TSCP) and Stability, Security, Transition, and Reconstruction (SSTR) missions and the frequently expressed need for tools to help decision makers, planners, and trainers to represent and analyze sociocultural behavior phenomena, no Research, Development, Technology, and Engineering (RDT&E) Program Elements (PEs) had human sociocultural behavior as their stated purpose. The SPG report found that the absence of concise, stated requirements in this area led to an ad hoc process of resourcing and transition planning. Organizations responded independently to user demands by developing new products or modifying existing ones without the potential for leveraging other investments or generalizing their own results. No one entity in the S&T community had sole or primary responsibility for the DoD's investment in human/organizational behavior and sociocultural modeling. Neither the Service components nor organizations at the OSD level had a structure for management or governance of sociocultural behavior modeling science, technology, or products.

The SPG report warned that even successfully transitioned products could not be managed throughout their life cycle in the absence of a coherent governance strategy. Until the DoD established such a strategy, even additional funding would likely result in wasted resources and limited delivery of new capabilities to U.S. forces.

RECOMMENDATIONS

The report offered three primary recommendations:

1. The DoD should increase and organize the FY08–13 S&T (BA1–3) investment in HSCB capabilities, particularly in research that would help to fill the identified gaps. The DoD should establish three new PEs for BA1–3, fund BA1 at $78 million, and fund BA2/BA3 at $342 million.

2. The DoD should establish a new PE for BA4 investment to support product maturation and transition, and fund it at $99 million.

3. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) and the Vice Chairman of the Joint Chiefs of Staff should establish human social cultural behavior modeling as a Joint Portfolio, managed by a Joint Program Office (JPO). The new JPO should manage the BA2–BA4 reallocated funding and guide the directed funding across the FYDP. USD(AT&L) should also establish a Program Executive Council to coordinate and integrate U.S. Government investments that contribute independently to human sociocultural behavior modeling goals.

CONCLUSION

Overall, the study concluded that only the DoD could support the R&D necessary to develop the specialized sociocultural behavior knowledge and tools that military users need to confront the challenges of irregular warfare and SSTR. Research at academic institutions and, more recently, industry often had little applicability to DoD needs and missions. Furthermore, while the U.S. commercial sector undoubtedly has the capability to develop software tools for the military, most of the tools created for the sociocultural behavior area were based on theories, rules, and heuristics that had not been demonstrated to be applicable to DoD missions.

Given this situation, the SPG report authors considered DoD investment in and governance of HSCB R&D inadequate to provide current and future warfighting and SSTR-relevant capabilities at the strategic, operational, and tactical levels. The DoD would need to increase its investment in order to fill known technical/capability gaps and ensure transition of proven capabilities into PORs. Managing sociocultural behavior modeling work as a Joint Portfolio would help to ensure that programs delivered the greatest possible benefit to U.S. warfighters.

SECTION II. THE OSD HSCB MODELING PROGRAM

The OSD responded to the recommendations of the SPG report by establishing the Human Social Culture Behavior (HSCB) Modeling Program in FY2008. This section reviews the Program's history, including its goals, technical objectives, engagement of end-users and the R&E community, and technical assessment processes.

PROGRAM GOALS AND ORGANIZATION

In keeping with the recommendations in the SPG report, OSD designed the HSCB Modeling Program to vertically integrate three levels of RDT&E: Applied Research (6.2), Advanced Technology Development (6.3), and Advanced Component Development and Prototypes (6.4). The Program concept strongly emphasized the transition of evolving S&T to fill the main 6.4 gap documented in the SPG report. Separate PEs were established for each of these RDT&E levels, along with mechanisms and processes for coordination with basic research programs to help ensure coherence across the defense R&E community.

More specifically, OSD designed and executed the Program to achieve four goals:

1. Build an applied science base for general-use, cross-domain capabilities and tools

2. Develop computational models that will support understanding and forecasting at the strategic, operational, and tactical levels

3. Integrate models into software tools that assist in considering human sociocultural factors to support course of action (COA) analysis and decision making

4. Support transition, whether through architectures of existing PORs or open architectures that would allow broad systems integration

ORGANIZATION

OSD established and funded the Program through the OSD DDR&E—which would become the Assistant Secretary of Defense Research and Engineering (ASD(R&E)) in 2011. The Program was housed in the Human Performance, Training and BioSystems Research Directorate, with responsibility for program direction given to that office's Deputy Director.

DDR&E created an HSCB program management team to provide the Program Director with technical input and assist in overall management of the program. Members were drawn from the Combating Terrorism Technical Support Office (CTTSO), the Office of Naval Research (ONR), USACE, U.S. Army Research, Development, and Engi-

neering Command, National Defense University, and The MITRE Corporation. To date, CTTSO and ONR have been responsible for the majority of Program execution, issuing BAAs and overseeing work by industry, academic, and government performers. Contracts have been the primary vehicle for HSCB Program projects. Other work, particularly at the RDT&E 6.4 level, has been funded directly by ASD(R&E), with performers including government or service institutions and Federally Funded Research and Development Centers (FFRDCs). Over its lifetime, the Program has supported approximately 100 discrete projects.

FUNDING

On the basis of the needs and recommendations described in the 2006 SPG report, DDR&E originally planned for the Program to have steadily increasing budgets over the period FY2008–2013, with particularly substantial increases in the out years of FY12 and FY13. The primary driver of growth in those out years would be increased investment in Advanced Component Development and Prototypes, in keeping with the 2006 SPG report's emphasis on under-investment in technology transition. The planned cumulative total over the six years was $198 million.

As Figure 1 shows, rather than increase as planned, executable funding levels essentially reached a plateau in FY09, at just over $20 million annually, before declining in FY13 when DoD adopted fiscal austerity measures related to the sequestration process. Overall, the Program has been executed to DoD benchmarks: as of December 2012, 100% of FY12 funding had been obligated, and 75% of the funds had been expended. The executable value of the Program is expected to total $121 million, 39% less than planned at the Program's onset.
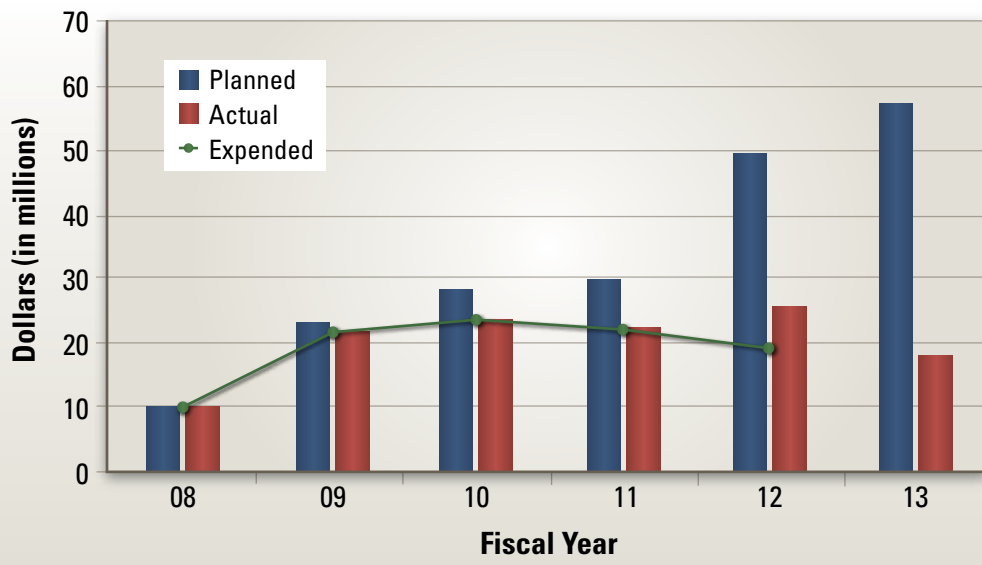
Figure 1. HSCB Funding Plan

Program Technical Objectives

Exhibit R-2 (R2) of the Budget Item Review Justification for each PE documents the technical objectives of the HSCB Modeling Program. Those objectives were derived from the gap analysis and recommendations of the SPG report, as well as from further review of sociocultural behavior research efforts across the DoD and dialogue with representatives from both research and end-user communities. As the research program gathered momentum, Program leaders also worked actively to facilitate exchanges among HSCB Modeling Program stakeholders to continue to identify critical gaps, and foster greater coordination and integration of research across the defense community. Figure 2 provides a summary of the Program objectives for each PE.

Mature, harden, and validate software for transition to meet warfighter needs, integration into architectures of existing PORs, and/or maturing software via open architectures.

6.4

Develop and demonstrate general-use, cross-domain modeling capabilities for forecasting, strategic decision-making tools, technologies enabling more widespread and effective use of sociocultural behavior models in operations, training/mission rehearsal systems capable of using cultural models, and visualization software toolsets.

6.3

Develop and validate theoretical constructions, generate knowledge products, and develop stand-alone computational models of sociocultural behavior; develop methods for visualizing sociocultural behavior variables; identify cultural competencies indexed to warfighter tasking and develop methods for flexible training; improve methods for sociocultural data collection.

6.2

Source: FY 2008 Budget Item Review Justification, Exhibit R-2

Figure 2. Program Objectives

As indicated in these summaries, each PE comprises a number of technical areas. Nearly all of the PE's involve developing new capabilities in four areas: methodologies for collecting and managing data on sociocultural behavior; computational models and their instantiation as software; techniques and tools for visualization of sociocultural behavior factors; and content and tools for training warfighters in sociocultural behavior knowledge, skills, and abilities. In the 6.2 PE the modeling area emphasized research to develop, refine, and validate theory and to generate knowledge products. The 6.4 PE did not include training, but incorporated an area specifying objectives for overall program risk reduction. The HSCB Modeling Program technical areas correspond to the gap areas identified in the SPG report, as shown in Table 1.

Table 1. SPG Gaps and HSCB Technical Areas

SPG Gap Areas	HSCB Program Technical Areas
Data and Knowledge Generation	6.2 Data
Data and Knowledge Management	6.3 and 6.4 Data
Theory and Understanding	6.2 Theory/Modeling
Analytics and Modeling	6.2, 6.3, and 6.4 Modeling
Visualization	6.2, 6.3, and 6.4 Visualization
Training	6.2 and 6.3 Training

The Program's technical objectives have evolved incrementally as the priorities and requirements of both PORs and end-users have evolved, and were adjusted to reflect initiatives by other elements of the DoD R&E community. Changes in fiscal resources have driven sharper, more fundamental changes, with the greatest impact falling on the training and visualization areas. Both areas were zeroed out starting in FY12 so that the Program could concentrate its investments on the core areas of modeling and data.

DISTRIBUTION OF EFFORT AND INVESTMENT

The Program's investment profile is consistent with the findings and recommendations of the 2006 SPG report. It includes a broad foundation of applied research, relatively heavy concentration in development of technologies, and a significant investment in efforts to mature those technologies into transition-ready prototypes. Figure 3 summarizes the distribution of OSD HSCB Modeling Program effort by RDT&E level. Funding was weighted somewhat more heavily toward Advanced Technology Development—the bridge

Program Investment by RDT&E Level (in thousands)

$30,327 $41,897 $49,119

Projects by RDT&E Level

13% 39% 48%

- Applied Research
- Advanced Technology Development
- Advanced Component Development/Prototypes
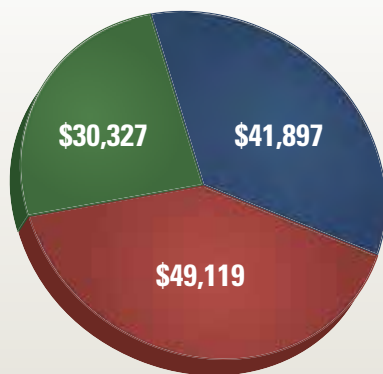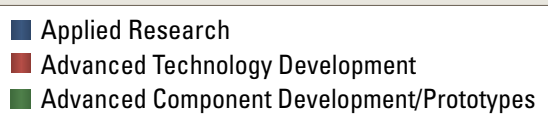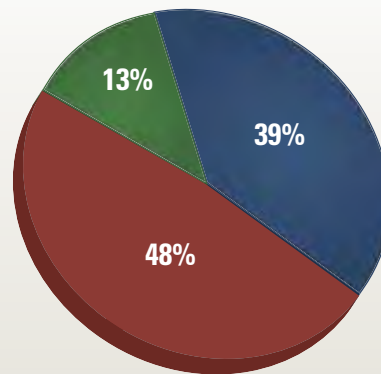
Figure 3. Program and Project Investment by RDT&E Level

between Applied Research and transitionable prototypes. Over the life of the Program, 40% of funding has supported 6.3-level work, compared to 35% for 6.2 and 25% for 6.4.

The distribution of the number of projects across the levels tells a similar story. Advanced Component Development and Prototypes efforts represent a smaller share of the total number of projects, but have been comparatively larger in scope and resourcing.

Figure 4 and Figure 5 provide another perspective on the Program: one tied directly to the 2006 SPG report. Figure 4 shows the distribution of projects across the technical objectives given in the R2s for each PE, while Figure 5 shows a distribution based on gap areas from the 2006 SPG report.
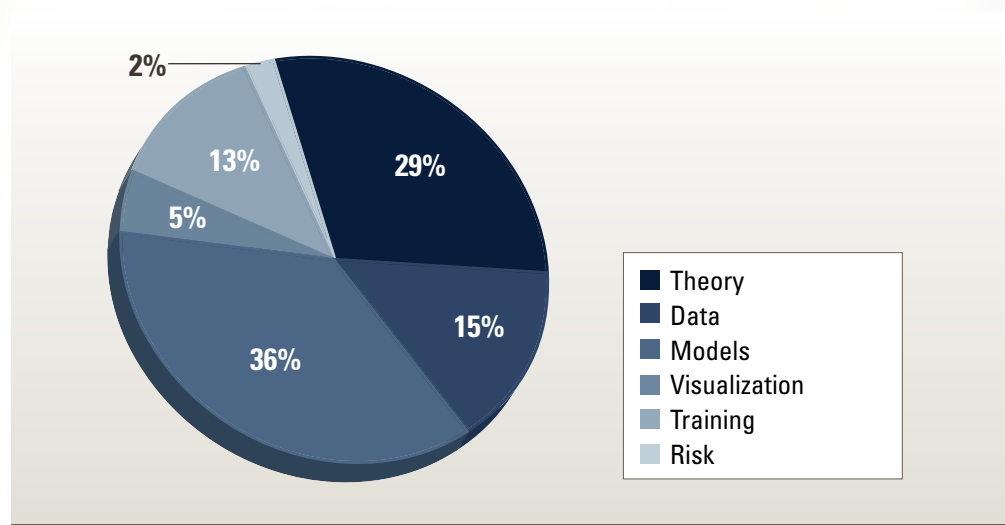
Figure 4. R2 Groupings
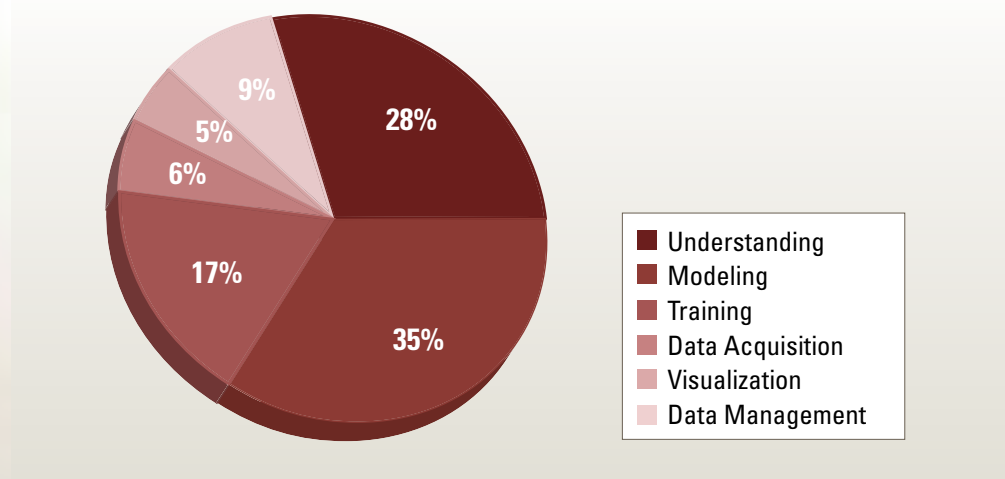
Figure 5. HSCB Modeling Program Projects and SPG Gaps

The two figures present a comparable picture of the Program's technical work. The distribution of projects shown is cumulative for the 2008–13 period. It is based on the assignment of each project to only one of the R2 areas; in reality, most projects support objectives in more than one area. Figure 5 shows a significant concentration of effort in computational modeling, along with applied research on development of theoretical constructs and knowledge products. Data methodologies and tools represent 15% of the projects under the Program; 13% of the portfolio has focused on training objectives (this representing approximately 9% of funded value).

Both Figure 4 and Figure 5 indicate relatively low investment in R&E focused on visualization, despite the identification of many visualization-related capability gaps in the 2006 SPG report. However, while few projects focused on visualization-related challenges, many projects advanced the state of the practice in visualizing sociocultural behavior data and analyses. These projects centered on engineering user interfaces (for those whose work was instantiated in software) and representing their models and data to HSCB Modeling Program leadership and potential transition partners.

LEADING CONTRIBUTORS

Figure 6 and Figure 7 depict data on the people and organizations performing the sponsored R&E and offer a final summary perspective on the OSD HSCB Modeling Program. The project teams involved in the program have been drawn from across the spectrum of candidate organizations, with just over half from industry—many of them small businesses, nearly a quarter each from academia and government labs, and 5% from FFRDCs such as MITRE, RAND, the Jet Propulsion Laboratory at the California Institute of Technology, Los Alamos National Laboratory, and the Institute for Defense Analyses (IDA).
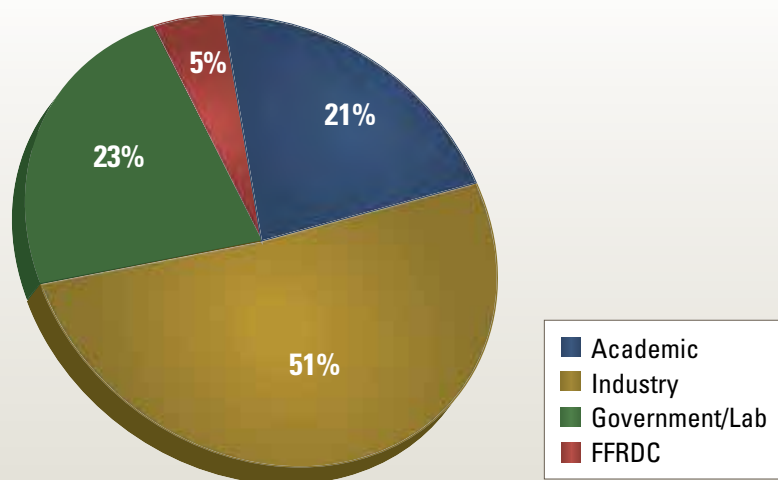
Figure 6. HSCB Modeling Program Project Leadership

Figure 7 provides one indicator of the Program's scientific and technical diversity. It charts data for 38 teams with agreements executed through ONR, covering most of the Program's core, multi-year efforts active since 2011. These projects, which span 6.2 through 6.4 work, vary widely in terms of technical scope, budget, and team size. They therefore represent a good sample of the Program and its multi-disciplinary character. As befits a program centered on computational modeling, the most common discipline among awardees is computer science. The physical and engineering sciences are also heavily represented, followed by a variety of social and behavioral sciences, including political science, psychology, sociology, economics, and anthropology.
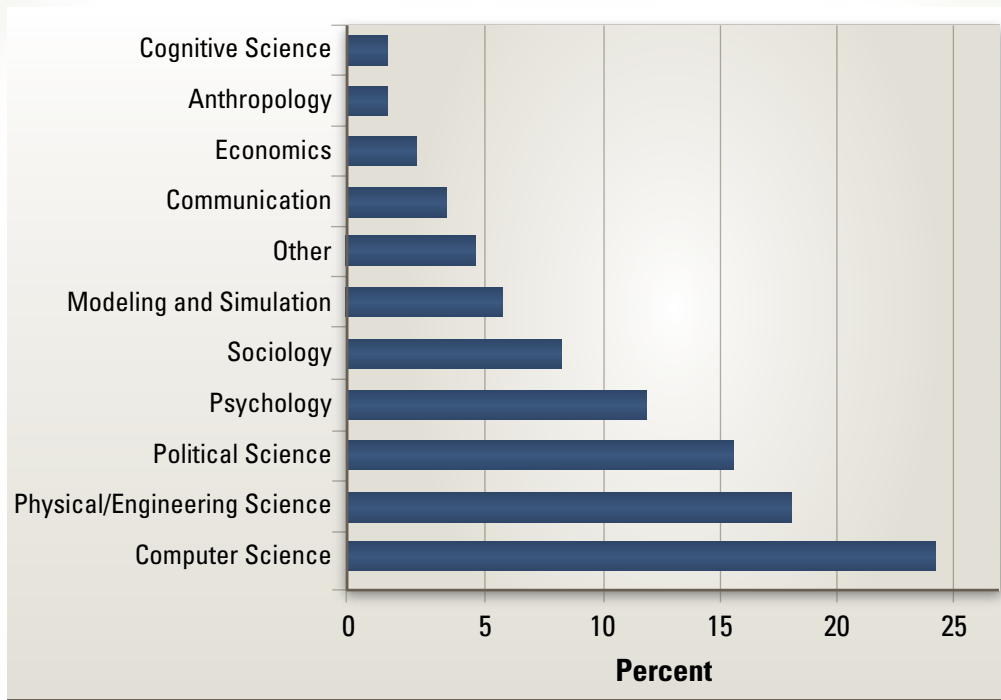
Figure 7. Scientific Disciplines of Awardees

USER ENGAGEMENT AND TECHNOLOGY TRANSITION

One of the core recommendations of the 2006 SPG report focused on governance, and on the need to ensure a coherent DoD-wide program of R&E in HSCB modeling. For the OSD HSCB Modeling Program, such coherence has derived in part from ensuring that the Program's vision, objectives, and portfolio are aligned with national strategic guidance, as expressed in the National Security Strategy, the Quadrennial Defense Review, the National Military Strategy, and Joint Vision 2020. Achieving coherence also requires persistent and reliable mechanisms for engaging with the community of PORs, U.S. Combatant Commands (COCOMs), and other potential users of sociocultural behavior S&T.

The HSCB Modeling Program has instituted a variety of processes to make PORs and other potential users aware of sponsored R&E, to build and maintain awareness of user needs, and to create paths for technology transition. During the Program's foundational stage, a program execution Integrated Product Team (IPT) and a Senior Technical Advisory Group provided input on strategic direction, interagency coordination, and transition support. In 2009, the U.S. House of Representatives directed the USD(AT&L) to "establish a DoD User Community Advisory Group (UCAG) to provide input to the Department on the utility of existing HSCB research efforts." The DoD Irregular Warfare Modeling and Simulation Senior Coordinating Group (IW M&S SCG) has fulfilled that user group function.

In addition to working with the formally designated UCAG, the HSCB Modeling Program has emphasized coordination of its activities with the Minerva Research Initiative, Strategic Multilayer Assessment (SMA), Defense Intelligence Socio-Cultural Capabilities Council, Human Systems Community of Interest, Human Terrain System Program, and Defense Language Steering Committee. Program leadership has also routinely participated in and briefed at the COCOMs' S&T meetings.

Technology transition presents a significant challenge for any S&T program—particularly in the area of HSCB capabilities, given the relative scarcity of programs that explicitly incorporate sociocultural analytic and modeling requirements. While user needs constantly increase, considerable time elapses before the official DoD acquisition community can formally codify these requirements and create the POR necessary to field and sustain capabilities. Meanwhile, warfighters actively wrestling with challenges in the area of sociocultural behavior have issued a very strong call for HSCB understanding, data, and tools. With leadership from the Army Geospatial Center, MITRE, and ONR, the OSD HSCB Modeling Program has placed the highest priority on responding to that call, offering a form of transition that is much more rapid and targeted than the standard acquisition process. Section III presents details on the Program's transition activities and accomplishments.

TECHNICAL ASSESSMENT

From its inception, the HSCB Modeling Program has emphasized technical rigor, instituting processes to evaluate individual Program-funded performers and assess how well the Program as a whole addresses DoD needs. Running through both lines of assessment is the recognition that deep uncertainty is inherent in sociocultural models and cannot be eliminated by verification and validation. Rather, the objective of such models is to help decision makers visualize more culturally complete futures and choose robust options that will prove effective across the broadest swath of those futures. The crucial contribution of these models is conveying understanding—enhanced awareness of situations and options. The Program has ensured that sociocultural models meet this criterion by conducting technical assessments of the models' underlying construction,

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and by enlisting SMEs to validate the key factors, key relationships, and causal reasoning driving the models. The SMEs also perform empirical assessments to ensure that situation awareness and option awareness are conveyed in a manner acceptable to users.

At the project level, the Program requires selected individual performers to demonstrate the technical elements of their R&E efforts and discuss them with a SME team during a technical performance evaluation (TPE). The SME teams consist of social and behavioral scientists, computer scientists, modeling and simulation (M&S) experts, operations analysts, and others able to evaluate the disparate elements of a project in any of the research categories funded by the HSCB Modeling Program.

The TPEs systematically characterize the performance status of more mature projects along a common set of dimensions. Each TPE has multiple phases. In the preparation phase, performers address a set of 10 core generic criteria, such as a demonstration of how their system can or will interoperate with other systems. The second phase consists of a day-long collaborative event, during which performers demonstrate their R&E efforts to the SME team and answer questions about the technical and theoretical elements involved. Questions posed by the SMEs reflect topics often raised by operational and transition partners, thus serving to assist performers in their development process while also providing the TPE SMEs with valuable information about the project. The final phase involves condensing SME characterizations into an integrated report delivered to Program leadership for review, with recommendations and suggestions for further research, development, and transition. The entire TPE process systematically provides indicators of progress for individual projects, allowing Program management to further guide performers, and ensuring that projects remain relevant, grounded, and moving towards successful transition.

While the TPE process focuses on the performance of individual projects, Program Management Assessments (PMAs) characterize the entirety of the HSCB Modeling Program. A PMA identifies gaps in the Program that would drive investment decisions, facilitates the transition process by demonstrating how the Program meets warfighter needs, identifies and characterizes critical technical risks, and ultimately provides an overview of the Program to OSD. To achieve these purposes, the Program defined discrete measures of effectiveness for each year, for each funding category, and for each major technical area in the Program.

CONCLUSION

The OSD HSCB Modeling Program represents the single most significant response to the 2006 SPG report. The findings and recommendations of that report drove all of the Program's technical objectives, structure, and processes, although funding—particularly in 2012 and 2013—did not reach planned levels. Section III provides a summary of the Program's activities, accomplishments, and impacts.

SECTION III. OSD HSCB MODELING PROGRAM ACCOMPLISHMENTS AND IMPACTS

The OSD HSCB Modeling Program addresses complex challenges facing the DoD in the sociocultural analysis and modeling domain and has succeeded in bringing practical tools for sociocultural analysis and forecasting to users in the field. This section summarizes and provides data on the HSCB Modeling Program's investments and technical activities for 2008–2013, and highlights accomplishments of the Program and its performers, as well as the impact of Program efforts on end-users. It groups projects within the four main areas of the Sociocultural Behavior Capability Areas framework introduced in the 2011 report *Sociocultural Behavior Research and Engineering in the Department of Defense Context* (hereafter referred to as the SBRE report).

CAPABILITY AREAS FRAMEWORK

As depicted in Figure 8, each set of capabilities in the framework feeds into the next, forming a cycle. ***Understand*** refers to capabilities that support perception and comprehension of the sociocultural features and dynamics in an operational environment. ***Detect*** covers capabilities to discover, distinguish, and locate operationally relevant sociocultural signatures through the collection, processing, and analysis of sociocultural behavior data. ***Forecast*** capabilities aid in tracking and predicting change in entities and phenomena of interest along multiple dimensions through persistent sensing and modeling of the environment. The end of the cycle is ***Mitigate***, encompassing capabilities to develop, prioritize, execute, and measure COAs grounded in the social and behavioral sciences.
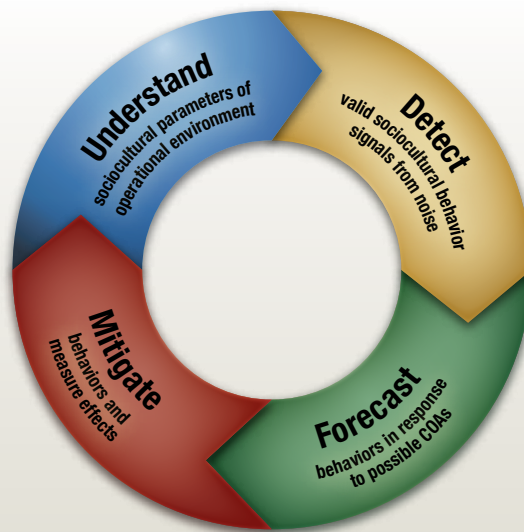
Figure 8. Capability Areas Cycle

Figure 9 shows the distribution of projects by capability area and gives a perspective on the overall technical character of the OSD HSCB Modeling Program. As shown in the figure, the Program portfolio has been relatively well balanced across the four areas. The **Mitigate** area has the lowest concentration of projects, in part because it presents the most significant technical and operational challenges and depends to some extent on success and capability already existing in other areas. Mitigation capability requires that operators and decision makers be able to simulate alternative COAs that are almost certainly interdependent, as well as the possible range of effects those COAs will have, while appropriately accounting for uncertainty.
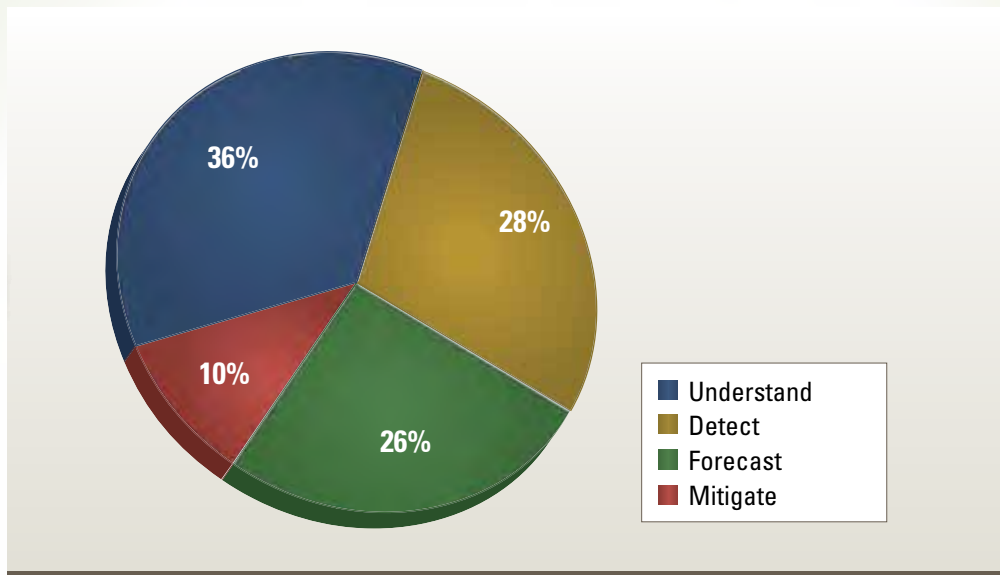
Figure 9. Distribution among Capability Areas

PROJECT TECHNICAL ACCOMPLISHMENTS

Taking the capability areas as an organizing framework, the following sections summarize the technical accomplishments and impacts of many of the projects sponsored by the OSD HSCB Modeling Program. Appendix A provides a bibliography of publications and presentations derived from HSCB-funded research.

UNDERSTAND

The HSCB Modeling Program places strong emphasis on improving understanding of the behavior and decision making by malicious actors and organizations, the sociocultural dynamics that drive events in societies of interest across the globe, and potential U.S. responses to Humanitarian Aid and Disaster Response (HADR) operations. This understanding supports the interpretation of human and sociocultural features and dynamics in strategic and operational environments. In addition, the HSCB Modeling Program has focused on improving sociocultural training to support the sociocultural fluency and agility of U.S. warfighters.

Understanding Terrorist and Insurgent Dynamics

The first step toward countering adversaries lies in understanding their motivations, methods, and relationships. HSCB performers made considerable progress in developing the DoD's understanding of the dynamics and interrelationships that underlie terrorist and insurgent groups. A research partnership between the **University of Washington** (UW) and **Johns Hopkins Applied Physics Laboratory** (APL) developed an innovative methodology for the integrated analysis and modeling of insurgent rhetoric, networks, and decision making. This methodology includes models of insurgent leadership, foot soldier dynamics, rhetoric-based metrics of insurgent factional polarization, and how internal dissension moves within an insurgency—all of which can contribute to identifying and exploiting potential weaknesses in the insurgency. UW and APL successfully applied this methodology to develop models in the context of two case studies: the Sunni insurgency in Iraq and the Pashtun insurgency in Afghanistan and Pakistan, thereby increasing understanding of the underlying dynamics that drive these conflicts.

Another key effort that focused on the internal dynamics of terrorist groups, **Pennsylvania State University's** Competitive Adaptation of Terrorist Networks (CATNet) project, built computational models of competitive adaptation in terrorist networks based on interviews with individuals involved in terrorist and extremist organizations and with counterterrorism personnel. The research team also developed a methodology for extracting relevant information concerning actors, events, beliefs, and relationships from raw text documents that showed significant increases in speed, scalability, and focus over prior methods. Combining text analysis with the interview data, the researchers modeled how terrorist and counterterrorist organizations adapt to each other's strategies and devise new methods for reaching their goals in light of their adversary's behavior. This research has the potential to offer both policy makers and the operational community new insight into how best to act or react to limit terrorist group activity.

Understanding is equally concerned with capturing lessons from the past as with analyzing current dynamics. To advance understanding of the history and dynamics within Afghanistan, a joint project by **Stanford University** and the **Naval Postgraduate School** mined unique primary data sources that include formerly highly classified Soviet government documents now available at Stanford University's Hoover Institution Library and Archives, as well as the memoirs and records of Soviet veterans. This analysis shed new insight into the dynamics of Soviet conflict in Afghanistan, and how those lessons might apply to today's mission. The project delivered an analysis of this information to military leaders in a variety of forums and also distributed it to deploying units with the relevant background tailored to their destination areas.

Understanding the Population

Research at **Eastern Michigan University** has made considerable progress in improving understanding of the shifting sociocultural dynamics across the Middle East. The Comparative Project on Islamic Fundamentalism in the Middle East was built

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CULTUREGEAR

361 INTERACTIVE

The culturally immersive nature of contemporary military missions such as Counterinsurgency (COIN) operations, disaster relief, stability-support operations, and foreign forces training dictates that the leaders of small units regularly interact with foreign nationals and make cultural assessments of their operating environments. To foster critical observation, assessment, and awareness skills prior to deployments, 361 Interactive developed CultureGear, a computer-based training and self-assessment tool that promotes warfighters' ability to assess and proactively shape their cultural environments in order to achieve mission success *regardless of deployment location*.

CultureGear is based on the tenet that effective cross-cultural training must leverage the expertise of warfighters with relevant, real-world experience. Cognitive analyses conducted with over 400 culturally experienced soldiers and marines constitute the foundation of CultureGear's content and structure.

CultureGear presents trainees with opportunities to examine their own cultural biases, receive feedback on their cross-cultural strengths and weaknesses, conduct cultural assessments, compare their assessment performance to that of experts, and learn how to model their own pre-deployment preparation strategies on those of culturally seasoned leaders. Its effectiveness has been demonstrated in controlled experimental settings. For example, in an empirical study conducted with Reserve Officer Training Corps (ROTC) cadets, those who received CultureGear training detected and interpreted critical cultural cues within novel geographic environments faster and more accurately than participants who did not receive the training.

361 Interactive is collaborating with the US Army John F. Kennedy Special Warfare Center and School to integrate CultureGear into their operational training curricula over the next three years. Further, Army ROTC Command leverages the CultureGear self-assessment module to assess the impact of the Command's Culture and Language Immersion Internship Programs on cadet cross-cultural competence.

around a series of surveys performed in Egypt, Iraq, Lebanon, Pakistan, and Saudi Arabia. These surveys measure the attitudinal components of religious fundamentalism, as well as the attitudes, values, and perceptions of individuals in each of these countries, further improving understanding of the social dynamics driving change in these societies. Future surveys are being planned in Syria, Iran, and Turkey.

Understanding U.S. Actions

The need to increase understanding does not apply only to U.S. adversaries; DoD is also keenly aware of the need to increase situation awareness of its own actions and those of U.S. allies, particularly in the realm of improved coordination and response during HADR activities. **Lockheed Martin's** Relief Social Media project was one of the earliest DoD-funded efforts to examine the impact of social media on HADR efforts. This project captured social media data on real-world disaster relief events, to include earthquakes in Haiti, Chile, and China, as well as wildfires and hurricanes. The effort developed a widely cited "gold standard" approach to crowd-sourcing techniques for defining the social media content suitable for use in training machine learning algorithms in this domain. The results have supported the development of prototype tools and concepts of operation for better understanding the use of social media in support of HADR operations.

One aspect of improved understanding is the ability to better manage, share, and catalogue the wealth of information about the areas where the DoD operates, particularly in the realm of HADR operations. **Milcord's** Semantic Wiki project, part of the Marine Corps Civil Information Management System (MARCIMS), enables users to semantically link information in a Wikipedia-like database, speeding up search, analysis, and display of relevant data and relationships as well as supporting increased collaboration and communication across groups. The Milcord team has successfully demonstrated the semantic wiki numerous times within HADR-focused military exercises.

Training

The SPG report emphasized the need for improved sociocultural training for our deployed forces. Simultaneous U.S. engagement in Iraq, Afghanistan, and elsewhere highlighted the need for cross-cultural fluency and appropriate culturally sensitive planning and decision-making skills in novel environments. To this end, the HSCB Modeling Program supports various performers who have advanced the state of the art in cross-cultural training, both to develop knowledge about specific cultural environments and to teach skills that increase the ability to operate in novel situations.

To leverage the wealth of cultural experience gained by returning warfighters, the CultureGear project by **361 Interactive** developed innovative interview methodologies and used them to capture relevant expertise from over 300 previously deployed soldiers and marines. 361 Interactive used this cultural knowledge, which includes perceptual cues, information sources, and the sequencing and details of decisions in novel cross-cultural

environments, to develop a computer-based training program that promotes cross-cultural assessment and awareness skills. An evaluation of this experimental program showed significant improvements in trainees' cross-cultural awareness and performance of mission tasks. Plans are underway to incorporate this training program into curricula at the ROTC Command and the John F. Kennedy Special Warfare Center and School.

Other projects demonstrate the progress that the HSCB Modeling Program has made in supporting the development of virtual cross-cultural fluency training software. The Commonsense Socio-cultural Models for Culture Training in Serious Games, developed by **Alelo, Inc.**, bolstered the DoD's training capability by refining the ethnographic models and artificial intelligence underlying simulated cross-cultural conversational behavior used in virtual training scenarios. Alelo's research established that these advanced training simulations can achieve increased cultural fidelity and complexity at a reduced or similar cost compared to existing models.

Kinection's Task Based Training project helped refine training in basic cross-cultural communication and the accompanying vocabulary for Marine Expeditionary Forces. The project also covered hand gestures that U.S. forces should understand and use to succeed in a variety of situations, such as operating checkpoints and performing medical triage. Another research effort by **VCOM3D** and **Soar Tech** developed detailed physical and cognitive models that portray subtleties of close-up interaction through reusable interactive intelligent software agents or "cultural avatars." These avatars can demonstrate appropriate culturally and theoretically grounded nonverbal behaviors to enhance realism within training simulations across a range of cultures.

DETECT

Various HSCB-funded projects center on enhancing capabilities to discover, distinguish, and locate operationally relevant signatures through the collection, processing, and analysis of sociocultural and behavioral data.

Detection in Text

Much of the HSCB research in this domain focuses on using automated text extraction and analysis. **Strategic Analysis Enterprises'** research on Turning Text into Behavioral Processes allows decision makers to understand how U.S. government actions can mitigate the intensification of violent political conflict and simultaneously aid reconstruction and development operations. This research applies natural language processing capabilities to automate the processes of obtaining information about new regions and assessing the mood of groups, and serves as a viable alternative to surveys or polling when accessibility, manpower, or time is limited. Tests run with this system achieved a 75% precision level on extracting features from a random sample of global text corpora and demonstrated the ability to parse major issues into a variety of related sub-issues.

The Automated Discovery and Explanation of Adversarial Behavior project by a research team at the **University California at Davis** leverages data mining techniques to give military commanders a capability for predicting insurgent activities and behaviors. Using a multimodal and multisource spatial and temporal event model drawn from a database of 20,000 adversarial events in Iraq and 18,000 in Afghanistan, the researchers have shown that they can reliably predict adversarial behavior based on the behavior of other friendly, opposing and civilian actors.

Lockheed Martin's Establishing Trust in Crowds project seeks to enhance exploitation of crowd-sourced information through an automated computational assessment of trust. This system works by increasing reliability, minimizing the effect of intentional misreporting on situational understanding, and improving content correlation and trust aggregation. These features combine to help analysts focus quickly on the right reports and thus respond accurately to fast-paced events and support decision cycles in seconds or minutes, instead of hours.

Finally, **Arizona State University's** research into Identifying & Countering Terrorist Narratives has developed a database of the archetypes that help spread terrorist ideology, based on an analysis of 4,500 Islamist extremist texts and 7,500 stories. The approach includes a method that helps operational teams to recognize these narratives/ fragments in the statements of extremist groups, and a model and heat index that enables teams to quantify the narrative traction.

Novel Approaches to Detection

Moving beyond text analysis, researchers at **Northeastern University** are working to understand the spatio-temporal description of group formation in social systems and developing cutting-edge methods for understanding, visualizing, and anticipating the behavior of complex social networks. Using cell phone data, they have pioneered a novel method for detecting real-world anomalous events based on social network signals. Along these same lines, they have developed a new algorithm for predicting social ties based on spatio-temporal information and individual mobility patterns. The researchers have found that the similarity between the geographic movements of two individuals strongly correlates with their proximity in the social network. Northeastern has undertaken further research to understand population responses to large-scale emergencies and unfamiliar situations.

Draper Labs has tested the hypothesis that surrogate indicators of well-being and effective governance can be derived from overhead imagery. If observation confirms the value of this approach, the risks and costs for on-the-ground data collection can be greatly reduced. Using a set of test data, Draper's system achieved a classification accuracy rate of 70–80% across 76 survey-based indicators. The system has demonstrated good performance in identifying such key indicators of well-being and trust in government as income, access to social capital, and confidence in authorities to provide security and dispute resolution.

REMOTE SENSING AND INDICATORS OF WELL-BEING AND GOVERNANCE

DRAPER LABORATORY

Many military missions, such as COIN operations, require a detailed understanding of the local population. Information about the state of the economy, levels of community support and involvement, and attitudes toward government authorities can guide decision makers in choosing optimal tactics, techniques, and procedures (TTPs) for COIN operations and estimating the potential likelihood of success. However, such information is difficult to gather in remote, inaccessible, or denied areas.

Draper Labs has helped to address this problem by combining automated processing of satellite imagery with machine learning techniques. Draper has demonstrated several models for predicting key indicators of village experience and attitudes using these remote sensing techniques. For example, satellite imagery can reveal crop health, road networks, and the condition of infrastructure in rural areas. As illustrated in the figure, imagery of one town in Chishti Sharif shows that crops are robust and that the town has access to water and good road transportation. In contrast, a village in Sang Takht shows a dispersed building infrastructure and lower crop vigor. This gives good indicators of the economic health of the two villages. Draper's models have used this type of information to predict with 88% accuracy whether villagers will need to take out loans in the coming year. If the crops are healthy and the village has good access to other resources, the likelihood of needing a loan is much lower.

The modeling results also suggest that imagery analysis can provide useful estimates for important measures of local attitudes. Draper's models predict with 79% accuracy whether villagers will volunteer their time to support a community project, and with 78% accuracy whether the village will look to the government or local resources for protection. Understanding these aspects can inform decision makers as they select the most appropriate strategy for engaging with the local populace to foster stable institutions and reduce violence.

Have you or any member of your family received a loan from your friends, family, boss, bank, NGO, businessman, or other sources in the last 12 months that should have been reimbursed?

(a) Yes
- Robust crops & orchards
- Water
- Access to roads

Chishti Sharif
Village #16

(b) No
- Small, dispersed village
- Crops show modest health

Sang Takht
Village #15

Yes
No

Correctly Classified	**88%**
Incorrectly Classified	**12%**

HumanGeo's Integrated Socio-Cultural Environment for Behavior Observation Exploitation Application (ISEBOX) project represents another example of innovative methods to detect information. This project developed a new method for fusing geospatial vector data of different resolutions into a single reference system. It applies the geohash encoding scheme to enable the modeling and reference of billions of spatially annotated data elements using next-generation data engines. Further work has integrated the consumption of events from multiple open sources and aggregated the signals for threat forecasting. A version of this system has been transitioned to the Marine Special Operations Command (MARSOC) for evaluation.

A research team at the **University of California at San Diego** followed another nontraditional approach in its Multi-Scale Geography of Conflict and Stability project. This analysis of conflict and stability is based upon micro-scale geographical data about violent events and potential causal factors, e.g., ethnic, religious, political, or economic differences within a population. Based on the concept that political violence is scale invariant, this research allows analysis of the statistical significance of apparent hotspots, and also provides quantitative indicators of instability and novel measures of effectiveness for Diplomatic, Information, Military, and Economic (DIME) activities.

FORECAST

Another capability area of interest covers forecasting and tracking change in entities and phenomena of interest along multiple dimensions (e.g., time, space, social networks, and types of behavior) through persistent sensing and modeling of the environment. A number of HSCB projects have directly advanced the DoD's knowledge and capabilities related to forecasting.

One of the HSCB Modeling Program's signature successes in the field of forecasting is **Lockheed Martin**'s World Wide Integrated Crisis Early Warning System (W-ICEWS) project. W-ICEWS combines a series of capabilities that include iTRACE (detection), iCAST (forecasting), and iSENT (sentiment analysis). It also incorporates research performed under Lockheed's Model Evaluation, Selection, and Application (MESA) project. W-ICEWS has significantly advanced the state of the art in modeling and forecasting of events of interest across the globe.

Additional research centered on forecasting events includes **GeoEye's** research on Design Tools Enabling Mission-Specific Sensor Fields. This program uses hybrid technologies and advanced algorithms to identify current and likely future hotspots for the origin, destination, and key waypoints of large-scale human movements within Europe. The research created a new paradigm for signature analysis through geospatial predictive analytics and applied it to patterns of emigration from Turkey and North Africa headed into France. GeoEye has also produced a prototype Twitter-based geospatial analysis tool and employed it to analyze activity in the areas surrounding Tahrir Square in Egypt at the time of the protests in early 2011.

MODELING AND ANALYSIS OF STRATEGIC CONTEXTS (MASC)

COMPUTATION INSTITUTE, UNIVERSITY OF CHICAGO, AND ARGONNE NATIONAL LABORATORY

Because diverse forms of social instability operate at multiple levels that interact and influence each other, analysts and decision makers may need various types of expertise to identify causes, likely outcomes, and possible approaches for prevention or mitigation. Even when such expertise is readily available, it is challenging to integrate the insights that experts provide. The research team from the Computation Institute at the University of Chicago and Argonne National Laboratory has based its analytic tools on the premise that modeling strategic contexts (e.g., economic, social, and political) can make the forecasting of potential areas of conflict and the outcome of prospective scenarios more reliable and robust than existing systems provide.

vmStrat, developed by the MASC project, represents complex problems by integrating insights, assumptions, theories, and empirical generalizations across multiple forms of intelligence, from the academic to the pragmatic. The tool provides a theoretically shaped and empirically grounded computational model of strategic contexts with rich, multidimensional interactions to help users explore emergent initiatives, campaigns, scenarios, and policy outcomes. It is specifically designed to assist decision-makers in merging the insights that arise from diverse sources of expertise and/or interacting scenarios. *vmStrat* supports iterative analysis, allowing a team of analysts to begin with a simple notional model and then revisit each aspect of the problem, extending the model in various ways, exploring different assumptions, simulating possible outcomes, and assessing the impact of available policy alternatives. Designed to be cumulative, *vmStrat* readily incorporates additional insights, even into mature models, as the analytical cycle continues.

The release of *vmStrat* 2.5 (expected in September 2014) will represent a significant step toward enabling analyses of international conflicts by using interactive constraints and affordances mirroring the conditions that shape competing initiatives and campaigns.
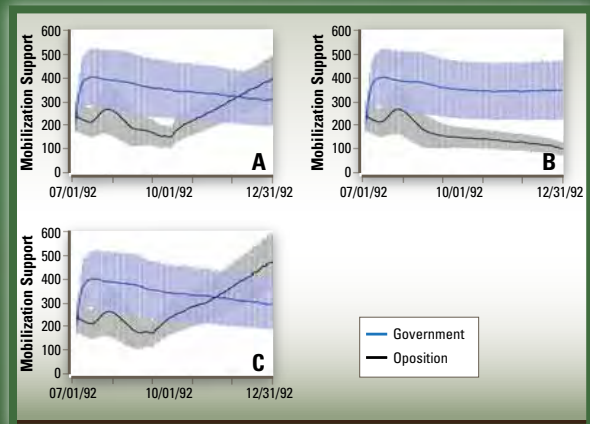
Other research in this domain includes **Strategic Analysis Enterprise's** Sub-Regional Modeling of Conflict, which has improved DoD's ability to understand conditions that foment violence and instability and where and when such events will take place. This research has developed a hybrid approach for geolocating event reports to specific areas at a rate more than 10 times faster than that of alternative approaches. In tests focused on the Philippines, these models demonstrated 90% accuracy and more than 70% precision and recall.

Research at the **University of Chicago** in the area of forecasting centered on the design and development of a Versatile Multiscale Strategist (vmStrat) that can support analysis of international conflicts. The research has created rich models of strategic context that undergird and give rise to implicit threats, situated decisions, and available lines of action. This project, called the Modeling and Analysis of Strategic Contexts (MASC), has already demonstrated the ability to represent the role of emotions in conflict interactions and to express preference falsification in social actors. MASC has also broadened and deepened game theory to make it historically effective.

Other work, such as the Virtual Strategic Analysis and Forecasting Tool (V-SAFT) project carried out by **Lustick Consulting**, uses cutting-edge modeling based on well-informed judgments about plausible and possible futures under different circumstances or on different assumptions or policy choices to enhance responsiveness to unfolding events. V-SAFT enables commanders to monitor the velocity, scope, and magnitude of change in politically fragile societies.

Finally, **Carnegie Mellon University** has made strong contributions to the HSCB Modeling Program, particularly with its Service Oriented Architecture for Socio-Cultural Systems (SORASCS) project. With HSCB support, Carnegie Mellon is developing a coherent, flexible, extensible data-to-model service oriented architecture for sociocultural modeling and analysis to support the military intelligence and modeling communities. The researchers have developed new network-based metrics for discovering change in dynamic networks and identifying emergent issues and new trends. This research has led to a number of important advances, to include reductions in the time and effort required to extract, codify, and analyze social, knowledge, activity, and location data. It has also created new metrics and visualizations for identifying an actor's region and sphere of influence.

MITIGATE

The HSCB Modeling Program funds research that can produce capabilities to devise, order/prioritize, execute, and measure COAs intended to influence entities and phenomena of interest. The Socio-Cultural Analysis Tool (S-CAT) developed by a partnership among the **Set Corporation**, **SAIC**, and **SRI**, is designed to bridge the gaps among military planners, analysts, social scientists, and computer scientists. S-CAT supports culturally informed DIME/PMESII

ENHANCED COA ANALYSIS BY INTEGRATION OF DECISION AND SOCIAL INFLUENCE MODELING WITH MULTI-AGENT SYSTEM TECHNOLOGY (CADSIM)

PERCEPTRONICS SOLUTIONS, INC.

Perceptronics Solutions, Inc., is providing computational modeling capabilities for forecasting sociocultural responses at the strategic, operational, and tactical levels. Initiated in 2012, CADSIM will give commanders and staffs modeling, simulation, and visualization tools to perform COA analysis, a critical part of the Joint Operations Planning Process.

In today's diverse operational environment, COA analysis involves complex forecasting of actions, reactions, and counteractions among many actors. Existing tools provide little support for such analysis. By combining social science theory, decision-analytic methodologies, and multi-agent system computations, CADSIM allows planners to identify critical points of social interaction and project the second- and third-order effects of friendly actions on COA outcomes.

The figure illustrates CADSIM's process for delivering capabilities that assist military leaders in developing and evaluating COAs in cross-cultural environments.

1. **Mission Analysis.** CADSIM applies social science theories to provide a guided workflow to aid users in describing complex interactions among various adversary, neutral, and friendly actors capable of influencing an operation.

2. **COA Development.** A novel graphical COA modeling interface permits rapid authoring of COAs and inter-actor dynamics. COAs specify key observations and decisions that each actor might make and describe how other actors would influence each option.

3. **Forecast COAs.** CADSIM's state-of-the-art multi-agent systems solver enables users to simulate the n-sided COA sets and project a future space of states and actions that each actor might take.

4. **Analyze COAs.** Users perform COA analysis by employing CADSIM's intuitive visualizations of the second- and third-order effects of each COA option in order to assess which COA provides the most favorable outcomes.

Ultimately, CADSIM delivers unique capabilities for the Joint Operations Planning Process by providing a framework to perform COA analysis for "*N*-way" war-games. Commanders can test, refine, and select COAs on the basis of insights gained with CADSIM's projections.
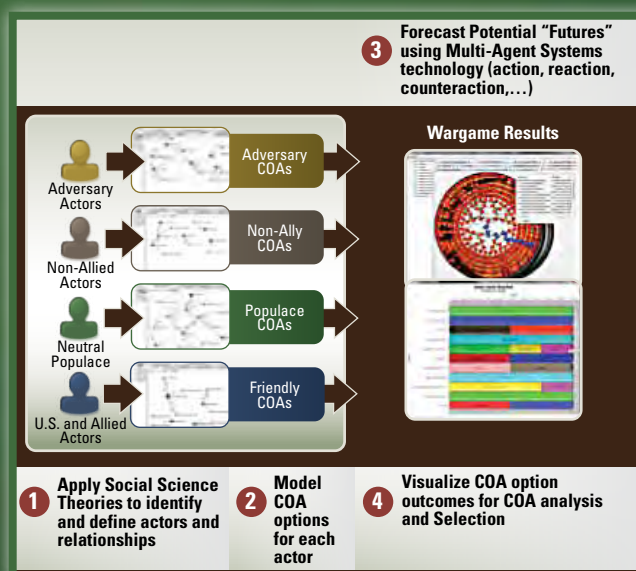
[Political, Military, Economic, Social, Infrastructure, and Information] analysis. The tool can generate models of sociocultural behavior at various resolutions, explore the sociocultural factors influencing instability and insurgency, and generate plausible futures/outcomes using both rule-based models and agent-based simulation informed by sociocultural models. Research in this area has led to significant technological improvements and integration in the use of structured argumentation, agent-based simulation, SME-appropriate knowledge acquisition, and knowledge representation and reasoning. Examples include the probative forecasting of plausible consequences of specific actions.

The Enhanced COA Analysis by Integration of Decision and Social Influence Modeling with Multi-Agent System Technology (CADSIM) project by **Perceptronics Solutions** gives commanders and their staff new capabilities for analyzing the impact of sociocultural factors to determine optimal COAs in hybrid threat operations and irregular warfare. While still in an early stage, the project has achieved initial successes that include a methodology for applying a range of social science theory and behavioral modeling approaches to forecast a range of outcomes using a large number of agent-based actors.

A number of HSCB projects have focused on non-kinetic military operations. To aid information sharing and more efficient HADR operations, **eCrossCulture** conducted an analysis of nine contemporary and historical conflicts and natural disasters. The researchers used this information to identify coordination problems between the U.S. military, the U.S. Agency for International Development, Provincial Reconstruction Teams, and Non-governmental Organizations (NGOs). This information served as the foundation for a system to better coordinate and measure the effects of HADR missions across the disaster response community. eCrossCulture's system underwent field evaluation in both Southern Sudan and Timor Leste.

Soar Tech's Agent-based Modeling Framework for SSTR Mission Planning and Assessment is a simulation-based analysis workbench combining several theory-based computational models of social, cognitive, and cultural phenomena to simulate a "virtual target audience," allowing users to experiment with and analyze the effectiveness of influence actions on target populations. Soar Tech incorporated selected influence theories from business marketing and social psychology into its models.

Charles River Associates (CRA), U.S. Army **TRADOC Analysis Center** (**TRAC**) and the **University of California at Davis** collaborated to develop a prototype modeling and analysis capability for IW at both the tactical and operational levels. The project provides analytic methods, models, and tool suites as well as reachback analysis teams, and gives downrange deployed analyst cells the ability to examine the impact of military actions on the operational environment and specifically on the population.

Finally, **CRA** has developed a suite of tools to assist the Military Information Support Operations (MISO) community, including the Susceptibility And Vulnerability Analysis Network Tool (SAVANT). This operator-centric tool helps analysts build models of

their own reasoning about population behaviors, explore the effects of different lines of persuasion, check that their reasoning is rigorous and substantiated, and perform their work thoroughly and more quickly. Like other CRA-developed tools, SAVANT fits into the MISO workflow and both conforms to and reinforces the doctrinal process.

BUILDING AN HSCB COMMUNITY

Outreach to the larger science, technology, and engineering community has been central to the goals of the HSCB Modeling Program since its inception. HSCB management and performers have served as both organizers and active participants across a range of academic conferences, venues, and publications.

One of the first significant outreach efforts hosted by the HSCB Modeling Program was the Focus 2010 conference held in August 2009. The conference brought together leading scientific and technical experts from the DoD and other government departments who showcased their work in the HSCB modeling arena. Focus 2010 drew over 600 attendees from the DoD, other government organizations, industry, and academia; participants' backgrounds ranged from sociology and anthropology to computer science and engineering.

The following year, Focus 2011 showcased research and applications in the general HSCB modeling area and gave OSD HSCB Modeling Program personnel and leading scientific and technical experts working in HSCB-related fields the opportunity to engage in technical exchanges. This conference focused specifically on promoting communication between the development and user communities and facilitating the transition of HSCB capabilities into operational use. Focus 2011 drew over 600 participants as well.

Performers and staff of the HSCB Modeling Program have also had a major presence at other national and international conferences. The first International Conference on Cross-Cultural Decision Making (CCDM), held in July 2010 in conjunction with the third annual Conference on Applied Human Factors and Ergonomics, was co-chaired by Captain Dylan Schmorrow, USN, the HSCB Modeling Program manager, and Dr. Denise Nicholson (DSCI, Inc.). The meeting served to introduce academic researchers to the modeling and research opportunities funded by the DoD, specifically those within the HSCB Modeling Program. During the conference representatives from academia, government, and industry delivered over 50 presentations on topics ranging from training and modeling decision making to applications and multi-model computational techniques. The HSCB Modeling Program also had a significant presence at the 2nd CCDM conference. Further, the Program leadership regularly gives briefings about the Program and the state of S&T at government, scholarly, and industry meetings.

Central to the HSCB Modeling Program's outreach and communication efforts is the HSCB newsletter (http://www.dtic.mil/biosys/newsletter.html). First published in

2009, the quarterly newsletter contains program updates, information about upcoming events, and insight into the work being done across the community. Performer spotlights in each newsletter highlight the research being done by select HSCB performers.

The 2011 SBRE report also reflected and contributed to building the sociocultural behavior R&E community. It identifies the strategic and operational drivers of socio-cultural behavior capability, explains the role and importance of sociocultural behavior R&E, discusses major technical and scientific challenges, and offers 10 recommendations for long-term success.

TRANSITION

In addition to sponsoring the rigorous R&E required to develop sociocultural capabilities, DoD seeks to implement well-targeted and planned technology transition. Technology transition is complicated because it depends on synchronization among operational users who must articulate their requirements, enterprise engineers who establish technical requirements, and acquisition professionals who perform planning and programming. A strong partnership between capability developers and the targets of transition has proven key to success. Broad categories of these target groups include intelligence and analysis, operational planning, influence operations, experimentation, and training/mission rehearsal. The HSCB Modeling Program engages with all of these communities, particularly those located at the COCOMs. Each group has particular needs that range from Indications and Warnings (I&W) to forecasting the third-order effects of kinetic action, which illustrates the broad reach of HSCB efforts.

Each of these groups also functions across a range of geospatial areas and mission types, with IW, non-Western cultures, and SSTR having particular salience. Since publication of the 2006 SPG report, the HSCB Modeling Program has received clear evidence that all Phase 0 activities (those designed to shape and stabilize an environment, e.g., through building partnership capacity, humanitarian assistance, and whole-of-government engagements require tools and information to strengthen sociocultural capabilities, particularly software tools and knowledge products and databases.

Although dedicated funds and processes are essential to successful transition to PORs, the HSCB Modeling Program has demonstrated that other types of transition are equally viable for sociocultural capabilities. Requirements for POR transition are often relatively inflexible, and delivery schedules may be planned a year or more in advance. This presents challenges for programs seeking to accommodate emerging requirements in a rapidly developing domain such as sociocultural analysis and planning. The OSD HSCB Modeling Program has responded to this difficulty by cooperating with PORs and COCOMs to "pre-stage" capabilities in laboratories, testbeds, and exercises, to transition methodologies or data, and to develop sociocultural models that partners can use with their existing systems. Table 2 summarizes the transitions of OSD HSCB-developed products.

Table 2. Transitions of HSCB Modeling Program Outputs

Project	Product	Partner
Social Network Analysis Reachback Cell	Knowledge products; analytic methodology	ISAF J2 NEC
iSENT	Software tools	USSTRATCOM ISPAN POR
CANVAS	Software tools	USSOCOM SKOPE
Designing Tools Enabling Analysis and Modeling	Analytic methodology	USEUCOM J2/ Deep Futures
Designing Tools Enabling Analysis and Modeling	Sociocultural models	USAFRICOM J2/IKD
Senturian	Sociocultural models	USPACOM SOCPAC
Ethnic Conflict, Repression, Insurgency and Social Strife (ERIS)	Sociocultural models	USSOCOM PM MISO
SAVANT-HSCB/MIMFO	Sociocultural models	USSOCOM PM MISO
Virtual Strategic Analysis and Forecasting Tool (V-SAFT)	Sociocultural models	USSOUTHCOM
Worldwide Integrated Crisis Early Warning System (W-ICEWS)	Sociocultural models, social radar tools	USSOUTHCOM
International Stability Assessment and Analysis Capability (ISAAC)	Software tools	USMC MCCDC
Semantic Wiki for Complex Operations	Software tools	USMC MCCDC
Semi-Automated Force (SAF)	Software tools	USATRADOC TRAC
Military Information Support Operations Planner	Software tools	USATRADOC TRAC
ISEBOX	Software tools	USATRADOC TRAC
Identifying and Countering Terrorist Narratives	Software tools	USAFRICOM J39
Simulation of Afghanistan Opium Economic Systems	Knowledge products	ISAF
Understanding Cross-National Variations and Trends in Islamic Fundamentalism	Knowledge products	USAFRICOM J39
Mining Afghan Lessons from Soviet Era (MALSE)	Knowledge products	ISAF
Plug and Play Cultural Avatars for Training and Mission Rehearsal	Software tools	USASOC JFKSWCS

HIGHLIGHTED TECHNOLOGY TRANSITIONS

This section of the report presents various prominent and high-impact projects that have been the focus of successful technology transitions, such as W-ICEWS and MARCIMS. The following subsections highlight a selection of other projects to illustrate the range of transition modes from 6.2 through 6.4.

ISAF NETWORK EFFECTS CELL (6.4)

Independent HSCB performers at the 6.2–6.4 levels developed the Social Network Analysis Reachback Capability (SNARC) for analysts at the International Security Assistance Force (ISAF) Joint Command Network Effects Cell. To build this warfighter-focused technical capability, the participants worked within a two-week Request for Information (RFI) cycle. As shown in Table 3, SNARC incorporates enterprise-level data strategies; operationally effective methods, models, and tools; and an effective FFRDC-led transition model for operational situations.

Table 3 SNARC Project Benefits

Performer	Project Description	Benefit
Carnegie-Mellon University	Automated network creation, metrics for sparse networks	Rapidly populates a network to be reviewed by an analyst (e.g., for triage)
MITRE	Sentiment analysis toward a topic, e.g., spheres of influence	Identifies sentiments expressed about a person, group, etc.
University of Washington—Applied Physics Lab	Method to map power-brokers' ideological positions	Provides rhetoric analysis based on individual quotes and media
Milcord	Sentiment analysis from survey data	Generates visualization products for analytical reports
Los Alamos National Lab	Potential links in a network using financial data	Generates various options to analyze a network
University of California—Davis	Definition of precursors to adversarial events	Allows early detection of unwanted events/potential actions
Northeastern University	Rigorous approaches to determining network robustness	Generates rigorous procedures for analyzing social networks
Milcord	Semi-automated semantic wiki to document link analysis data	Provides linked, narrative wiki format to view link analysis data

US MARINE CORPS CIVIL INFORMATION MANAGEMENT SYSTEM (MARCIMS)

MILCORD

The Marine Civil Information Management System (MARCIMS) is a cloud service that delivers capabilities for mobile information collection, knowledge management, and situational awareness to aid in US Marine Corps Civil Information Management (CIM). MARCIMS enables Marine Corps Civil Affairs users to collect, organize, analyze, visualize, and share data from the field with military, interagency, partner nation, and non-governmental/international organizations participating in Civil-Military Operations.
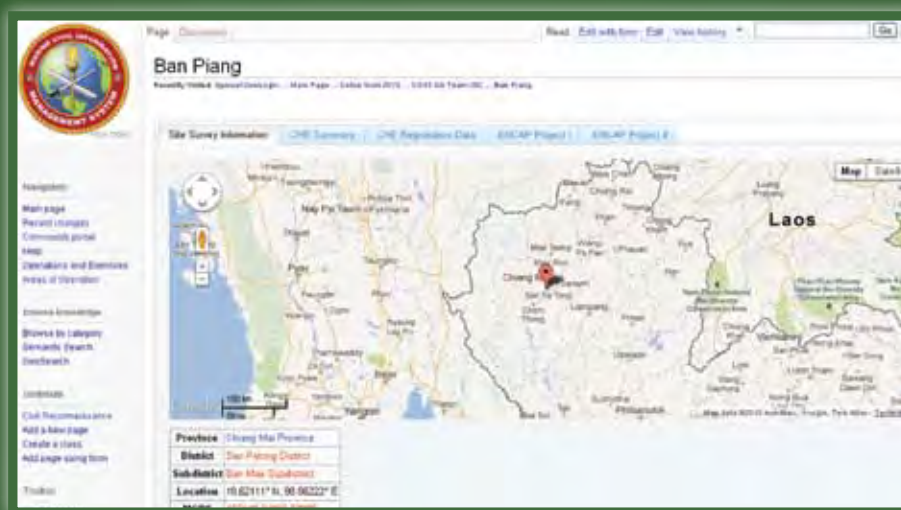
MARCIMS is unique among CIM systems in that it uses semantic technology to author, publish, and distribute Joint CIM doctrine and TTP-driven semantic forms to mobile devices. It also sends notifications and alerts to mobile users to improve their situational awareness. Recently, Milcord has extended the semantic knowledge management constructs to help users conceptualize and reason about information by applying geospatial methods.

MARCIMS provides efficient and reliable management of field data collection, as well as semantic enrichment of collected data and real-time analysis with spatial semantics, all in a web/mobile environment based on commercial cellular and wireless networks. It enables Marines to build information products by automatically transforming map and graphical user interface (GUI) commands into semantic queries, and displaying results in charts, tables, calendars, maps and timelines. Further, MARCIMS allows users to export data automatically to existing information products for reporting, briefing, and external sharing.

Under HSCB and internal ONR funding, Milcord developed and integrated the MARCIMS technology, while the Army Geospatial Center managed technology transition to the Marine Corps in coordination with USMC Systems Command, III Marine Expeditionary Force (MEF), Marine Experimentation Center (MEC), and Center for Irregular Warfare Integration Division (CIWID). The MARCIMS capability is scheduled to become the Initial Operational Capability of the MARCIMS Abbreviated Acquisition Program in 4QFY14.

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USAFRICOM J2 (6.3)

As a proof of concept requested by U.S. Africa Command (USAFRICOM), HSCB performer GeoEye applied two geospatial modeling tools to the activities of the Lord's Resistance Army (LRA) and associated Internally Displaced Persons (IDP) camps in central Africa. The first tool, AnthroMapper, is an ArcMap extension that uses terrain and population density information to identify geospatial regions that could contain family or tribal groups, and then maps those regions to particular groups based on known point locations. The other tool, Signature Analyst, examines the relationships between historic locations for an activity or entity of interest and geospatial data layers that represent such factors as natural terrain, human infrastructure, and demographics. Together, these statistical relationships form a geospatial "signature" of the activity or entity of interest that can be applied to identify unknown locations where that activity or entity is more likely to occur. Signature Analyst also identifies the environmental layers that contribute most to likely locations for an activity, providing input to decision-makers who may need or want to influence that activity. Anticipating the most likely locations for new violence and the environmental factors that support or mitigate it provides valuable insights to USAFRICOM, local governments, and NGOs.

ARMY TRADOC ANALYSIS CENTER (6.3)

The HSCB Modeling Program has worked with TRAC to integrate the University of California at Davis's Semi Automated Force (SAF) and CRA's MISO Planner into TRAC's Irregular Warfare Tactical War Game (IW TWG). The IW TWG is implemented as a composition of tool modules whose input includes the state of the operational environment and output represents the perceptions of the population and key individuals. These provide intermediate metrics in the PMESII spectrum to use as indicators of success.

During a war game the SAF tool speeds up Red's task selection to allow more time for planning. It draws on historical data about the players and their standard operating pro-cedures, commander's preference for kinetic versus non-kinetic tasks, and commander's tempo preference for the given week. Input data includes executed (known) tasks for all players, the Red players' scheduled (intended) tasks, the population's observed attitudes and behavior, population density (by zone), and other factors to produce a list of pre-dicted tasks for Red to implement in the following week.

The MISO Planner uses the observed attitudes and behavior of populations from the Cultural Geography model and the total list of scenario events generated by all player tasks to evaluate which information operations messages would have the optimal effect across the demographic groupings. The commander then selects the most effective mes-sage for the demographic he wishes to reach, chooses the means of delivery (leaflet, radio, or poster), and designates a list of target zones for the message (as well as the tim-ing of delivery, and the quantity). The output is a single-page printout showing allocated MISO tasks, the message to deliver, the means of delivery, the date when supplies will become available for the units to distribute, and the zones in which to deliver them.

AIR FORCE TARGETING CENTER (6.2)

In partnership with the AFTC, the HSCB Modeling Program launched a project in FY12 to develop operationally relevant mechanisms for suggesting and assessing the potential impacts of non-kinetic targeting actions. The overall vision incorporates agent-based modeling tools for COA planning and text-based analysis to aid "battle damage assessment" of the non-kinetic measures selected. AFTC serves as an operational sponsor for the University of Chicago's MASC project, which provides strategic-level models of alliances and sub-national group dynamics. AFTC also supplies operational use cases for the CADSIM, a multi-agent COA tool, and will use the W-ICEWS sentiment analysis and trend recognition capabilities (iSENT and iTRACE, respectively) to gauge the effects of the Air Force's influence actions.

For the MASC project, the University of Chicago is building a theoretically shaped and empirically grounded computational model of strategic contexts that can be used to explore emergent initiatives, campaigns, scenarios, and policy outcomes. MASC applies the interactive constraints and affordances by which competing initiatives and campaigns are forged to generate methods and tools for the analysis of international conflicts. Specifically, the project has delivered a prototype "gaming engine," training modules, and the underlying computational social theory to the AFTC.

Perceptronics Solutions, Inc. is developing a toolset for "Enhanced CADSIM." Upon completion, these tools will give commanders and their staff capabilities for analyzing the impact of sociocultural factors in determining optimal COAs for a variety of current operations. By combining advanced social science theory with decision analytical methodology and multi-agent system computations, the Enhanced CADSIM framework will allow planners to identify critical points of social interaction as well as the likely influence of nth order communication effects on COA outcomes. A primary focus of their research will be adapting social influence network theory to enable valid predictions in the military operational environment—in particular, to allow commanders to model the evolution of beliefs, attitudes, behaviors, and allegiances in complex cross-cultural environments.

CONCLUSION

The OSD HSCB Modeling Program has executed a wide-ranging portfolio of projects spanning the capability areas and gaps documented in the 2006 SPG report. The Program has successfully transitioned various models, knowledge products, software, and other tools both to PORs and directly to warfighter organizations. In addition, the Program has taken the lead in building a broader community engaged in R&E of applied sociocultural behavior relevant to DoD. Section IV focuses on the scope, activities, and achievements of the broader community.

SECTION IV. SIX YEARS LATER

While the OSD HSCB Modeling Program represents the primary direct response to the 2006 SPG report, various other institutions, programs, and initiatives sponsor research, develop data, determine best practices for analysis, and foster coordination across the DoD enterprise in the area of sociocultural behavior. This section summarizes initiatives and investments across the DoD, notes some of the most recent projects and programs, and gauges progress toward building a more extensive community whose combined efforts address DoD's needs for improved sociocultural behavior capabilities.

GROWTH OF A DOD COMMUNITY SUPPORTING RESEARCH AND ENGINEERING

As noted in Section I, DoD research in HSCB-related areas had little centralized direction in 2006, and was dominated by three organizations: ERDC, DTRA, and AFRL. In the intervening years, warfighters and DoD organizations have significantly increased their interest in sociocultural information, and the organizational base has grown accordingly.

Within OSD, ASD(R&E) provides leadership in sociocultural behavior R&E across DoD, coordinating closely with the Under Secretary of Defense for Intelligence (USD(I)) and the Under Secretary of Defense for Policy (USD(P)). Most of the ASD(R&E) initiatives, including the HSCB Modeling Program and a number of SBIR projects, are managed through the Human Performance, Training and BioSystems Directorate.

Another element of ASD(R&E), DARPA, sponsors basic and applied research in many areas, including some topics associated with sociocultural behavior capabilities. The Information Innovation Office (I2O) funds much of that work. One significant program executed through I2O was the Integrated Crisis Early Warning System (ICEWS), a system to monitor, assess, and forecast movement toward or away from stability at the nation-state level. That system, now supported by the OSD HSCB Modeling Program, has become the Worldwide-Integrated Crisis Early Warning System (W-ICEWS). Another recent I2O program, Social Media in Strategic Communication (SMISC), supports basic research to develop automated and semi-automated operator support tools and techniques to enable the systematic, methodical, and timely use of social media at a global scale.

As the primary military intelligence advisor to the Office of the Director of National Intelligence, USD(I) oversees a number of military collection and analysis agencies, including the Defense Intelligence Agency (DIA). USD(I) also chartered and still chairs the Defense Intelligence Socio-Cultural Capabilities Council (DISCCC), an interagency group that seeks to establish sociocultural capabilities to meet the requirements of commanders, staffs, and policymakers at all levels of DoD. USD(P) leads the Minerva Initiative, which sponsors university-based social science research to improve DoD's basic understanding of the social, cultural, behavioral, and political forces that shape regions of the world of strategic importance to the United States.

From 2008 through 2013, the Armed Services invested in sociocultural behavior research, including both core funding and support through various programs, such as the Minerva Initiative, the SBIR Program, and the MURI. All Federal agencies with an annual extramural R&D budget exceeding $100 million must participate in the SBIR Program. MURI supports basic research by multidisciplinary teams to address issues of critical concern to the DoD and the Services.

The U.S. Army funds a range of research initiatives relevant to sociocultural behavior capabilities. Core and leveraged projects are executed through ARI, USACE-ERDC, the ARL Human Research and Engineering Directorate (HRED), the ARL Computational and Information Sciences Directorate (ARL CISD), and the Army Research Office (ARO).

- ARI's portfolio, which emphasizes training and competency building, includes Socio-cultural Aspects of Mission Performance (SCOPE), a project to identify sociocultural performance requirements across different strata such as jobs, missions, and ranks. The ARI Fort Leavenworth Research Unit also supports a number of training-focused applied research efforts.

- ERDC has initiated a variety of applied research projects on sociocultural behavior, including Cultural Reasoning, a project to collect, organize, and synthesize diverse quantitative and qualitative data and information to provide a knowledge framework linking sociocultural information to support understanding host population behavior.

- ARL HRED sponsors the Relevant Information for Social Cultural Depiction (RISC-D) program, which supports applied research concentrated on understanding and modeling the sociocultural factors that affect decision making by soldiers and commanders, specifically addressing how a soldier's own cultural background influences his or her decision making.

- ARL CISD's recent applied research programs have focused on sociocultural data collection and processing, and on developing requirements for a decision support tool capable of visually presenting complex cultural and social attitudinal/behavioral variables extracted from large datasets that can be used to forecast attitudes and behaviors in a cultural context. CISD has executed a number of SBIR projects focused on extracting themes/topics/sentiment/trends from social networks, sociocultural reasoning, and collaborative visual displays for distributed teams.

- The ARO Information Science Portfolio includes the Modeling of Complex Systems program, whose thrust on Human Cognitive and Behavioral Modeling supports basic research on the quantitative, analytical models of cognition and behavior required for training, simulation (computer-generated forces), and mission planning.

The TRADOC Intelligence Support Activity (TRISA) led the effort to stand up the Cultural Knowledge Consortium (CKC). Now an interagency initiative, CKC offers services that include a data repository and advanced tools for the Distributed Common Ground System—Army (DCGS-A) Standard Cloud (DSC).[4] Another Army initiative is OneSAF, a program office created to engineer a single, shared capability for simulations involving computer-generated forces. The mission is to build a single SAF that can support large-scale exercises and training. One of the key components of OneSAF is a model called Athena, which is designed in part to represent the interaction of PMESII effects and dynamics over time. The model helps analysts understand the impacts of complex operations, including their possible second-, third-, and higher-order effects.

Air Force sponsorship of sociocultural behavior-related research is concentrated in two organizations of the AFRL: the Human Effectiveness Directorate (RH) and the Information, Decision and Complex Networks Department in the AFOSR. The latter funds efforts that include the Trust and Influence Program, a Basic Research portfolio that will provide the empirical foundation for the science of reliance and contemporary influence. This portfolio specializes in research focused on the empirical science of trust in both interpersonal and complex human-machine/robot interactions; the science of influence effects, including the psychological and behavioral impact of novel technology on the battlefield; and the cognitive and social avenues of influence based on cultural, social, or technological means. Beginning in 2011, AFOSR began a strategic shift away from cultural modeling work toward more empirical efforts.

AFRL RH includes the Human-Centered Intelligence, Surveillance, and Reconnaissance (ISR) Division (RHX), which executes a number of relevant SBIR projects and currently supports a five-year program titled Cultural Radar for Human Terrain Effects. This effort will develop mathematical and computational models of information diffusion within diverse societies, characterize how information flows through a population with various types of connectivity, and create a testbed to model the impact of military operations on adversaries' decision making. AFRL RH remains engaged in the development, application, and integration of sociocultural models, but its involvement has recently declined as other priorities take precedence. The overall strategy balances transition projects and scientific efforts centered on foundational sociocultural behavior. AFRL RH has successfully transitioned mature technology to AF customers (AF Targeting Center, the National Air and Space Intelligence Center, and AF Special Operations Command) and to joint, external customers.

There has also been relevant activity supported by AFRL's Information Directorate (RI), most notably the National Operational Effects Model (NOEM), which includes a module for conducting what-if analysis of alternative COAs.

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4. https://www.culturalknowledge.org/

ONR coordinates, executes, and promotes the S&T programs of the U.S. Navy and Marine Corps, and has supported a wide range of basic and applied research and advanced technology development in the area of sociocultural behavior. The Expeditionary Maneuver Warfare and Combating Terrorism Department (Code 30) thrusts include HSCB Sciences. Code 30 invests in building capability by developing a knowledge base, building models, and creating training capacity to understand, predict, and shape human behavior cross-culturally. Code 30 has executed much of the portfolio funded by the OSD HSCB Modeling Program. The Warfighter Performance Department (Code 34) includes the Human and Bioengineered Systems Division (Code 341), which supports basic and applied research in a variety of areas, including social, cultural, and behavioral modeling. Affordable Human Behavior Modeling (AHBM) is a Code 341 project involving cognitive and computer science, aimed at the creation of techniques and tools to increase the affordability and usability of human behavior models for application as computer-generated forces or intelligent agents in simulations for military training and analysis. Code 341 also executes a number of Minerva Initiative projects, including projects focused on understanding violent extremism. Other recent Code 341 activity has focused on information technology and emerging media, including tools and technologies for social media analysis and the development of novel analytics for social discourse and online news media.

Given their leading role in strategic engagement and building partner capacity in their respective Areas of Responsibility, the COCOMs are increasing their attention to development of sociocultural behavior data and analytic capabilities. With support from USD(I), most COCOMs have participated in programs and/or stood up analytic cells focused on areas that include analyzing patterns of life, social media, and social networks; countering violent extremism; and forecasting instability.

Military educational institutions, including the Naval Postgraduate School (NPS) and West Point, also contribute significantly to basic and applied sociocultural behavior research. One example of their contributions is the Cultural Geography model, developed at NPS, which has been used for wargaming.

CTTSO is charged with providing a forum for interagency and international users to discuss mission requirements to combat terrorism, prioritize those requirements, fund and manage solutions, and deliver capabilities. CTTSO was a lead for execution of projects funded by the OSD HSCB Modeling Program. Recent CTTSO-funded projects include Social Cultural Assessment from Passive Sensing (S-CAPS), which responds to the need for social cultural intelligence in stabilization/ reconstruction, counterterrorism, and counterinsurgency missions, particularly in austere and denied areas of operations. S-CAPS is providing a proof of concept by assessing patterns of life, establishing baselines for "atmospherics," and monitoring trends with limited sensor data.

DTRA is the Department of Defense's Combat Support Agency for countering weapons of mass destruction (WMD). The agency's programs include basic science research and development, operational support to U.S. warfighters, and a think tank designed to

anticipate and mitigate future threats. DTRA recently introduced the Comprehensive National Incident Management System (CNIMS), which includes a modeling system to support simulation of large-scale behavior in the aftermath of a catastrophic event. CNIMS, a Virginia Tech research program, is a hybrid capability with interoperable simulations of societal infrastructures, coupled with individual-based social networks.

DoD researchers often coordinate or partner with other Federal Departments and Agencies that conduct research in sociocultural behavior. These organizations include the Intelligence Community (IC), the National Laboratories, the Department of Homeland Security, and the National Science Foundation (NSF). A leading sponsor of relevant R&E is the Intelligence Advanced Research Projects Activity (IARPA), which supports cutting-edge research that has the potential to provide the United States with an intelligence advantage over adversaries. Much of IARPA's sociocultural behavior work comes out of the Incisive Analysis Office.

GOVERNANCE AND RESEARCH COORDINATION

The 2006 SPG report emphasized the need for improved governance to ensure the coordination of research necessary to build sociocultural behavior capabilities throughout DoD. The Defense Science Board (DSB) echoed this conclusion in its 2009 report on the domain of human dynamics.[5] Subsequently, DoD assigned internal coordination and staff specialists to oversee, coordinate, and support its fiscal and technical portfolios. Current working groups, steering committees, coordinating meetings, and collaboration best practices (e.g., cross-program scientific peer review) facilitate coordination, collaboration, investment planning, and guidance. These DoD structures and processes provide appropriate levels of expert review and guidance while continuing to embrace opportunities for closer ties and enhanced collaborative mechanisms.

GOVERNANCE

The DoD organizes its sociocultural activity domain within three broad categories: R&E, data collection and analysis, and training/education. Each of these three areas is guided by a lead oversight organization that has strategic investment, governance, and decision-making authority over its specified programs and related activities. Within OSD, ASD(R&E) leads R&D; USD(I) leads data collection and analysis; and the Defense Language Office (DLO) leads development of training/education programs. Collectively, the three organizations comprise the oversight and decision-making body for the sociocultural area, but each lead organization has purview and authority over that specific organization's investments and programmatic foci. Per DoDD 5134.3, ASD(R&E) is authorized to engage in activities that include, but are not limited to:

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5. Per *Understanding Human Dynamics*, "…the term 'human dynamics' comprises the actions and interactions of personal, interpersonal, and social/contextual and their effects on behavioral outcomes" (p. vii).

- Making recommendations and issuing guidance for DoD R&E plans and programs

- Recommending approval, modification, or disapproval of programs and projects of the Military Departments and other DoD Components in assigned fields to eliminate unpromising or unnecessarily duplicative programs, and initiating support of promising activities for R&E

- Promoting coordination, cooperation, and shared understanding of R&E within DoD and among DoD, other federal agencies, and the civilian community

- Developing and maintaining an R&E metrics program to measure and assess the quality and progress for DoD's R&E program.[6]

COORDINATION AND COLLABORATION

The DoD's sociocultural R&E efforts are not centrally organized around one program, although many of them are funded and managed by ASD(R&E). Regular meetings, listserv emails, websites, and newsletters ensure that information about each program's efforts is coordinated and shared among the other sociocultural R&E programs. The R&E programs sponsor annual collaborative symposia; other organizations are invited to report on progress and planning for their respective technical areas. These events include program status overviews, project-level updates, reports on new technology demonstrations, future plans, and expert panel discussions with updates that describe intra- and inter-departmental coordination activities. Meeting participants include representatives of organizations and communities that will implement the new knowledge and technologies.

DoD's sociocultural R&E programs rely on established scientific collaboration practices to ensure cross-pollination of ideas and the development of scientifically distinct research portfolios that anticipate and align with emergent research developments. These practices include involving the sociocultural R&E community in BAA development, in the peer review project selection process, and in project and program evaluation.

DoD has established a number of standing organizations that facilitate coordination, collaboration, and user engagement.

- The Human Systems Community of Interest (HS CoI) is a DoD Senior Executive Service (SES)-level coordination group formed under the auspices of the DoD Science and Technology Executive Committee (DoD S&T EXCOM). The HS CoI is composed of representatives of leading research areas oriented to HS integration, including Sociocultural Behavior Understanding. The HS CoI serves as a key link to other DoD CoIs and supports increased outreach for international cooperation.

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6. *Department of Defense Directive 5134.3* (November 3, 2003).

- The Irregular Warfare Modeling and Simulation Senior Coordinating Group (IW M&S SCG) enhances visibility, collaboration, and coordination of IW M&S across DoD. Activities include assessing IW M&S capabilities; identifying potential gaps, solutions, and metrics for IW M&S; producing reusable IW M&S that provides common solutions; and leveraging existing investments in M&S. The group holds monthly meetings attended by 18 senior leaders at the General Officer and SES levels who represent potential end-users for the products developed by ASD(R&E) and USD(I).

- The DISCCC, chartered and chaired by USD(I), pursues the establishment of sociocultural capabilities that meet the requirements of commanders, staffs, and policy makers at all levels of DoD. DISCCC's standing membership represents those organizations within the Defense Intelligence Enterprise (DIE) responsible for the management or use of sociocultural capabilities that inform the decision making of senior leaders. Enabling objectives include coordination of capability development, operational collaboration, and institutionalization of sociocultural capabilities.

- The Defense Language Steering Committee recommends and coordinates language policy, needs, training, education, personnel, and financial requirements. It consists of General Officer or SES representatives from USD(P); USD(I); USD Comptroller; USD(AT&L); the Office of the Director, Program Analysis and Evaluation; the COCOMs; the Office of the Chairman of the Joint Chiefs of Staff; the Military Departments; DIA; the Defense Security and Cooperation Agency; DTRA; the National Security Agency; and the National Geospatial-Intelligence Agency.

In addition to participating in groups such as the IW M&S SCG and the DISCCC, members of the DoD sociocultural community often take part in informational and coordinating meetings across departments and offices. USD(I), USD(P), USD(AT&L), the Joint Staff, COCOMs, and members of the DIE hold both formal and ad hoc meetings with each other. These regular interactions ensure that members of various socioculturally focused communities remain apprised of evolving requirements, gaps, and investment strategies. Organizations such as ASD(R&E) involve other R&E funders and staff from the data and analysis and training/education communities, as well as end-users, in the R&E process. They participate in discussions of requirements and gaps for incorporation into R&E strategy and BAAs and reviews of research proposals during the scientific peer review process, ensuring that end-user needs are identified and included in the DoD's R&E portfolio.

As noted in Section III, meetings such as the HSCB Modeling Program's series of "Focus" conferences and the COCOMs' S&T workshops take place annually. They offer venues for members of socioculturally oriented communities to formally present their perspectives, interact with each other, and gain insight into the needs, gaps, and strategic directions of the broader sociocultural community.

As the description above shows, a significant amount of coordination and collaboration is already taking place—far more than in 2006. DoD should seize any opportunity to further minimize duplication and inefficiency while preserving innovation and keeping the needs and interests of operational end-users first and foremost.

CLOSING THE CAPABILITY GAPS

DoD has made measurable progress in remedying the technical and capability shortcomings denoted in the 2006 SPG report. That report identified a number of broad issues: lack of a military technical core capability in sociocultural behavior, limited "reuse" of data and software, lack of life-cycle management plans for products, absence of data and collection methods to support understanding, limitation of models in scope and scale, limited domain and inter-domain knowledge and experience, and a shortfall in general use of science or technology to aid soldiers in gaining language skills and cultural awareness. As summarized in Table 4, evidence suggests that in the intervening years DoD has addressed each of these issues to some degree.

Table 4. Capability Status, 2006 and 2012

Category	2006	Present
Core Socio-cultural Capability	Technical sociocultural behavior capability drawn from academia, labs, industry.	Standing programs in all Armed Services focus on sociocultural behavior analysis and modeling. Geographic COCOMs, Special Operations Command, the Armed Services and intelligence agencies have dedicated personnel performing sociocultural research and analysis.
Data and Tool Transfer	No investment in resources to port or extend relevant data, knowledge, and tools.	Increased DoD investments in data collection, storage, and transfer. The OSD HSCB Modeling Program has completed transition agreements with multiple COCOMs, and with the Integrated Strategic Planning and Analysis Network (ISPAN), an Acquisition Category (ACAT)-1 POR. Other tools and resources have been transferred to meet near-term operational demands.
Data and Collection Methods	No data and collection methods to support understanding, models, or tool development.	Increased focus across DoD on mobile data collection, crowd-sourced data collection, remote data collection. The MARCIMS wiki exemplifies advances in mobile data collection, analysis, and visualization. Research and technology investments have been extended to capitalize on social media resources. USD(I) and TRADOC have stood up the CKC.

Category	2006	Present
Model Scope and Scale	Models not broad enough to cover full range of military operations, nor detailed enough to forecast behaviors at scale.	Increased DoD investment focus on hybrid models. W-ICEWS is a leading example of integrating different types of models and working with multiple data formats at global scale to support operations-ready forecasting.
Model Integration Across Levels	Limited capacity to support integrated modeling of strategic/ operational/ tactical planning and operations.	Development and testing of architectures and infrastructure necessary to support integration of computational models, particularly across operational and strategic levels. The Social Network Analysis Reachback Capability (SNARC) integrates HSCB technologies to meet warfighter and analyst requirements.
Gaps at Individual Soldier Level	No general-use S&T to achieve the "language-agile cultural chameleon" warfighter.	DoD has strengthened its focus on language and cultural training and retention. Formal strategy developed to actively encourage and reward warfighters for sociocultural knowledge. S&T solutions for individual warfighters remain a long-term goal.
Governance of Sociocultural Behavior R&E	Sociocultural behavior R&E highly distributed with limited coordination and few DoD-wide solutions.	DoD directives and initiatives establish governance authorities for R&D, analysis, and training. USD(I) DISCCC, IW M&S SCG, and the HS CoI each convene regularly. Hundreds from industry, academia, and government participate in annual national conferences on human sociocultural behavior analysis and modeling.

A broad, interdisciplinary research community now exists, with much greater engagement by both industry and academia than in 2006. Large integrators are now becoming involved in internal R&D and direct-funded projects. The COCOMs possess more in-house sociocultural analytic capability and warfighters now have much better and more timely access to sociocultural behavior data. As evidenced by the W-ICEWS (see Spotlight), integrated, global-scale modeling has not only advanced, but is also driving POR-ready capabilities. The Services in particular have devoted considerable effort to sociocultural behavior and language training in order to narrow the gap in individual soldier capabilities.

WORLD-WIDE INTEGRATED CRISIS EARLY WARNING SYSTEM (W-ICEWS)

LOCKHEED MARTIN, DUKE UNIVERSITY, LUSTICK CONSULTING, STRATEGIC ANALYTICS ENTERPRISES, AND RAYTHEON BBN TECHNOLOGIES

One of the HSCB flagship programs, W-ICEWS has developed and is deploying a comprehensive, integrated, automated, generalizable, and validated system to monitor, assess, and forecast national and international crises in a way that supports decision making on how to mitigate them. W-ICEWS offers COCOMs, the IC, and various government agencies a powerful, systematic capability to anticipate, track, and respond to stability challenges.

W-ICEWS has four primary components:

- **iDATA** provisions the W-ICEWS models from over 6,000 international, regional, national, and local news sources. iDATA has processed more than 30 million news stories published over the past 13 years to extract <who, did-what, to-whom, when, where>, and performs updates in near-real time.

- **iTRACE** provides situation understanding through analysis and visualization of event history trends and patterns generated by iDATA. The capability produces time series, map-based views, trends, relationship matrices, and other visualizations and enables user to drill down to underlying stories.

- **iCAST** is a mixed-methods modeling approach that leverages over 80 heterogeneous model types to forecast major instability events of interest worldwide with greater than 80% accuracy and recall.

- **iSENT** measures population attitudes and perceptions on issues, people, and events by performing sentiment analysis on data from blogs, tweets, and Facebook. The capability also shows sentiment propagation across the Internet and identifies sites and people with key roles in shaping opinion dynamics.

W-ICEWS has had tremendous success in supporting operational users. In 2012 the project expanded its support to the COCOMs by standing up an unclassified server at USSOUTHCOM that supports all the COCOMs as well as users from the IC and Department of State. It expanded the user base to over 230 users on that server in 2012.

The team transitioned the first W-ICEWS component to the USSTRATCOM Integrated Strategic Planning and Analysis Network (ISPAN) POR in 2012. iTRACE became fully operational on SIPRNet in April 2012 and JWICS in July 2012. The transition to ISPAN will continue with iCAST in the fall of 2013 and iSENT in the fall of 2014.

Insurgency in Syria
(Historical and Aggregated Forecasts)

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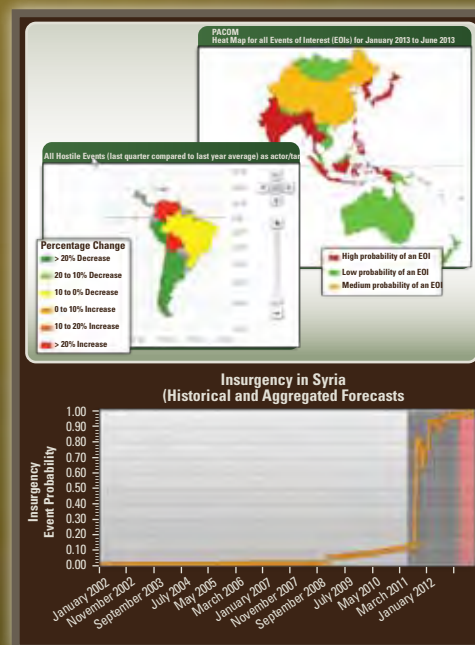
Thus, when considered in the aggregate, DoD has made encouraging progress. A closer examination of the particular gaps identified in 2006, however, suggests that much remains to be done. Preparation of this report included asking a sample of Armed Services program managers, OSD personnel, and COCOM S&T Advisers to assess progress relative to the 70-plus capability gaps identified in the 2006 SPG. In all, 15 individuals provided their assessment of (a) progress since 2006 and (b) current capability, using a scale from 1 (very strong) to 5 (very weak). The pie charts in Figure 10 depict an integrated assessment for each of the six areas identified in the 2006 SPG report, with gap scores for each assessor averaged and then clustered into three groups: Strong or Very Strong (green), Modest (yellow), and Weak or Very Weak. Integrated results for all of the gaps are provided in Appendix C.
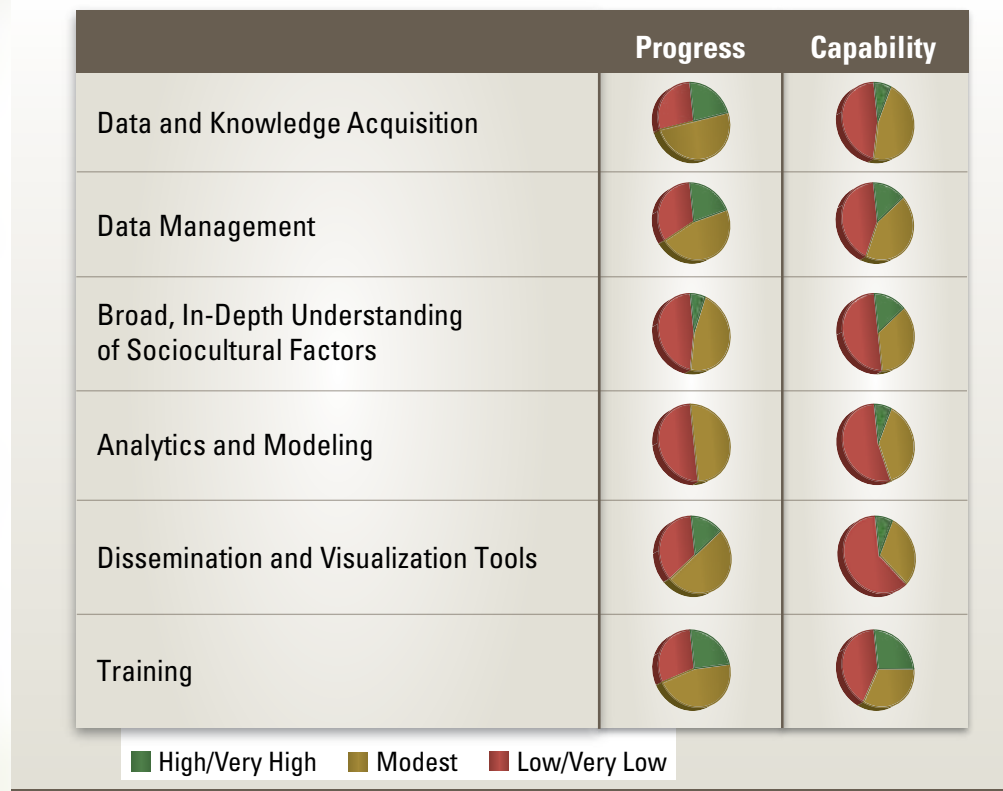
Figure 10. DoD Progress in Six Domains

These results, based on the judgments of a cross-section of those most familiar with DoD science, technology, and capabilities in the area of sociocultural behavior, indicate that most believe the DoD has made at least modest improvements across all areas of capability, with the most significant advances in Training, followed very closely by Data and Knowledge Acquisition and Data Management. As for current capability, assessors clearly see persistent gaps across all areas. The greatest gap occurs in the area of Dissemination and Visualization, though most also felt that capability remained either low or very low for Analytics and Modeling, and few believe that DoD has so far achieved high or very high capability in Understanding of Sociocultural Factors.

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That the capability gaps identified in the 2006 SPG report should persist is hardly surprising, for at least two reasons. First, the fiscal pressures experienced across DoD have unquestionably impacted R&D, to some extent slowing the development of data and tools as well as their transition into the hands of the warfighter. As summarized in Section I, the 2006 SPG report called for new investment of more than $300 million, primarily across the BA2–4 lines that support Applied Research, Advanced Technology Development, and Advanced Component Development and Prototypes. The total recommended investment for those lines was $441 million.

Preparation of this report included review of publicly available materials on major programs sponsoring relevant research as well as requests for information from research program leaders across the Armed Services. Table 5 summarizes the results of that review, along with the original SPG report recommendations. Actual obligations were available for the HSCB Modeling Program; other figures are estimates, based on best available information. No account of this kind can be definitive, in part because the DoD research program is very complex with structures and processes varying widely across the various organizational units. Also, there is no fixed specification of "sociocultural behavior research," so determining what (and what not) to include in the estimates was not always straightforward. Thus, totals are presented as estimated ranges.

Table 5. Sociocultural Behavior Research Funding

BA	SPG Plan*	OSD HSCB Actual FY08–13**	Other Programs (Estimated)	Delta
2–3	$342 million	$90 million	$155–$175 million	($77–$97 million)
4	$99 million	$30 million		($69 million)
Total	$441 million	$120 million	$155–$175 million	($146-$166 million)

* Includes baseline for FY08–11, plus recommended investments for BA2–4. Assumes all planned and recommended SBIR funding supports BA2–3, and is equally split between those two levels.

** Obligated for FY08–12, budgeted for FY13.

The investment in sociocultural behavior R&E has been significant compared to prior years—perhaps approaching $300 million for BA2-4. However, the estimated totals are between $146 and $166 million less than the amounts recommended to close the gaps documented in the 2006 SPG report for Applied Research, Advanced Technology Development and—particularly—Advanced Component Development and Prototypes.

However, the more fundamental reason why gaps persist is simply that R&E in sociocultural behavior for military application is still a very new area, and thus is immature. Six years is a very short time over which to achieve widespread and enduring change in any kind of capability, and particularly in this area, where the challenges are inherently so great.

CONCLUSION

Six years after the SPG study, DoD can point to considerable advances in building the DoD's S&T foundation for examining sociocultural behavior. The defense community has also improved its overall capability to forecast behaviors driven by social and cultural variables and to pursue effective COAs in the full range of military operations. Yet much remains to be done. This is to be expected; consider that a six-year investment in conventional radar would have ended research on that technology in 1940. DoD must take a long-term view when evolving its sociocultural behavior capabilities. The final section of this report describes that long-term vision, and presents recommendations for how to realize it.

SECTION V. CONCLUSION AND RECOMMENDATIONS

CHANGING NATIONAL SECURITY ENVIRONMENT

The preceding section documented the persistence of certain capability gaps originally described in 2006. That persistence is important, in part because the United States will continue to face certain kinds of mission challenges where capabilities related to sociocultural behavior will be critical. However, not only do the gaps described in 2006 remain—though, importantly, at a reduced level—but new needs are emerging, largely as a result of evolving U.S. strategic priorities and mission demands in response to changes in the global information and geopolitical context. Iraq and Afghanistan have receded as the primary geopolitical areas of interest, eclipsed by broader changes in the Middle East and a policy and operational re-focusing on the Asia-Pacific region. Following the continuing withdrawal of forces from Afghanistan, a similar massive deployment of U.S. military strength could take place during a worst-case scenario with near-peer states, or another nation whose destabilization significantly threatens U.S. interests.

Otherwise, multiple low-intensity conflicts ranging from extremist threats in Africa to destabilization in the Middle East and Southeast Asia will remain a significant concern. The situation in Syria is volatile, with the potential to spill over and destabilize other countries such as Iraq, Turkey, or Lebanon. Further destabilizing events could emerge from the Kurdish desire for statehood, simmering tensions between Pakistan and India, the China-Taiwan conflict, or further unrest in the Middle East. Nearly all of these conflicts would occur in areas of the world where U.S. troops would face considerable language and cultural barriers and traditional intervention strategies are less likely to be effective. Aside from these potential conflicts, the threat of terrorism remains ever present and organizations such as Al Qaeda continue to contribute to instability in the Middle East, Southeast Asia and Africa.

Several concerns not widely recognized in 2006 now present high-priority challenges. Hostile non-state actors can gain a foothold in local populations, particularly in areas where the rule of law is weak. Attention to such actors has increased, sharpened by the recognition that they might obtain access to an array of WMD relatively cheaply and easily. On a related front, drug economies and criminal issues drive instability in nations in both the Eastern and Western hemispheres, and are intermingled with slavery and local violence. Criminal, narcotics, and human trafficking organizations will provide additional challenges to international security, human rights, and the rule of law. Criminal organizations have a corrupting effect on judicial and law enforcement systems and this can exacerbate problems within already weak states.

Disaster coordination, HADR, and Non-Combatant Evacuation Operations all represent much higher priorities now than in 2006. The need for the U.S. military to assist in responding to natural and man-made disasters both internationally and domestically is likely to continue. Flooding, hurricanes, droughts, and other natural disasters will challenge U.S. capabilities to provide timely, targeted, and appropriate response and relief. Environmental changes will have a destabilizing effect when certain industries such as farming or fishing become untenable as climate patterns change or natural resources are exhausted. Demographic shifts as a result of population relocation, migration, flight from combat zones, and internal political unrest will have a similar effect. Forecasting and mitigating these changes before they reach a tipping point or terminal point are key to limiting the disruption they cause.

Challenges in the cyber-security realm will also pose threats to our national security. As our adversaries become increasingly technologically sophisticated, new denial and deception tactics will reduce our ability to gain accurate information about situations. Nations are developing systems to restrict the Internet and cellphone access of their citizens during times of internal strife, and these situations pose problems for U.S. systems designed to accurately read the extent of a conflict using open-source information. Cyberspace is used for networking and recruiting (e.g., Facebook), fundraising, training, sanctuary, command and control (e.g., Twitter), and strategic communication (e.g., YouTube). These factors indicate the rich opportunity for further sociocultural behavior research and engineering.

VISION

Recent, profound changes to the global information environment will mediate the particular manifestation of these national security challenges. In 2006, Twitter had not been invented, and Weblogs were just becoming a mainstream tool. Now "twitterverse" and "blogosphere" have entered the popular lexicon, and the world media environment is characterized by unprecedented volume, extreme interconnectivity, and very rapid information exchange. In this era, where "going viral" is the yardstick of impact, change can occur very rapidly and on a large scale. Influence can emerge from unexpected places, can be difficult to trace, and can result from manipulation and deception. Hate speech amplified and distributed through social media and mobile phones can lead to mob violence and instability.

Thus, it seems apparent that the power of populations to communicate, mobilize, and effect great change has dramatically increased over the past few decades, and especially rapidly over the past several years. This is due in part to the availability of near-instantaneous point-to-point or broadcast communication afforded by cellphone and Internet technologies, sometimes despite the attempts of governments to deny this communication. This relatively new environment affects many, if not most, DoD missions. Decision makers, analysts, planners, and operators need in-depth understanding of this environment, as well as the ability to continuously monitor it for relevant signals. DoD must provide decision makers early insight about rapidly emerging population-centric situations and

allow for the development and explorations of COAs. In the words of Lt. Gen. Michael T. Flynn, the director of DIA:

> Simply stated, the lesson of the last decade is that failing to understand the human dimension of conflict is too costly in lives, resources, and political will for the Nation to bear. Once a conflict commences, it is already too late to begin the process of learning about the population and its politics. The optimal condition is for our leaders to have the ability to influence budding conflicts "left of bang," that is, before tensions turn violent.[7]

Conventional ISR and I&W methods and tools were primarily designed to detect physical objects and movements. Alone, they cannot provide insight into how U.S. actions may deter strategic adversaries, understanding of how extremist rhetoric may radicalize youth around the world, or detection of disruptions associated with a loose nuclear device of a chemical or biological event. It is important to take advantage of an environment where useful information may be in "plain sight" and the subject of open conversation. But even if not in "plain sight," the enormous increase in open source data, especially when that data is aggregated and fused with traditional data, can supply direct and indirect indicators regarding topics of keen interest to the United States, potentially warn us of events of concern, provide insight into the cyber, physical, and human domains, and give decision makers the insight they need to make difficult decisions that address or even avert crises.

In the 20th century, advances in radar, sonar, and infrared sensing dramatically improved our ability to deal with military challenges by enabling us to perceive physical objects through air, water, and darkness or camouflage. To meet the demands of the 21st century, the defense, diplomatic, and development communities need integrated capabilities that will provide insight into the attitudes, perceptions, and intentions of citizens and leaders around the world. We "must develop a sensory capability to better detect the precursors to political change, a 'social radar' with a level of granularity, understanding, and confidence that enables policy leaders to make informed decisions that maximize national influence left of bang." [8] In his 2010 paper defining social radar, Dr. Mark Maybury, currently chief scientist of the U.S. Air Force, stated that:

> The center of gravity in modern warfare not only includes military targets such as tanks, ships, planes, command and control facilities, and military forces but equally important the perceptions, intentions and behaviors of citizens and leaders. While radar, sonar, and infrared vision serve our military forces well, they provide limited insight into

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7. Flynn (2012), p. 13.

8. Flynn (2012), p. 14.

the social, cultural and behavioral activities of populations.... A Social Radar needs to sense perceptions, attitudes, beliefs and behaviors (via indicators and correlation with other factors) and geographically and/ or socially localize and track these to support the smart engagement of foreign populations and the assessment and replanning of efforts based on indicator progression."[9]

The vision for social radar does not begin and end with indications and warnings, trend analysis, or alerting mechanisms. Those capabilities are vital, particularly for supporting situation awareness. However, informed decisions by military leaders can result only from option awareness, which depends on an ability to forecast possible adversary COAs, and to develop, analyze and compare alternative COAs for the United States and its allies. Both areas of capability—forecasting and COA analysis—will allow leaders to generate and visualize decision spaces and thereby enable option awareness.

To be most effective, a social radar should take a data-to-decision support perspective along with a data-centric architecture, allowing analysts to tailor and weight the fusion of indicators, draw on online sources to update model parameters, and use COA models to provide quantitative evidence for indicator integration strategies. Realizing this vision will require an analysis environment that supports the development of common output measures, management of uncertainty analyses, and model validation. Ultimately, such a framework will allow analysts to explore data, perform diverse analyses, generate products for decision makers, and help communicate findings through tailored dashboards that support drilldown and knowledge management.

Since the vision for a social radar was articulated just over two years ago, DoD has carried out considerable work to make it a reality. ASD(R&E) adopted "social radar" as part of its long-term vision for sociocultural behavior capability, and multidisciplinary, collaborative efforts among government, industry, academia, and FFRDCs address aspects of the problem. The OSD HSCB Modeling Program sponsors a number of projects that contribute to the social radar vision. The W-ICEWS, perhaps the most mature instantiation of social radar to date, is led by Lockheed Martin, with a team that includes university and small business representatives. Through its internally funded research program, The MITRE Corporation, which operates DoD's National Security Engineering Center (NSEC) FFRDC, has been building and experimenting with social radar prototypes. The prototypes aim at anticipating breakpoints in expression of emotion, recognizing ideological texts, detecting evidence of influence in blogs and social media, assessing the value of social media for monitoring instability, and integrating sociocultural behavior indicators to support decision making. (See the MoodMiner Spotlight for an illustration of that work.) MITRE's experimental work includes collaboration with both university and industry teams.

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9. Maybury (2010), p. 1.

MOODMINER

THE MITRE CORPORATION

Today, people increasingly turn to the Internet and especially social media to express their attitudes and opinions on a wide range of topics, including those that have geopolitical significance. MoodMiner, a prototype tool developed as part of The MITRE Corporation's Social Radar initiative, gives users an automated capability to extract and analyze trends in the emotions people express over the Internet. The tool enables users to rapidly scan large volumes of on-line text, plot trends in emotion levels in real time, and analyze those trends to support alerts and situation awareness.

The MoodMiner prototype leverages the Linguistic Inquiry and Word Count (LIWC)[1] framework, which was developed to support making inferences about people's psychological states based on their usage of specific categories of words. Using both LIWC and originally developed dictionaries, MoodMiner calculates a series of ratios for a given text, representing the number of words for each category of interest relative to the total number of words in the text. Users can then generate and view a trend line of ratios across time, and apply a "breakpoints" algorithm to determine when shifts in emotion levels represent a significant new phase. The algorithm can help analysts detect hard-to-spot patterns in very large volumes of noisy data more quickly. By viewing the trend lines and breakpoints in emotion levels expressed toward a topic across time against the events that unfolded on the ground, users can gain situational awareness that cannot be obtained from knowledge of the events alone. For example, if the streets are quiet during a political crisis, but citizens are still venting rage toward their government via Twitter, then analysts should be aware that the crisis may still escalate.[2]
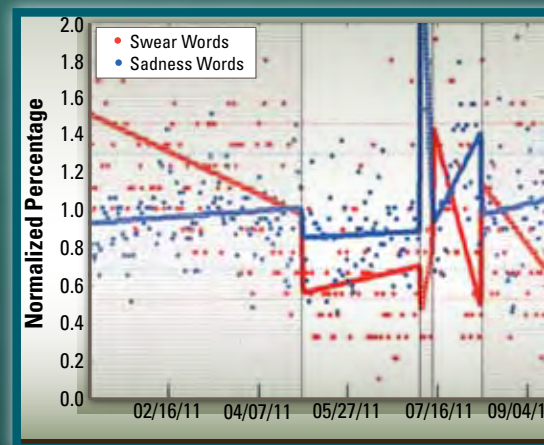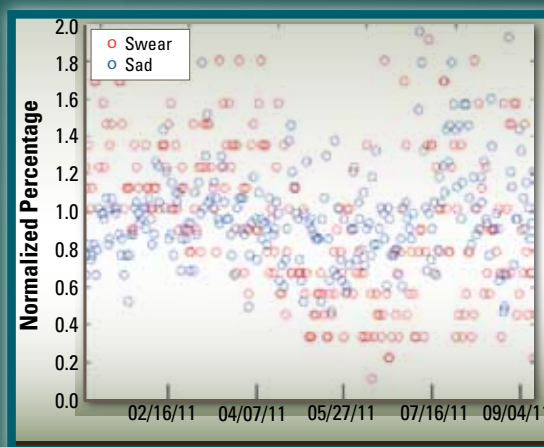
1. Pennebaker, J.W., Chung, C.K., Ireland, M., Gonzales, A., & Booth, R.J. (2007). The development and psychometric properties of LIWC2007. Austin, TX: LIWC.net.

2. Elson, S. B., Yeung, D., Roshan, P., Bohandy, S., & Nader, A. (2012). Using Social Media to Gauge Iranian Public Opinion and Mood After the 2009 Presidential Election. Santa Monica, CA: RAND Corporation.

CAPABILITY NEEDS

Just as the evolving global information environment has brought new challenges, new data types, sources, and technologies present opportunities. Data collected by unmanned aerial vehicles and sensors, and new information systems to integrate these new sources into models and visualize their data streams, have all undergone tremendous improvement, and are beginning to realize a small part of their potential. Handheld devices had started to emerge as tools with some social impact in 2006. Natural language processing, computer-assisted translation, and other semantic efforts have existed for some time, but events such as the Arab Spring have drawn much more attention to these initiatives.

The social radar experience to date suggests an exciting future in which global information, applied research, and analytics are fully and dynamically integrated. The three elements will work together, seamlessly and almost simultaneously. Global data will be rapidly collected and processed, fueling interdisciplinary research that creates new tools, which will then be applied to transform information into the understanding needed to support effective, agile decision making. As new data and research arrive, the information and the tools themselves will be updated to give decision makers new information and new ways of looking at that information.

Realizing this broad—and ambitious—vision will entail development of more highly tailored capabilities. The set of sociocultural behavior capabilities provided in Table 6 is grounded in the foregoing discussion and analysis, and was developed with input from a variety of SMEs, including managers of leading research programs across the Armed Services. The table is organized into the now-familiar capability areas of Understand, Detect, Forecast, and Mitigate. This set of capabilities is not intended to be comprehensive, but represents a core list that can guide DoD efforts in the longer term.

Table 6. Sociocultural Behavior Capabilities

Understand
Understand structure of threat narratives and their potential impact on meaning making by local populations and their leaders.
Identify previously unknown groups or individuals that may present threat and situate them within a social network.
Collect quality sociocultural behavior data in denied or limited access areas.
Improve understanding of social identity and social behavior.

Detect
Detect activities of groups or individuals attempting to exert influence, and track those activities over time, space, and social networks.
Detect and control for deception, particularly in social media.

Synthesize data of multiple types and varying granularity sufficiently to detect an integrated signal.
Persistently surveil and detect behavior pattern changes to identify adversaries.
Forecast
Forecast onset and pattern of large-scale movement of populations in response to highly disruptive natural or man-made events.
Anticipate and trace propagation of effects from tactical to operational and strategic levels.
Identify discourse communities and monitor patterns in their rhetoric and messaging that support forecasting of group decisions and behavior.
Detect and track signals of excited networks that may indicate emergent unrest or behaviors relevant for missions such as countering WMD and countering violent extremism.
Mitigate
Track rate, extent, and pattern of spread of Blue Force messaging.
Compare and visualize alternative COAs, while providing some estimate of uncertainties associated with each option.
Measure interdependent effects of kinetic and non-kinetic COAs on sentiments, attitudes, and behaviors of adversary and general populations.
Geolocate sociocultural behavior features to a level of precision that supports visualization of those features as geospatial layers.

ENABLING RESEARCH

To achieve practical capabilities in these areas DoD should conduct research grounded in the social and behavioral sciences and executed with an eye toward operational needs and documented requirements. The nature of global change discussed earlier suggests the importance of applying "big data" and cloud-based processing to effectively manage the enormous volumes of available open source material. Analysts must make sense of that data via algorithms derived from basic research and applied theory, as well as methods, models, and technologies that promote deep understanding of the global human domain in which warfighters operate. To keep pace with the rapidly increasing interconnectivity of global populations, DoD must seek to understand how populations use cellular and other mobile technologies, including how networks grow, function, and carry influence.

The vision and capabilities discussed in the preceding sections imply several lines of R&E that DoD should pursue. Table 7 lists a recommended set of research thrusts based on the preceding analysis and discussion in this report, and informed by the authors' experience with the HSCB Modeling Program, the Armed Services S&T community, and both academic and industry researchers who have led applied sociocultural behavior research with DoD sponsorship.

Table 7. Recommended Research Thrusts

Understanding
Techniques for comparison and fusion of different sources of data, as well as the blending of qualitative and quantitative data
Modeling the psychological dynamics of small groups and networks
Basic and applied research to populate integrated models of emergent violent extremism and instability
High-resolution model to predict growth of factions and ideologies in cultures
Research to link individual behavior pattern recognition to implied intent
Models that will support understanding of crowd control/neutralization
Cognitive task analysis with trainers and forces to improve understanding of needed sociocultural behavior knowledge, skills, and abilities
Empirical, longitudinal evaluation of cost effectiveness and impact of cross-cultural training
Detection
Tools and techniques for detecting disinformation from a variety of sources
Entropy semantics—automated detection of and alerting to changes in the distribution of semantic search results
Continued investment in tools to detect and extract event data from non-English text
Automated data ingest and analysis for less structured open media data and non-textual media
Entity resolution research to help create a "trusted data" model that takes advantage of duplicate references to a single subject
Visualization of key dynamics in networks, including assessment of group dynamics; identification of stable, emergent, and dispersing groups; and identification of stable, emergent, and degrading patterns of influence and trust
Enhanced geo-temporal network extraction, spatial link inference and assessment, geo-network metrics, and location-based network reasoning and visualization—all robust and scalable to big data
Sentiment models that can associate sentiments with their sources and subjects at levels of precision and recall that are operationally acceptable, and that work for multiple major languages

Forecasting

Improved verification, validation, scalability, and maintenance of models coupled with additional experimentation to ensure robustness of the concepts being modeled

Adaptive artificial intelligence environments and characters to improve modeling of COA effects

Computational models that support probabilistic forecasts of group decision making by political leaders and organizations (actors)

Agent-based and hybrid models tailored to forecasting the dynamics of mass forced or unforced migrations

Techniques for tracking a forecast on a daily basis to see how it may be playing out in unfolding events and to uncover additional, actionable detail

Methods and data for validating the predictive value of social media

Mitigation

Models and processes that identify messaging options for maximizing effectiveness and propagation of influence

Measures of effectiveness that can be used to evaluate the impact(s) of COAs

Exploratory modeling techniques and tools

Techniques and systems for effective management of big data produced by large-scale simulations involving cognitively realistic agents

Distributed, high performance simulation engine that accommodates multi-disciplinary models to support COA analysis across the PMESII domains

Cascading effects models to simulate the combined effects of kinetic, non-kinetic, and IW events on the behaviors of individuals, organizations, and societal groups

Predictive computational models of green/white/red behaviors, both as individuals and as tightly and loosely coupled teams

CONCLUSION

Innovative ideas for research, science, and technology are essential to long-term success in building DoD sociocultural behavior capabilities. However, those ideas can only be translated into practical tools if appropriate programs and processes are in place. DoD should seize any opportunity to further minimize duplication and inefficiency in its programs while promoting innovation and keeping the needs and interests of operational end-users as the first and foremost priority.

The following series of recommendations is derived from the experience of the last six years, including an understanding of current commercial technology and research efforts underway in this domain. The recommendations recognize the need to support near-, mid-, and long-term research efforts while accounting for affordability, effectiveness, and efficiency across the research domains. Further, they reflect the importance of reaching across the DoD and broader U.S. government enterprises and mission sets to ensure that mission-focused research and transition take place in a coordinated and effective fashion.

1. DoD needs a robustly funded 6.2–6.4 sociocultural modeling research program to address the range of capabilities users demand. The area of applied sociocultural behavior research and engineering is still relatively young, specified requirements remain relatively limited despite widespread acknowledgment of needs, and the Services provide primarily Basic Research oriented to their particular priorities. There remains a need for a program and processes that can help mature Basic and Applied Research into software and tools that can be transitioned and sustained. Planned levels of approximately $50 million per year for the HSCB Modeling Program were not unreasonable, and experience with the Program suggests that resourcing under $20 million annually is not likely to be effective.

2. The Services should prioritize science and technology for sociocultural behavior capabilities, building on some of the innovative work already underway. This needs to be supported by specification of sociocultural behavior-related capabilities and associated requirements. These should be derived through coordination across the Services to maximize leveraging opportunities and minimize inefficient redundancies. With the joint requirements as drivers, each Service should then sponsor Basic and Applied Research tailored to the needs of their respective warfighters' missions.

3. To maximize the success of the first two recommended actions, DoD needs to intensify coordination across the sociocultural behavior research space. Using mechanisms such as the OSD Human Systems Social, Cultural and Behavioral Understanding sub-area group, DoD should increase coordination both horizontally (across the Services and at any given level of research) and vertically (from Basic through Applied and on to Advanced Technology Development and Prototyping programs).

4. DoD should identify a center of excellence for sociocultural modeling integration and analysis, focused on application of technology to user needs, transition to users and PORs, metrics, data interoperability, model validation, and model reuse and generalizability. This center should emphasize identifying and supporting operationalization of sociocultural behavior tools. This could include helping to identify and develop resources and best practices for training, experiments with end users, requirements development, and rapid fielding.

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123. Cheong, P. (2010). "Ethics of Social Media: Tensions and Challenges in a Transmedia and Ambient Culture." Keynote address at the 23rd Annual David C. Bicker Communication Ethics Conference at Azusa Pacific University, CA.

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127. Cheong. P. (2010). Presentation at the Global Media and the War on Terror Conference in London, England.

128. Corman, S. (2010). "The Role of Narrative in Strategic Communication." NATO Third Symposium on Global Terrorism and International Cooperation, Ankara, Turkey.

129. Corman, S. (2009). "A New Model for Narrative Networks." Presented at HSCB Modeling Program: OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

130. Corman, S. (2010). Panel discussion, "Constructing Interdisciplinary Collaborations: Applying Communication and Narrative Theories to Counter-Terrorism." National Communication Association Convention, San Francisco, CA.

131. Corman, S. (2011). "Project review at a mining and mapping." Presented at Cyber-Enabled Discovery and Innovation (NSF-CDI) Workshop.

132. Corman, S. (2011). Presented a discussion on Rhetoric and Narrative at the MITRE Technical Exchange Meeting in the science and technology of strategic communication in VA.

133. Corman, S. (2011). Presented as a Distinguished Visiting Fellow at the Center of Excellence for National Security at Nanyang Technological University, Singapore. (Four lectures presenting results from the HSCB project.)

134. Corman, S. & Trethewey, A. (2011). Presented at the HSCB Focus 2011 Conference in Chantilly, VA with a follow-up Technical Review Session with ONR and Corman.

135. Corman, S. R. (2009). "Promises and Challenges of Computerized Knowledge Management in a Best-Case Scenario." International Communication Association, Chicago, IL.

136. Corman, S. R. (2009). "Respondent. Innovations in Group Communication Theory: Dual-Level Connectionist Models." National Communication Association, Chicago, IL.

137. Corman, S. R. (2010). "A Narrative Perspective on Extremist Im/materiality." International Communication Association, Singapore.

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148. Corman, S.R. (Ed.) (forthcoming February 2013). *Narrating the Exit form Afghanistan*. Tempe, AZ: Center for Strategic Communication. CSC Project Team. (2009). Poster presented at HSCB Modeling Program: OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

149. D'Orazio, V. (2011). "War Games and Korea." Paper presented at the International Studies Association, Montreal (March 2011).

150. Davidson, I. (2009). "Knowledge Driven Dimension Reduction." 23rd International Joint Conference on Artificial Intelligence (IJCAI).

151. Davidson, I., Ravi, S.S. & Shamis, L. (2010). "A SAT-Based Framework For Efficient Constrained ClusterinG," 8th SIAM Data Mining Conference.

152. Davidson, I. & Qi, Z. (2008). "Finding Alternative Clusterings with Constraints." 9th IEEE ICDM.

153. Davidson, I. & Walker, P. B. (2010). "Predicting Adversarial Intent from Adversarial Event Data." Paper presented at the 62nd Biannual Meeting of the Department of Defense Human Factors Engineering Technical Advisory Group, Key West, FL.

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158. DeCino, A. & Meyer, D. A. (2012). "Forgetting functions for collective memory." Second International Conference on Cross-Cultural Decision Making: Focus 2012, San Francisco, CA, 24 July.

159. Dennis, B. M. (2009). "An Introduction to Understanding Relief Social Media." OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

160. Dennis, B. M. (2009). "Visualizing Galaxies of Networks: Systematic Yet Flexible Approaches." OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

161. Dennis, B. M., Finin, T., Joshi, A., Kopack, M. & Roberts, A. (2011). "Relief Social Media: Analysis and Applications." International Cross-Cultural Decision Making Conference. San Francisco, CA.

162. Douglass, R. W. (2012). "Hearts, minds, or bodies: Information sharing and the portfolio of violence towards civilians in civil war." Working paper and invited presentation to the Department of Political Science, Emory University, Atlanta, GA, 2 November.

163. Douglass, R. W. (2013). "Expert surveys as a source of longitudinal civil war data: Measuring territorial control in the Vietnam War." Working paper and accepted for presentation at the 2013 Midwest Political Science Association Conference.

164. Douglass, R. W. & Harkness, K. (2013). "A case for a heavy hand? The effects of collective punishment on patterns of violence in the Mau Mau Uprising." accepted for presentation at the 2013 Midwest Political Science Association Conference and the 2013 International Studies Association Conference.

165. Douglass, R. W. & Peritz, L. (2013). "What have we learned from microlevel conflict studies?" Working paper.

166. Drozdova, K. (2010). "Leaving Afghan – Easier Said than Done: Afghan War Lessons from the Soviet Archives." Presentation, Stanford University, Hoover Institution, annual Hoover Soviet Archives Workshop, July 20.

167. Drozdova, K. (2010). "The U.S. Must Win This War." The Free Lance-Star, Nov 28, 2010. The Free Lance-Star Publishing Company, Fredericksburg, VA. (op-ed; picked up and also published by other national and international papers).

168. Drozdova, K. (accepted, forthcoming). "Evaluating Strategies toward Stability in Afghanistan and the Region." 2012 APSA Annual Meeting.

169. Drozdova, K. & Gaubatz, K. (accepted for publication, forthcoming). "Reducing Uncertainty: Information Analysis for Comparative Cases." International Studies Quarterly.

170. Drozdova, K. (forthcoming 2013). "War in Afghanistan: Before and After 9/11." Encyclopedia of Military Science, Piehler, Kurt, Ed., SAGE.

171. Drozdova, K. (submitted; under review). "Methods for Mining Afghan Lessons from the Soviet Era (MALSE) Archives with US National Security Applications." International Studies Association 2013 Annual Meeting.

172. Drozdova, K. & Felter, J. (2011). "Afghan Stability and Transition Conditions." MALSE Research Paper on how the USSR attempted to strengthen Afghan government, train security forces, prepare for transition & conventional withdrawal, results.

173. Drozdova, K. & Felter, J. (2011). "Sample Lessons from the Soviet Archives: Security, Governance, Development, Transition, Risks Ahead." MALSE Research Paper on Soviet Lines of Effort in Afghanistan, as well as withdrawal and transition plans.

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181. Frantz, T. & Carley, K. M. (2009). "Toward a Confidence Estimate for the Most-Central-Actor Finding." Paper presented at The Academy of Management Annual Conference, Chicago, IL, August 7–11, Sage Publications/RM division Best Student Paper.

182. Friedland, L., Sagae, A. & Wertheim, S. (2011). "Data collection for cross-disciplinary models of interpersonal dialog." in proceedings at the HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

183. Furlow, R. B. & Goodall, H.L. Jr. (2011). The War of Ideas and the Battle of Narratives: A Comparison of Extremist Storytelling Structures. *Cultural Studies— Critical Methodologies, 11, 215–223.*

184. Gabbay, M & Thirkill-Mackelprang, A. (2011). "A Quantitative Analysis of Insurgent Frames, Claims, and Networks in Iraq." Paper presented at Annual Meeting of the American Political Science Association, Seattle, WA.

185. Gabbay, M. (2012). "Modeling Decision-Making Outcomes in Political Elite *Networks." Proceedings of 2nd International Conference on Complex Sciences: Theory and Applications*, December 2012.

186. Gabbay, M. (2012). "The Rabbani Assassination: Taliban Strategy to Weaken National Unity?," *CTC Sentinel* 5(3), p. 10–14.

187. Gabbay, M. (2009). "Rhetoric-Based Mapping of Insurgent Factional Structure and Evolution." Presentation, OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

188. Gabbay, M. (2010). "Insurgencies and the Web." Presentation, 2010 Intelligence Community Colloquium of the Institute for National Security Education and Research, Seattle, WA.

189. Gabbay, M. (2011). "You are Who You Kill: Insurgent Claims, Frames, and Identities in Iraq." Presentation, Annual Convention of the International Studies Association, Montreal, Quebec.

190. Gabbay, M. (2012). "Insurgent Factional Structure and Strategy in Afghanistan." Presentation, British International Studies Association and International Studies Association joint meeting, Edinburgh, UK.

191. Gabbay, M. (2012). "Modeling Decision-Making Outcomes in Political Elite Networks." Presentation, Second International Conference on Complex Sciences: Theory and Applications, Santa Fe, NM.

192. Gabbay, M. & Thirkill-Mackelprang, A. (2010). "Insurgent Operational Claims and Networks." Presentation, 2010 Annual Meeting of the American Political Science Association, Washington, DC.

193. Gabbay, M. & Thirkill-Mackelprang, A. (2010). "Insurgent Operational Claims and Networks." Paper presented at the 2010 Annual Meeting of the American Political Science Association, Washington, DC.

194. Gabbay, M. & Thirkill-Mackelprang, A. (2010). "Modeling Insurgent Network Structure and Dynamics." Presentation, American Physical Society March Meeting, Portland, OR.

195. Gabbay, M. & Thirkill-Mackelprang, A. (2010). "Modeling Insurgent Network Structure and Dynamics." Presentation, 78th MORS Symposium, Quantico, VA.

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203. Georgeon, O. L., Morgan, J. H., Horgan, J. & Braddock, K. (2010). "Process modeling for the study of non-state political violence." Paper presented at the 19th Behavioral Modeling in Modeling and Simulation Conference, Charleston, SC, March 2010.

204. Ghoshal, G. & Barabási, A-L. (2011). "Ranking stability and super-stable nodes in complex networks." *Nature Communications* 2, 1–7.

205. Gilpin, S., Davidson I., Incorporating Sat Solvers into Hierarchical Clustering Algorithms, KDD 2011.

206. Goodall, H. (2009). "Blood, Shit and Tears: The 'Terrorist' as Abject Other." Presented at the Economic and Social Research Council, University of York, United Kingdom.

207. Goodall, H. L. Jr. (2011). "The Twin Paradoxes of Master Narratives at Home and Abroad." San Antonio, TX: Academy of Management.

208. Goodall, H. L. Jr., Cheong, P., Fleischer, K. & Corman, S. (2012). "Rhetorical Charms: The Promise and Pitfalls of Using Humor and Ridicule to Combat Extremist Narratives." *Perspectives on Terrorism*, 6(1).

209. Halverson, J. (2010). "The Tyrant Archetype in Radical Islamist Narratives." Presented at the WECSOR conference in Tempe, AZ.

210. Halverson, J. (2011). "Tariq ibn Ziyad master narrative." Report #1101, Center for Strategic Communication, Arizona State University.

211. Halverson, J. R. (2010). "A Counter Narrative for Iranian Tyranny." Report #1002, Center for Strategic Communication, Arizona State University.

212. Halverson, J. R. (2011) "Yusuf al-Qaradawi." In Tamara Sonn (Ed.) *Oxford Bibliographies Online: Islamic Studies*. New York: Oxford University Press.

213. Halverson, J. R. (2011). "Muslim Brotherhood." In J. I. Ross (Ed.) *Religion and Violence: An Encyclopedia of Faith and Conflict. Antiquity to the Present*, vol. 2 (482–487). Armonk, NY: M.E. Sharpe.

214. Halverson, J. R. (2012). "Civil Society Initiatives in Post-Revolution Tunisia." presented at *2nd International Conference on Cross-Cultural Decision Making: Focus 2012*, San Francisco, CA, July 21–25.

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217. Halverson, J. R. and Way, A. K. (2012). "The Curious Case of Colleen LaRose: Social Margins, New Media, and Online Radicalization." *Media, War & Conflict*, 5(2). USC Annenberg Press.

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220. Halverson, J. R., Ruston, S. & Trethewey, A. (in press). "Mediated Martyrs of the Arab Spring: New Media, Civil Religion and Narrative in Tunisia And Egypt." *Journal of Communication*.

221. Halverson, J., Ruston, S., Cheong, P. & Goodall, H. (2010). Panel presented on Re-Imagining the Role of Narrative Methods To Identify and Counter Terrorist Organizing at the Qualitative Research in Management and Organization Conference in Albuquerque, NM.

222. Halverson, J.R. (2010). "Beyond Words: Sacred Text and Sound in Islamic Discourse." presented at Qualitative Research in Management and Organization Conference, University of New Mexico.

223. Halverson, J.R. (2012). *Searching for a King: Muslim Nonviolence and the Future of Islam*. Washington DC: Potomac Books.

224. Halverson, J.R. & Corman, S. R. (2011). *Jobbik, Magyar master narratives and the neo-fascist Threat*. CSC Report for the EUCOM Deep Futures Cell.

225. Halverson, J.R. & Ruston, S. (2013). "The New Media Pulpit: Understanding Anwar Awlaki's Global Emergence." New Media and Society. (Under review).

226. Halverson, J.R. & Ruston, S. W. (2010). "Counter Narratives and New Media." Terrorism and New Media Conference, Dublin City University, Dublin, Ireland.

227. Hildebrandt, W. & McCue, C. (2012). "Unbiased Analytics for the COCOMs." Applied Human Factors and Ergonomics (AHFE) International.

228. Hobbs, J. R., & Sagae, A. (2011). "Toward a Commonsense Theory of Microsociology: Interpersonal Relationships." Paper presented at the AAAI Spring Symposium.

229. Horgan, J. (2009). "Towards Effective HSCB Modeling: 10 Golden Rules for Researchers." OSD Human Social Culture Behavior Modeling Program Focus 2010 Conference, Chantilly, VA, August 6.

230. Horgan, J. (2010) "Competitive Adaptation in Terrorist Networks." Presentation to the Marshall Center, Garmisch, Germany, July 6.

231. Horgan, J. (2010). "Interviewing the Terrorists." International Society for Political Psychology Annual Conference, San Francisco, CA, July 7–10.

232. Horgan, J. (2010). Briefing for Laura Voelker, Special Assistant to Deputy UnderSecDef for HUMINT. Applied Research Laboratory, Pennsylvania Statue University, April 5.

233. Horgan, J. (2011). "Case Study Examples: Working Through the System." Panel presentation, HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

234. Horgan, J. (2011). "Interviewing the Terrorists: Reflections on Fieldwork and Implications for Psychological Research." *Behavioral Sciences of Terrorism and Political Aggression* 4(3): 195–211.

235. Horgan, J. (date unknown). Presentation to College of International Security Affairs, National Defense University, Fort Bragg, Fayetteville, NC.

236. Horgan, J. & Horne, C. (2012). "Methodological Triangulation in the Study of Terrorist Networks." *Studies in Conflict and Terrorism* 35: 182–192.

237. Horgan, J., Bloom, M., Carley, K., Kenney, M. & Braddock, K. (2011). "Technical Performance Evaluation." MITRE Corporation, McLean, VA, June 7.

238. Horgan, J., Kenney, M. & Vining, P. (2010). "Adversarial Behavior in Complex Adaptive Systems: An Overview of ICST's Research on Competitive Adaptation in Terrorist Networks." Annual Meeting of the International Society of Political Psychology, San Francisco, CA, July 7–10.

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241. Horgan, J., Kenney, M., Bloom, M., Braddock, K., Zinni, N., Vining, P. & Horne, C. (2010). "Adversarial Behavior in Complex Adaptive Systems: An Overview of ICST's Research on Competitive Adaptation in Terrorist Networks." Annual Meeting of the American Political Science Association, Washington, DC, September 2–5.

242. Horgan, J., Kenney, M., Bloom, M., Carley, K & Braddock, K (2012). Interim Performance Review to the Office of Naval Research, Arlington, VA, February 3.

243. Horgan, J., Kenney, M., Bloom, M., Horne, C., Braddock, K., Vining, P., Zinni, N., Carley, K & Bigrigg, M. (2011). "Adversarial Behavior in Complex Adaptive Systems: An Overview of ICST's Research on Competitive Adaptation in Militant Networks." Detecting Terrorist Activities session at the 9th International Conference on Engineering Psychology and Cognitive Ergonomics in Orlando, FL, July 9–14.

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246. Irvine, J. M., Lepanto, J., Regan, J. & Young, M. (2012). "Deriving Economic and Social Indicators from Imagery" IEEE Applied Imagery and Pattern Recognition Workshop, 9–11 October 2012, Cosmos Club, Washington, DC.

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249. Ivengar, A., Finin, T. & Joshi A. (2011). "Content-based prediction of temporal boundaries for events in Twitter." *Proceedings of the Third IEEE International Conference on Social Computing*, October 9.

250. Johnson, W. L., & Sagae, A. (2010). "Adaptive Agents for Promoting Intercultural Skills." Paper presented at the Adaptation and Personalization in E/B-Learning Using Pedagogic Conversational Agents (APLeC), workshop of UMAP 2010, Big Island, HI.

251. Johnson, W.L. (2009). "A Dynamic Methodology for Developing Situated Culture Training Content." Presentation, HSCB Technical Exchange Meeting, Bedford, MA.

252. Johnson, W.L. (2010). "Training and Mission Rehearsal in Evolving Cultural Contexts." Presentation, OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

253. Johnson, W.L. & Sagae, A. (2010). "Commonsense Socio-Cultural Models for Culture Training." Presentation, OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

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255. Johnson, W.L., Friedland, L. & Sagae, A. (2011). "ICULT: An Immersive Intercultural Trainer that Adapts to Trainees' Intercultural Competence." Invited presentation to C 1MEF and TECOM at Camp Pendleton. October 17–19.

256. Johnson, W.L., Sagae, A. & Friedland, L. (2012). "VRP 2.0: Cross-Cultural Training with a Hybrid Modeling Architecture." *Proceedings of the 2nd International Conference on Cross-Cultural Decision Making.* San Francisco, CA, July 2012.

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258. Kenney, M. (2011). "Competitive Adaptation: Learning in Trafficking and Terrorist Networks." Graduate School of Public and International Affairs, University of Pittsburgh, February 25.

259. Kenney, M. (2011). "Dumb yet Deadly: Jihadist Knowledge, Tradecraft, & Limitations of Online Training." George C. Marshall European Center for Security Studies Meeting: "Our Threat Transforming: al-Qaeda and al-Qaeda Associated Movements in a post-bin Laden Era." Garmisch-Partenkirchen, Germany, October 24–27.

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262. Kenney, M. (2012). "Networks, Leadership, and Change within al-Muhajiroun." CMU-Pitt Pittsburgh Area Network Scholars Brownbag Series, Pittsburgh, PA. May 9.

263. Kenney, M. (2012). Participant in workshop on "New Power Politics: Networks, Governance, and Global Security." International Studies Association Annual Conference, San Diego, CA. April 1–4.

264. Kenney, M. (2013). "Adaptation and Diffusion with Al-Muhajiroun: Results from a Field Study." International Studies Association Conference, San Francisco, CA. April 3–6.

265. Kenney, M. (date unknown). "International Terrorism: The Arab World and Beyond". L-3 STRATIS, Annapolis Junction, MD.

266. Kenney, M., Horgan, J., Horne, C., Vining, P., Carley, K., Bigrigg, M. W., Bloom, M. & Braddock, K. (in press). "Organisational Adaptation in an Activist Network: Social Networks, Leadership, and Change in al-Muhajiroun." *Applied Ergonomics*.

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268. Ksarandikar, A. (2010). "Clustering short status messages: A topic model based approach." Masters Thesis, Department of Computer Science and Electrical Engineering, University of Maryland, Baltimore, MD.

269. Landwehr, P., Carley, K., Spraragen, M., Ranganathan, B. & Zyda, M. (2010) "Planning a Cosmopolis: Key Features of an MMORPG for Social Science Research." CHI 2010 Workshop, Atlanta, GA.

270. Landwehr, P., Spraragen, M., Ranganathan, B., Carley, K. & Zyda, M. (2012) "Games, Social Simulations, and Data—Integration for Policy Decisions: The SUDAN Game." *Simulation & Gaming.* 44: 1 February 2013,. p. 151–177. 277. Lanham, M. J., Morgan, G. P., & Carley, K. M. (2011). "Data-Driven Diffusion Modeling to Examine Deterrence." Paper presented at the IEEE NSW 201, 1st International Workshop on Network Science, West Point, NY, June 22–24.

271. Lazer, D. (2012). "Political networks." Workshop on Information in Networks, NYU, September 28.

272. Lazer, D. (2011). "Computational social science meets open government." White House Open Government Research and Development Summit, March 21.

273. Lazer, D. (2011). "Computational Social Science: What should be next?" Workshop on Information in Networks, NYU, September 30.

274. Lazer, D. (2011). "How computational social science reads our digital traces." Swissnex Boston, MA, November 29.

275. Lazer, D. (2011). "How we think together." Brandeis University, November 9. 283. Lazer, D. (2011). "How we think together." Business Complexity and Global Leader Conference, Suffolk University, October 19.

276. Lazer, D. (2011). "How we think together." UMass, April 22.

277. Lazer, D. (2011). "Issues in studying human networks." Netsci 2011, Budapest, June 7.

278. Lazer, D. (2011). "Social network analysis." Technical Exchange Meeting on Smart Power in Action: the Science and Technology of Strategic Communication, organized by MITRE, McLean, VA, January 19.

279. Lazer, D. (2012). "Gleaning insights from digital traces of human behavior." Boston University, October 26.

280. Lazer, D. (2012). "The governance of knowledge networks in decentralized systems." University of Hamburg, July 4.

281. Lazer, D. (2012). "The Madisonian Cycle in the 21st century" (panel). Connecting Democracy: Online Consultation and the Flow of Political Communication, Harvard Law School, February 7.

282. Lazer, D. (2012). "The role of networks in building prosperity." Global Empowerment Meeting 2012, Harvard, October 25.

283. Lazer, D. (2012). "Will 'big data' yield big insights about human society?" The Institute for Applied Computational Science, Harvard University, November 30.

284. Levey, B., Bentley, P. & Shellman, S. (2012). "Forecasting Political Violence in Africa." Presented at the Robert S. Strauss Center and U.S. Africa Command, Climate Change and African Political Stability (CCAPS) conference on Evolving Dynamics of Security in Africa: Assessing Diplomacy, Development, and Defense Responses, University of Texas, Austin, TX.

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288. Lin, Y. (2012). "Mining Big Data: Understanding Human Cultures through Many Imperfect Len." The 4th International Conference on Applied Human Factors and Ergonomics 2012 (AHFE 2012), San Francisco, CA.

289. Lin, Y. (2012). "The geography of money and politics." NetSci 2012, Evanston, IL, June 2012.

290. Lin, Y. (2012). "The geography of money and politics." The 5th Annual Political Networks Conference, June 2012.

291. Lin, Y. (2012). "Tracing the invisible networks of US politics." NetSci 2012, Evanston, IL, June 2012.

292. Lin, Y. (2012). "Whisper: Tracing the Spatiotemporal Process of Information Diffusion in Real Time." Arts, Humanities, and Complex Networks – 3rd Leonardo satellite symposium at NetSci 2012.

293. Liu, Y.-Y., Csóka, E., Zhou, H. & Pósfai, M. (2012). "Core percolation on complex networks." *Physical Review Letters* 109, 205703-1.

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295. Liu, Y.-Y., Slotine, J.-J. & Barabasi, A.-L. (2012). "Control centrality and hierarchical structure in complex networks." *PLoS One* 7, e44459.

296. Lundry, C. (2009). Panel Chair and presented paper: "Ambonese, Christian, and Indonesian: Identity Formation and Representation among Ambonese in Early Indonesia." Presented at the Association of Asian Studies, Western Conference in Tucson, AZ.

297. Lundry, C. (2010). Invited Lecture: "Communicating Terrorism in Southeast Asia: Web 2.0, Transmediation and Hearts and Minds." US Naval War College.

298. Lundry, C. (2011). "The Urge to Fight in Indonesia: Demobilization, Rebellion and Jihad in Historical Perspective." Association of Asian Studies Conference.

299. Lundry, C. (2012). "Success and Failure in Strategic Communication: Indonesian and Singaporean Responses to Islamist Terror." International Communication Association, Phoenix, AZ.

300. Lundry, C. (2012). "The Enemy of My Enemy is... My Enemy: Online Indonesian Extremist discourse and the Libya Conflict." Association of Asian Studies Annual Conference, Toronto, March 15–18.

301. Lundry, C. & Cheong, P. (2010). "Rumor, Culture and Strategic Communication Across Old and New Media in Southeast Asia: The Case of Terrorist Noordin Top." Presented at the Centre of Excellence for National Security Workshop in Singapore.

302. Lundry, C. & Cheong, P. (2011). "Rumors and Strategic Communication – The Gendered Construction and Transmediation of a Terrorist Life Story". In T. Kuhn (Ed.) *Matters of Communication/Matters of Engagement*. New York: Hampton Press.

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304. Lundry, C. & Halverson, J. R. (2010). "Translation Challenges in Narrative Analysis: Issues of Data Purity." National Communication Association, San Francisco, CA.

305. Lundry, C., Corman, S., Furlow, B. & Errickson, K. (2012). "Cooking the Books: Strategic Inflation of Casualty Reports by Extremists in the Afghanistan Conflict." *Studies in Conflict and Terrorism*, 35(5).

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307. Lustick, I. S. (2011) "Taking Evolution Seriously: Historical Institutionalism and Evolutionary Theory." *Polity*, January 2011.

308. Lustick, I. S. (2012). "Deploying Constructivism for the Analysis of Rare Events: How Possible is the Emergence of Punjabistan?" in *Constructivist Theories of Ethnic Politics*, Kanchan Chandra, ed. (Oxford University Press), 422–451.

309. Lustick, I. S. (2012). "Institutional Rigidity and Evolutionary Theory: Trapped on a Local Maximum (with comment)." Accepted for publication to *Cliodynamics: the Journal of Theoretical and Mathematical History*.

310. Lustick, I. S. (2011). "Secession of the Center: A Virtual Probe of the Prospects for Punjabi Secessionism in Pakistan and the Secession of Punjabistan." *Journal of Artificial Societies and Social Simulation*, January 2011.

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312. Lustick, I. S. & Miodownik, D. (2009). "Abstractions, Ensembles, and Virtualizations: Simplicity and Complexity in Agent-Based Modeling." *Comparative Politics*, 41:2, 223–244.

313. Lustick, I. S., Alcorn, B., Eidelson, R., Garces, M. & Tubin, M. (2011). "Forecasting Political Futures for Thailand: Leveraging Social Science Theory in a Virtualization Model." Poster prepared for presentation at HSCB Focus, February 2011.

314. Lustick, I. S., Alcorn, B., Garces, M. & Ruvinsky, A. (2012). "From Theory to Simulation: The Dynamic Political Hierarchy in Country Virtualization Models." *Journal of Experimental and Theoretical Artificial Intelligence*, 24:3, 279–29.

315. Lustick, I. S., Miodownik, D. & Eidelson, R. J. (2004). "Secessionism in Multicultural States: Does Sharing Power Prevent or Encourage It?" American Political Science Review, May 2004.

316. Madan, A., Cebrian, M., Lazer, D. & Pentland, A. (2010). "Social Sensing to Model Epidemiological Behavior Change." Proceedings of ACM Ubicomp 2010, Copenhagen, Denmark (Nominated for Best Paper).

317. Madan, A., Moturu, S., Lazer, D. & Pentland, A. (2010). "Social Sensing: Obesity, Unhealthy Eating and Exercise in Face-to-Face Networks." Proceedings of ACM Wireless Health 2010, San Diego, CA.

318. Marine Corps University / Expeditionary Maneuver Warfare School, USMC, Quantico, VA, Boyd & Beyond Annual Symposia.

319. Martin, A. (Draft 2012). "The Future of Afghanistan from a Strategic Management Perspective: Does the Taliban have a disruptive strategy?"

320. Martinez-Moyano, I. J., North, M. J., Tatara, E. R., Altaweel, M. R. & Sallach, D. L. (2010). "Using system dynamics and agent-based modeling to simulate a proxy war for resources." Presentation at the 28th International Conference of the System Dynamics Society. Seoul, Korea.

321. McCloskey, M. & Behymer, K. (2011). "Modeling and Assessing Cross-Cultural Competence in Operational Environments." In D. Schmorrow and D. Nicholson (Eds.), *Advances in Cross-Cultural Decision Making.* Boca Raton: CRC Press.

322. McCloskey, M., & Behymer, K. (2013). "Methods for capturing cultural lessons learned and training cross-cultural skills." In D. Schmorrow and D. Nicholson (Eds.), *Advances in Design for Cross-Cultural Activities Part I.* Boca Raton: CRC Press.

323. McCloskey, M.J. (2009). "Cognitive Interfaces to Support Cultural Competence *Assessment." Proceedings of the Human, Social, Cultural and Behavioral Summit, Office of Naval Research*, August 1–3, 2009.

324. McCloskey, M.J. (2009). "CultureGear: A Cognitive Approach to Promoting Cross-Cultural Perspective Taking Skills." *Defense Equal Opportunity Management Institute Biennial EO, Diversity, and Culture Research Symposium*, Patrick AFB, FL.

325. McCue, C. & Hildebrandt, W. (2012). "Optimizing Asset Allocation through Statistical Modeling of Human Behavior." Applied Human Factors and Ergonomics (AHFE) International.

326. McCue, C., Hildebrandt, W. & Campbell, J. K. (2012). "Pattern analysis of the Lord's Resistance Army and Internally Displaced Persons." *Human Social Culture Behavior (HSCB) Modeling Program Winter 2012 Newsletter*, 12, 9.

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328. Moaddel, M. (2009) "Ongoing Research on Islamic Fundamentalism, Secular Politics, and Liberal Values: Egypt, Iran, Iraq, Lebanon, Pakistan, and Saudi Arabia" Poster Presentation at the Office of Naval Research Technical Demonstration Event, Washington, DC, August 3–6.

329. Moaddel, M. (2011). "Cross National Analysis of Values and Values Change." Presentation at the HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

330. Moaddel, M. (2011). "The Arab Spring and Reflections on Political Sociology." *States, Power, and Societies*, 15, 3 (autumn): 4–6.

331. Moaddel, M. (2011). "Trends in Values among the Middle Eastern Publics." New York University-Abu Dhabi, United Arab Emirates, October 9, 2011.

332. Moaddel, M. (2012). "Values, Trends, and the Arab Spring." Presentation at the Institute for Social Research, University of Michigan, Ann Arbor, MI, February 29, 2012.

333. Moaddel, M. (2012). "Values, Trends, and the Arab Spring." Presentation at the Institute for Social Research, University of Michigan, Ann Arbor, MI, February 29, 2012.

334. Moaddel, M. (2012). "Cultural Change as Issues Resolution: Predicting Change in the Middle East." Paper presented at a Workshop organized by the U.S. Army Research Institute, Fort Leavenworth, KS, January 12–13, 2012.

335. Moaddel, M. (2013) "The Arab Spring and Egyptian Revolution Makers: Predictors of Participation." A paper being prepared for submission to American Sociological Review.

336. Moaddel, M. (2013). "Why Do Egyptians Think Americans Are Immoral?" Working paper.

337. Moaddel, M. (2012). "Cultural Change as Issues Resolution: Predicting Change in the Middle East." Paper submitted for publication by the U.S. Army Research Institute, Fort Leavenworth, KS. Forthcoming.

338. Moaddel, M. (2012). "What Do Arabs Want?" Project Syndicate.

339. Moaddel, M. (2012)."Islam: Globalization and Its Intellectual Development." The Wiley-Blackwell Encyclopedia of Globalization, edited by George Ritzer, Malden, MA: Blackwell, vol. 3, I-No, pp. 1204-1216.

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341. Moaddel, M. & De Jong, J. (2013). "Trends in Values among Saudi Youth: Findings from Values Surveys." *Journal of the History of Childhood and Youth*, 6:1.

342. Moaddel, M. & Karabenick, S. (2013). *Religious Fundamentalism in the Middle East: A Cross-National, Inter-Faith, Inter-Ethnic Perspective*. Brill.

343. Moaddel, M. De Jong, J. & Dagher, M. (2011). "Beyond Sectarianism in Iraq." *Contexts* 10(3): 66–67.

344. Moaddel, M., & Young-DeMarco, L. (2011). "Survey Data on Middle Eastern Values: Making Connections between Culture, Values, Religious Fundamentalism, and Violence against U.S. Troops." Poster Presentation at the ONR HSCB Modeling Program Capability Open House sponsored by ASD(R&E), Arlington, VA., September 2011.

345. Moaddel, M., Kors, J. & Gärde J. (2013). "Sectarianism and Counter-Sectarianism in Lebanon." Submitted to *Journal of Conflict Resolution*.

346. Murnane, W. (2010). "Improving Accuracy of Named Entity Recognition on Social Media Data." Masters Thesis, Department of Computer Science and Electrical Engineering, University of Maryland, Baltimore, MD.

347. Murray, K, Lowrance, J., Sharpe, K., Williams, D., Gremban, K., Holloman, K., Speed, C. & Tynes, R. (2011). "Toward Culturally Informed Option Awareness for Influence Operations with S-CAT." in Proceedings of the 4th International Conference *on Social Computing, Behavioral-Cultural Modeling and Prediction (SBP11)*, Springer, vol. 6589, 2–9.

348. Murray, K., Lowrance, J., Sharpe, K., Williams, D., Gremban, K., Holloman, K. & Speed, C. (2010). "Capturing Culture and Effects Variables Using Structured Argumentation." in Advances in Cross-Cultural Decision Making, CRC Press, 363–373.

349. Nelson, D. (2009). "Translating Intercultural Competencies into Learning Objectives." Presented at HSCB Orlando, FL.

350. Nelson, D. (2010). "Task-Based Communications Training System." Presented OSD FOCUS 2010 Human Social Culture Behavior Conference, Chantilly, VA, August 5–7.

351. Nelson, D. (2011). "Customizing Culture and Language Training to Warfighter Needs." presented at HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

352. O'Connor, P. E., & Walker, P. B., (2011). "Evaluation of a Human Factors Analysis and Classification System as Used by Simulated Aviation Mishap Boards." *Aviation, Space, and Environmental Medicine*, 82, 44–48.

353. O'Brien, S. (2013). "Automating the Extraction of Bi-directional Sentiment Expressions from Social Media." 2013 Annual Meeting of INFORMS, Minneapolis, MN.

354. Online COMOPS Journal (http://comops.org/journal/). 179 entries.

355. Onnela, J. P., Arbesman, S., Gonzalez, M. C., Barabasi, A.-L. & Christakis, N. A. (2011). Geographic Constraints on Social Network Groups, *PLoS One* 6:4, 1–7.

356. Orkiolla, A. (2011). "Then As It Was, Then Again It Shall Be: Afghanistan before the Taliban and after the Withdrawal 1989–1994." MALSE Research Paper.

357. Orkiolla, A. & Martin, A. (2011). "The Rise of the Taliban 1994–1996." MALSE Research Paper.

358. Ozik, J., Collier, N., North, M. J., Rivera, W. A., Palomaa, E & Sallach, D. L. (2012). "The vmStrat domain-specific language." (To be published as a chapter) by CRC Press.

359. Pósfai, M., Liu, Y.-Y., Slotine, J.-J. & Barabási, A.-L. (2013). "Effect of correlations on network controllability." *Scientific Reports* 3:1067, 1–7.

360. Qi, Z. & Davidson I. (2009). "A Principled and Flexible Framework for Finding Alternative Clusterings." KDD.

361. Qian, B. & Davidson I. (2010). "Semi-Supervised Dimension Reduction for Multi-Label Classification." AAAI.

362. Rasmussen, L. J. (2009, August). "The puzzling Afghan: Making sense of Afghan interactions." Talk presented at the Human Social Culture Behavior Modeling Program Focus 2009 Conference, Chantilly, VA.

363. Rasmussen, L. J. & Sieck, W. R. (2010). "What happens after the 3rd cup of tea?: A cultural sensemaking guide to Afghanistan." Washington, DC: Government Printing Office.

364. Rasmussen, L. J., Grome, A. P., Crandall, B. W. & Sieck, W. R. (2009). "The Puzzling Afghan: Making Sense of Afghan Interactions." (Technical Report CTTSO W91CRB-09-C-0028a). Fairborn, OH: Klein Associates Division of ARA.

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368. Reynolds, W. N. & Wimberly, F. (2011). "Simulation Validation using Causal Inference Theory with Morphological Constraints." Proceedings of the 2011 Winter Simulation Conference. Phoenix, AZ, December 11–14.

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370. Reynolds, W. N., Weber, M. S. & Wimberly, F. (2011). "Extraordinary Science, Normal Validation: Towards Methodologies for Assessing Modeling at the Boundaries." Presentation at the HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

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372. Reynolds, W. N., Weber, M. S., Holden-Rhodes, J., & Felix, L. (2010). "Flashpoint Organizational Profiling: Structured, Theory-Driven Morphological Analysis of *Insurgent Networks." Proceedings of the 1st International Conference on Cross-Cultural Decision-Making*, Miami, FL, ISBN-10: 0-9796435-4-6.

373. Ruston, S. (2010)."Getting the Story Straight: Understanding Narrative Schema in Strategic Communication". Qualitative Research in Management Conference, Anderson School of Management, University of New Mexico, Albuquerque, NM.

374. Ruston, S. (2012)."State and Supra-State Sponsored Strategic Communication I: Theoretical Approaches to Foundations and Ethics." International Communication Association, Phoenix AZ. Panel Chair.

375. Ruston, S. & Halverson, J.R. (2012). "Video Wars: Extremism and Counter-Extremism in Digital Media." Visual Propaganda in Online Radicalization Conference, Georgia State University.

376. Ruston, S. W. & Halverson, J.R. (in press). "'Counter' or 'Alternative': Contesting Video Narratives of Violent Islamist Extremism." In C.W. Winkler and C.L. Dauber (Eds.), *Visual Imagery and Extremist Propaganda in the Online Environment*. Carlisle, PA: Army Strategic Studies Institute.

377. Ruvinsky, A., Shilliday, A., Wedgwood, J.E., & Welsh, J.J. (2011). "Purpose-Driven Metadata for Verification and Validation of HSCB Models." HSCB Focus 2011 Conference, Chantilly, VA, February 8–10.

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APPENDIX C: DETAILS ON ASSESSMENT OF ORIGINAL SPG GAPS

Individuals assessed each capability area for (a) progress since 2006 and (b) current capability. They used a scale from 1 (very strong) to 5 (very weak). Results were averaged to provide an overall rating.

	Progress	Capability
Data Knowledge and Acquisition		
Tools for collecting HUMINT and sociocultural data	2.9	3.3
Sensors with human feature resolution and analysis capability	3.7	4.2
Handheld tools to enable on-site ethnographic data collection—GPS, time, graphics, photos, and ethnographic questions	3.0	3.2
Behavior signatures tracking of adversaries—space, time, and cyberspace	3.9	4.3
Societal responses to Blue Force effects based operations	3.0	3.6
Team survey and ethnographic assessments of the stability, security, reconstruction, and transition needs of local villages, provinces, cities, and regions	2.6	2.8
Appropriate, holistic research plans that provide capability to scale up to regional views and down to local situations to improve situation awareness at every level of social complexity	3.3	3.5
Data Management		
Dynamic data-driven approach—near-real-time, on-demand configuration of live data sources	2.9	3.6
Metrics to assess military team performance/effectiveness at high levels of command	3.3	3.5
Data structure, data management and retrieval capabilities – Ontology development – for sociocultural data	3.3	3.5
Multilingual content analysis and ontology development	3.3	3.2
Standards-free interoperability between national forces	3.5	3.7
Open architecture standards, protocols, and supporting procedures to enhance information sharing and coordination	3.2	3.4
Text semantic analysis tools—tools that analyze text documents and compare the semantics with the data in the ontology database	3.2	3.4

	Progress	Capability
Ontology database—structured database that stores the data, relationships, and assumptions for the society of simulations	3.3	3.7
Ontology importing tools—tools that allow customization of ontology data by importing proprietary or classified data from external databases	3.3	3.5
Ontology visual analytics—suite of visualization tools that allow analysts to query and visualize data, relationships, and assumptions in the simulations	3.5	3.9
Ontology Integrated Development Environment—tools for subject matter experts to utilize in modifying or developing ontologies	3.3	3.7
Broad, in-depth Understanding of Sociocultural Factors		
Understanding and development of validation techniques for models of crowds, teams, and organizations	3.6	3.8
Anticipatory understanding of sociocultural factors affecting organizational and team effectiveness	3.2	3.5
Understanding of individual and aggregate behaviors	3.3	3.8
Research strategies to enable data collection for denied territory and societies	3.6	3.9
Crisis modeling assessment, response, and recovery tools that are culturally specific and sensitive	3.5	3.5
Understanding of sociocultural basis for development of trust with green/white	3.5	3.6
Understanding/modeling of how media and information propagation affect beliefs and behavior of individuals, groups, societies, states, and regions	3.5	3.7
Sensemaking support environment to enable rapid characterization of adversary proclivities and method of operations	3.8	3.9
Analytics and Modeling		
Sociocultural models supporting predictive understanding of red tolerant/supportive locations and environments—physical and social	3.4	3.5
Sociocultural and network models of green/white/red to enable projections of intent	3.6	3.5
Predictive behavioral analysis and green/white/red pattern assessment capabilities	3.5	3.8
Knowledge of sociocultural patterns to enable detection of abnormal behavior patterns	3.6	3.8

	Progress	Capability
High-resolution model for organizational growth based on ethnic, religious, political, economic, cultural, and other factors	3.8	4.0
High resolution models of how ideas spread within and among groups within a society	3.6	3.8
Anticipatory understanding of who will act contrary to stabilization efforts	3.7	3.8
Cascading effects models to simulate combined effects of kinetic, non-kinetic, and IW events on the behaviors of individuals, organizations, and societal groups	4.1	4.0
Predictive computational models of well-structured military and military-coalition/civilian/etc., teams	3.4	3.7
Predictive computational models of green/ white/red behaviors, both as individuals and as tightly coupled and loosely coupled teams	3.9	4.1
Understanding and modeling of the translation of individual versus aggregate (group, societal) behaviors	3.8	3.9
Anticipatory understanding of impact of PMESII reconstruction on societal support and tolerance for red	3.5	3.7
Integration of automated human intent models with TT&L technologies	4.2	4.3
Improved models of crowd behavior	3.5	3.8
Models of the mechanisms by which military organizations adapt to changing external contingencies	3.7	3.7
Models of terrorist information networks/media to disrupt messages and justifications	3.3	3.5
Ontology based models of information propagation to counter enemy messages	3.3	3.5
Multilingual media, leaders/organizational traits and behaviors modeling	3.6	3.7
Media and rumor propagation models/social network models to support psychological operations	3.5	3.8
Embedded human performance moderators	3.4	3.9
Creation of theory and formal models to support the development of culturally appropriate incentives and enabling capabilities to promote the stability of local civil society	3.7	3.8

	Progress	Capability
Dissemination and Visualization Tools		
Geospatial mapping of cultural factors (e.g., religious, ethnic, social, political, and economic)	3.2	3.3
Geospatial analysis and visualization tools	3.1	3.4
Persistent surveillance and reconnaissance with embedded explanatory behavior-based sociocultural models	3.7	4.1
Visualization capabilities for multiple layers of data	3.2	3.6
Change detection, motion detection, backtracking capabilities	3.6	4.1
Linguistic framing tools for coalition messages to ensure intended effects	3.2	3.6
Crisis modeling assessment, response, and recovery— tools that are culturally specific and sensitive	3.6	3.8
Dynamic data driven approach sensor management, employment, and tasking tools	3.3	3.9
Non-lethal capabilities, including modeling of crowd or individual responses and behaviors	3.3	3.8
Decision aids to provide crowd neutralization approaches	3.7	4.2
Technologies and tools for real-time monitoring of team and organizational effectiveness	3.3	3.7
Capability to rapidly disseminate information to the public via multiple media formats	3.0	3.3
PMESII data, models, and tools to sense instability in a nation or region	3.1	3.6
Integration of static and dynamic sociocultural factors into analysis and decision making (mapping agent traits)	3.6	3.7
Decision tools to support improved data acquisition, dissemination of research results, and interactive, incremental planning of civil-military operations	3.3	3.7
Systematic, quantifiable approach to representing the primary, secondary, and tertiary PMESII effects in IW modeling	3.7	4.3
Optimal integration of individual augmentees into unit manning for team effectiveness	3.7	3.9
Integration of NGO and interagency capabilities to achieve desired non-kinetic effects	3.4	3.9
Capabilities to rapidly develop effective teams and organizations with coalition partners	3.6	3.9

	Progress	Capability
Agent-based simulation engine—distributed and high-performance simulation engine that accommodates multi-disciplinary models across the PMESII domains	3.8	4.1
Training		
Training support for formal cultural and regional education curricula and language skills, focusing on potential adversaries and coalition partners	2.7	3.0
Adaptability training to support unique operations (e.g., IW, COIN)	3.2	3.6
Effects-based operations education, training, and simulation of leaders	3.4	3.8
Multi-national and interagency training curriculum and support for individual, team, and unit training	3.0	3.6
New generation tools that are culturally sensitive for understanding and responding to multi-dimensional problems in insurgency, instability, irregular warfare	3.2	3.3
Training support for organizational and team dynamics	2.9	3.4
Enabling technologies for adaptive individual education, training, and simulation	2.7	3.2

APPENDIX D: ACRONYMS

AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AFTC	Air Force Targeting Center
ARI	Army Research Institute
ARL	Army Research Lab
ARO	Army Research Office
ASD(R&E)	Assistant Secretary of Defense for Research and Engineering
BA	Budget Activity
BAA	Broad Agency Announcement
CADSIM	COA Analysis by Integration of Decision and Social Influence Modeling with Multi-Agent System Technology
CISD	Computational and Information Sciences Directorate
CKC	Cultural Knowledge Consortium
COA	Course of Action
COCOM	Combatant Command
COIN	Counterinsurgency
CRA	Charles River Analytics
CTTSO	Combating Terrorism Technical Support Office
DARPA	Defense Advanced Research Projects Agency
DDR&E	Deputy Director of Defense Research and Engineering
DIA	Defense Intelligence Agency
DIME	Diplomatic, Information, Military, and Economic
DISCCC	Defense Intelligence Socio-Cultural Capabilities Council
DoD	Department of Defense
DTRA	Defense Threat Reduction Agency
ERDC	Engineering Research and Development Center
FFRDC	Federally Funded Research and Development Center
FYDP	Future Years Defense Program
HADR	Humanitarian Assistance and Disaster Relief
HRED	Human Research and Engineering Directorate

HS CoI	Human Systems Community of Interest
HSCB	Human Social Culture Behavior
I2O	Information Innovation Office (DARPA)
ICEWS	Integrated Crisis Early Warning System
ISR	Intelligence, Surveillance and Reconnaissance
IW	Irregular Warfare
M&S	Modeling and Simulation
MARCIMS	Marine Corps Civil Information Management System
MASC	Modeling and Analysis of Strategic Contexts
MISO	Military Information Support to Operations
MURI	Multidisciplinary University Research Initiative
NGO	Nongovernmental Organization
NPS	Naval Postgraduate School
NSF	National Science Foundation
ONR	Office of Naval Research
OSD	Office of the Secretary of Defense
PE	Program Element
PMESII	Political, Military, Economic, Social, Infrastructure, and Information
POM	Program Objective Memorandum
POR	Program of Record
R&D	Research and Development
R&E	Research and Engineering
RDT&E	Research, Development, Technology and Engineering
RH	AFRL Human Effectiveness Directorate
S&T	Science and Technology
SAF	Semi Automated Force
SBIR	Small Business Innovation Research
SCG	Senior Coordinating Group
SES	Senior Executive Service
SME	Subject Matter Expert
SNARC	Social Network Analysis Reachback Capability
SPG	Strategic Planning Guidance

SSTR	Support to Stability Transition and Reconstruction
TPE	Technical Performance Evaluation
TRAC	TRADOC Analysis Center
TRADOC	Training and Doctrine Command
UCAG	User Community Advisory Group
USACE	U.S. Army Corps of Engineers
USAFRICOM	U.S. Africa Command
USD(I)	Under Secretary of Defense for Intelligence
USD(P)	Under Secretary of Defense for Policy
W-ICEWS	Worldwide Integrated Crisis Early Warning System

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