Enabling Socially and Culturally Adaptable Warfighters

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ABSTRACT

Traditionally, the development of training systems follows the well-established paths defined through Instructional Systems Design (ISD) guidelines. This approach works well when developing training for domains where core knowledge content is relatively static, such as Aviation, Marksmanship, Mathematics or Language. However, with the recent shift in military operations from predominantly kinetic to irregular and often non-kinetic, there has been a corresponding shift in the nature of the training that Warfighters require. In addition to static and well defined skill sets, Warfighters must now also be trained on specific social-cultural skills, general cultural awareness and sensitivity, and the more global ability to quickly integrate with new and potentially vastly different cultures. Warfighters must have the ability to quickly assess and identify the societal norms, behaviors, and social structures in a social or cultural group. Training technologies are needed that will prepare Warfighters to adapt to unfamiliar social-cultural environments. These technologies will leverage adaptable human behavioral representations, provide end-users with rapid authoring tools, provide instant and tailored feedback and will be able to be embedded into small footprint systems. This paper will discuss recent advances in each of these areas and provide a framework for how advances in each may be integrated into a process for developing training technologies that will provide Warfighters with the knowledge, skills and abilities they need to adapt to novel social-cultural experiences.

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INTRODUCTION

Human Social Cultural Behavior requirements

The Department of Defense (DoD) has traditionally focused on supporting large force-on-force scenarios. As a direct result of the U.S. military's dominance in traditional forms of warfare, current and anticipated adversaries have shifted their strategies to irregular and more disruptive methods to further their objectives. Consequently, while the U.S. military has focused on leading operations involving kinetics-oriented conflict with a state-sponsored adversary, now it also routinely participates in operations involving non-kinetic operations, with objectives focused on impacting non-combatant populations, and often times emphasizing Stabilization, Security, Transition, and Reconstruction Operations (SSTRO).

One of the most important consequences of this shift is that success in current and future U.S. military operations requires a significantly enhanced capability to understand, operate within, and affect the social and cultural terrain as well as the various dimensions of human behavior within these terrains. The 2006 Quadrennial Defense Review and DoD Directive 3000.05 (on Military Support for Stability, Security, Transition and Reconstruction Operations) specify the need for these non-traditional capabilities:

…preventing state or non-state actors from acquiring or using WMD [weapons of mass destruction] highlights the need for the following types of capabilities:… language skills and cultural awareness to understand better the intentions and motivations of potential adversaries and to speed recovery efforts (QDR, p.35)

Stability operations are a core U.S. military mission…given priority comparable to combat operations.… U.S. military forces shall be prepared to perform...stability operations tasks...Rebuild indigenous institutions.....bottom-up economic activity and constructing necessary infrastructure... (DoDD 3000.05)

The need to understand the motivations and influences underlying the behavior of adversaries and contested populations is critically important for future military missions and engagements as the United States interacts with numerous cultures to achieve national security goals and objectives. The changing nature of warfare requires that the U.S. Military be as well prepared to engage in non-kinetic operations as it is in kinetic warfare a requirement that spans all echelons.

Ongoing efforts in socio-cultural behavior research focus on developing capabilities for understanding and effectively operating in the human terrain (i.e., socio-cultural traits present at a specific time and location) for conventional and non-conventional warfare missions. The application areas for these capabilities span all operational environments, including: Analysis, Influence Operations, Experimentation, Operations Planning and Training and Mission Rehearsal. For example, effective influence operations must craft messages that will have the appropriate clarity and resonance with a target audience; this requires a thorough analysis and subsequent understanding of the audience. Similarly, commanders, warfighters and others central to SSTRO will enjoy significantly greater success if they are prepared with a more complete and sophisticated understanding of the human terrain in which they must function. Training and mission rehearsal should therefore incorporate information and data on that terrain.

Among all the contributors to operational success in these dynamic and unpredictable environments, training seems the most rapidly adaptable and responsive to the kinds of unforeseen operational requirements typical of these environments. These types of military engagements are, and will continue to be, effected at the lowest levels of command with minimal tactical and strategic oversight from higher-echelon command structures. If warfighters possess the knowledge, skills and abilities (KSAs) to quickly assess and identify the norms, behaviors and structures in a social or cultural group, they will be able to rapidly determine appropriate courses of action, tailored to the unique characteristics of the local environment in which they find themselves.

Concept for enabling socially and culturally adaptable warfighters

Traditional training approaches for enabling warfighters with a desired set of KSAs focus on a well-validated process of instructional systems design (ISD; Dick, Carey & Carey, 2001). The ISD process works well for developing training programs that support well understood systems, such as aircraft or power plant operations (Patrick, 2003), where material to be taught is relatively static or where components and operational techniques undergo well documented and well understood modifications.

For training programs that support dynamic and constantly changing requirements, significant alterations must be made to the ISD process. These enhancements could be achieved by pushing increasing amounts of the ISD process onto fieldable technologies that can speed up or extend those aspects of the ISD process that traditionally require significant amounts of time (Figure 1). The payoff is an added level of flexibility in the development process that allows for the timely and appropriate delivery of training to the warfighter.

Paper structure

The remainder of this paper focuses on characterizing the different technologies needed to enable effective training for socially and culturally adaptable warfighters. These technologies enhance the standard ISD process as follows:

1. Analyze:
   a. Providing the capability to collect up to the minute information concerning changing conditions in a given region
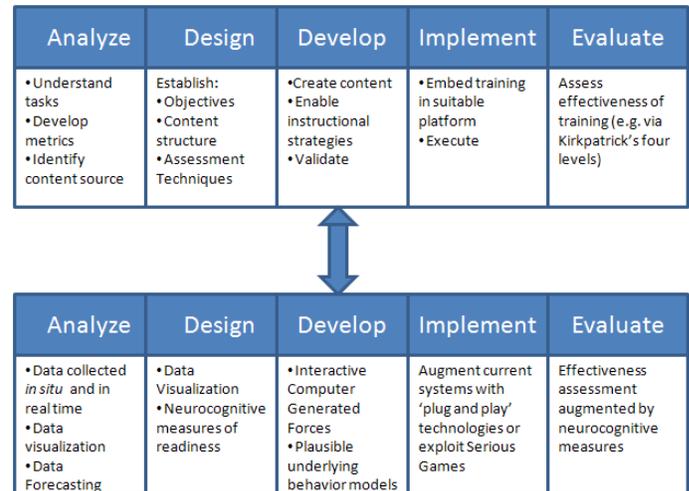

Analyze	Design	Develop	Implement	Evaluate
• Understand tasks • Develop metrics • Identify content source	Establish: • Objectives • Content structure • Assessment Techniques	• Create content • Enable instructional strategies • Validate	• Embed training in suitable platform • Execute	Assess effectiveness of training (e.g. via Kirkpatrick's four levels)

Analyze	Design	Develop	Implement	Evaluate
• Data collected *in situ* and in real time • Data visualization • Data Forecasting	• Data Visualization • Neurocognitive measures of readiness	• Interactive Computer Generated Forces • Plausible underlying behavior models	Augment current systems with 'plug and play' technologies or exploit Serious Games	Effectiveness assessment augmented by neurocognitive measures

Figure 1: *Top* **General ISD process, adapted from Dick, Carey, & Carey 2001; and Patrick, 2003). This process involves significant input from designers up front, working with well established materials and training objectives.** *Bottom* **Proposed enhancements to the ISD process for socio-cultural behavior applications using a suite of technologies currently in development.**

   b. Providing new capabilities to understand emerging and novel tasks to-be-trained, including visualization and forecasting from limited data sets
2. Design:
   a. Using available visualization and forecasting tools, establish training objectives and extract basis for content
   b. Using neurocognitive measures of readiness and performance, enable more effective assessments of individual and team performance during training
3. Develop:
   a. Interactive training to guide students through training in place of simply experiencing passively
   b. Establish high fidelity representations of behavior using neurocognitive modeling techniques
4. Implement:
   a. Moving away from high cost immersive training technologies, towards more cost effective serious game based systems
   b. Enable an architecture that supports rapidly changing content, high fidelity measures of effectiveness and works across platforms
5. Evaluate: Enhance standard methods using the tools, technologies and methods under development for steps 1-4.
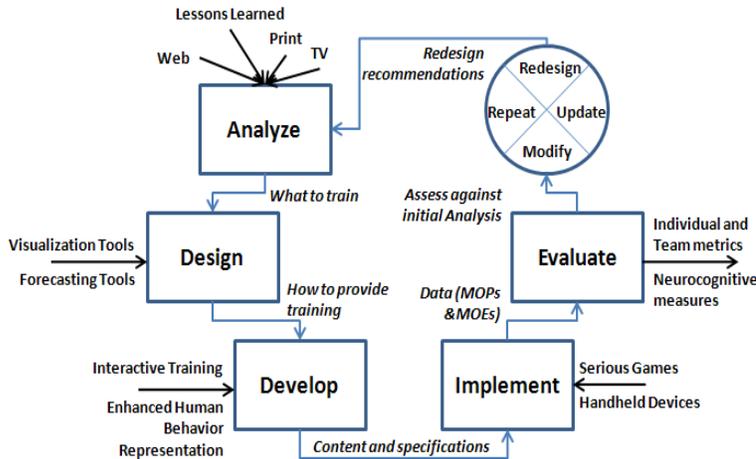
Figure 2: ISD process flow as outlined in text. Key enablers include rapid access to data leading to updates on training requirements (*front end analysis*) and direct access to assessment data to provide redesign recommendations (*back end analysis*).

These technologies are intended to enhance the existing ISD process, as indicated in Figure 2. Most of these technologies are emergent, and are in the process of being developed as part of the Office of the Secretary of Defense Human Social Cultural Behavioral (HSCB) Modeling program. The mission of the HSCB program is to support scientific and technological innovation in the development and application of social cultural methods, models, and tools in order to transition sustainable capabilities that meet operational needs.

The objectives for the HSCB program are derived from the Strategic Planning Guidance (SPG, Fiscal Years 2008-2013) which addresses the operational challenge of training warfighters to manage cultural variability and reduce cultural dissonance – two critical barriers to success in military missions that carry long-term consequences for U.S. interests worldwide.

TECHNOLOGIES FOR ENABLING SOCIALLY AND CULTURALLY ADAPTABLE WARFIGHTERS

What follows is a discussion of the different technologies needed to create a flexible ISD process to enable socially and culturally adaptable warfighters. Where such technologies currently exist, or prototypes of such technologies are being developed, specific examples are provided. In many cases, these technologies are in the process of being developed. For those cases, a description of the technology specifications is provided.

Analyze: In situ collection of data

Arguably, the most critical stage of developing any training system is identifying and capturing the content upon which such systems will be based. For well-defined training applications, like aircraft, this process generally requires in depth assessment of existing courses and manuals. The process is heavily augmented by interviews with users and subject matter experts, who can often times fill the gaps between theory and application. For socio-cultural behavior training applications, there are often few available courses and manuals. Moreover, the specific content that needs to be taught – including social networks, power structures and the like – is dynamic (Zacharias, MacMillan, & van Hernel, 2010). Within this context, time constraints and the need for "instant analysis" have increasingly exposed the limitations of more traditional data collection efforts (Russel & Clark, 2009).

The focus of this technology development effort is on developing the capability for long term, sustained data collection technologies from cultural and social regions of interest. The intended data collection capability will include: processes that incorporate techniques to pull in unfiltered data at the source from areas such as multimedia (e.g. world-wide-web, television, radio), online record storage, and individual inputs; and, techniques for representing these data in a standardized, searchable format. This technology is intended to work in an untended manner, for prolonged durations and will include a remote operation capability in order to sustain long-term data collection efforts. The expected result from this technology is the ability to access a continuous stream of data, spanning different modalities, that reflects real-time events. Armed with this information, instructional system developers will have the ability to continuously integrate the most current information into their training systems.

One example HSCB Program-funded effort that addresses this challenge is the Semantic Wiki for Complex Operations (Milcord). This project is developing a hybrid knowledge management service for modeling and simulation, training, and tactical decision-aid applications. The Semantic Answer Engine will bridge doctrine knowledge, encyclopedia and social science data, and human terrain and cultural information. It will enable users to locate, access, and use timely data from a variety of sources, for modeling and other purposes. A tool like this could be used by training system developers to integrate current

information that is supplied from across the complex operations community.

Design: Rapid data processing

The next step after accessing real-time information for developing effective socio-cultural behavior training systems is to create actual content from these data. There are two aspects to content creation. The first is processing the collected data in order to establish training objectives and supporting content, using data visualization and data forecasting techniques. The second is to develop techniques for quickly assessing user performance at the team levels – as current and foreseeable operations will require engagements at the team level.

Data visualization
The ability to process visual information plays a vital role in data analysis, especially when these data are presented in multiple streams, at multiple levels. Nevertheless, analysis of the kinds of real time data input proposed above introduces significant challenges in data visualization and will require new approaches for representing complex and dynamic data sets. Effective data visualization tools under development will enable users to:
• Collect, validate, visualize, and disseminate data to determine current baselines;
• Leverage computational modeling capability to determine trends in an effort to better target resultant training objectives to a specific cultural environment;
• Identify socio-cultural aware training objectives that support the commander's objectives;
• Link these training objectives current or future Diplomatic, Information, Military, and Economics (DIME) and Political Military Economic Social Infrastructure Information (PMESII) actions;
• Identify critical metrics so that the downstream effects of training can be understood in the relevant operational context.

As proposed, data visualization technologies will provide users with rich information displayed in appropriate and effective formats (graphics, text, numbers, images, etc) and have the ability to be placed in larger contexts – for instance, geo maps overlaid with economical, sociological and/or historical data. These displays may include static images as well as animation and interaction which in some instances may lead to better analysis and enhanced understanding and set the stage for more rapid development of training.

Data forecasting
While humans are able to extract patterns and synthesize information, they often bring with them unique and subconscious biases, which may lead to faulty recommendations (Russert, 2003). Alternative approaches, which significantly reduce or remove altogether these biases, will provide a major improvement over this status quo. Methods like genetic algorithmic modeling of human behavior (Vose, 1995; Lawrenz, & Westerhoff, 2005) are becoming increasingly prevalent inside marketing and advertising industries and have been shown to provide effective communication and marketing strategies (Anthes, 2006). At the same time, the development of modeling and simulation software has produced more accurate forecast and analysis capabilities of target population behavior (Kahlert & Sullivan, 2006; Lowrance et al 2008) such as economics, decision making and identification of key influencers within groups (Morrissey, 2008).

Performance assessment
Current and future combat operations will continue to place a strong emphasis on team and joint operations. It is vitally important for commanders and leaders to have the ability to quickly assess the overall performance of these teams and joint groups, as an outcome of training. Team performance is a unique extension of individual performance in that it is an outcome of individuals joining together for the purpose of exploiting one another's individual skills to successfully accomplish a common goal (Dyer, 1984). While much is known about how individuals develop skills (Dreyfus & Dreyfus, 1980; Ericsson, Krampe,& Tesch-Romer, 1993), comparatively less is known about how team skills develop and how team members work together as a coordinated unit. Importantly, team performance is not simply a linear combination of individual members' performance, because different individual levels of performance may combine constructively or destructively.

Current measures often rely on observation-based analyses coupled with expert evaluation (Modrick, 1986; Brannick, Roach, & Salas, 1993), or event based measurements (Fowlkes et al, 1984). These measures ignore the temporal nature of team behavior and reveal little about the dynamic processes through which teams respond, evolve and develop. Recent work that cuts across different domains – cognitive neuroscience, network science, non linear dynamics and neural-imaging sciences – has suggested that advanced measurement technologies and analytic techniques may be used to reveal the underlying basis for team coordination (Oullier et al, 2008; Gorman et al 2009; Dodel et al 2010). Ongoing development efforts focus on combining these emerging approaches with past work exploring the differences between effective and ineffective teams to establish criteria and technologies

for quickly assessing the cognitive performance readiness of teams.

Develop: Content development

A major hurdle that must be overcome in developing socio-cultural behavior training applications is to identify ways in which 'static' content can be transformed to deliver individualized, interactive and believable training. This can be done by enabling more realistic human representations.

Computer generated forces

Non-kinetic and SSTRO operations require a high degree of one-on-one interaction between the warfighter and civilian representatives. These interactions are typically nuanced, and laced with meta-content. Success in such interactions is not simply a matter of learning a language and/or regional dialect; one must also learn Native customs, key terrain features and more complex social and religious customs as well as how to apply this information. Development efforts in this area focus on enabling these interactions and behaviors using Computer Generated Forces (CGFs). Driven by the data captured in real time and analyzed accordingly, these CGFs will evince a range of believable and socio-culturally relevant behaviors (Lester et al, 1999), including facial gestures as well as other verbal and non-verbal cues (Ekman, & Friesen, 1971). Varying these properties in culture-specific ways will provide a unique approach for training Warfighters to understand the range of emotional states that can be attributed to such behaviors. By making these CGFs capable of both speech synthesis and recognition (in local dialect), as well as recognizing simple gestures, they will provide an interactive virtual capability for training basic social and cultural communication skills. One example of work in this area is the Vcommunicator software (VCom3D). With support from OSD, VCom3D is tailoring and advancing its cultural avatar technology to enhance the realism and adaptability of the avatars' interactions with military trainees.

Representing behavior

A critical aspect of creating 'believable' CGFs rests in the methods used for creating the underlying behavior models. The predicted outcomes of these models are only as good as the fidelity of the behavior representations that drive them (DTIC Review, 2008).These models may have poor fidelity due to factors that were not included in the original model but which will impact their overall behavioral responses. Factors that may be omitted include but are not limited to: fatigue, stress, cognitive overload, and changes in context. While human behavior is the result of the brain's cognitive processes (Adolphs, 2003), currently cognitive models are based on observed human behavior and do not account for the functions of the brain that give rise to actual human cognition (Gluck & Pew, 2003). The result is representations that provide only a snapshot of human behavior. Consequently, when they are included in models of socio-cultural behavior they produce predicted and simulated behaviors that are limited to specific activities in a given context.

Current technology investments in this area are focusing on developing higher resolution and more dynamic representations of human behavior by including neurally-based representations of human cognitive processes. Neuroimaging techniques provide the ability to identify individual cognitive processes as they arise, while recent advances in signal analysis technologies provide the means to quickly and accurately decode these processes (Linden & Fallgatter, 2009). These processes can be analyzed in terms of temporal measures (e.g. how long a "neural circuit" is active), in terms of spatial measures (e.g. which regions of the brain are active or co-active during the process) or both. Once identified and decoded, these processes could be modeled to understand their impact on alternate cognitive processes that may co-occur during a given military mission. These models would provide the needed fidelity by including the ability to model behavior in a wider array of cognitive situations and alternate contexts.

Implement: Training technologies

The Department of Defense spends billions of dollars annually to develop modeling and simulation based training capabilities (Kittfield, 2009). At one end of this training technology spectrum are fully immersive virtual environments, which have been shown to have some degree of training effectiveness (Lathan et al, 2002), but often the return on investment makes widespread application of these technologies unfeasible. At the other end of this spectrum, results from both basic and applied scientific assessments of the effectiveness of games indicates that when properly developed, these low cost-tools may have a much higher return on investment in terms of the cost to develop as compared with the long term performance effectiveness they impart to their users (Greitzer, Kuchar, & Huston, 2007; Morris & Tarr, 2002).

The key challenge with applying these game-based applications to the training needs of the DoD is that most of these game-based applications focus on a small range of very detailed scenarios. As noted previously,

current and future missions typically involve a wide range of non-kinetic and SSTR activities. In practice, these actions range from Phase 0 (planning/shaping) to Phase 4 (stabilization) military operations, in a wide range of socio-cultural environments. Developing a game-based training application for each would be prohibitive in terms of time and cost. An alternative approach currently under development is to build an adaptive architecture that: 1) incorporates up-to-the minute regional, social, cultural and 'human terrain' data automatically; 2) monitors trainee performance in order to provide appropriate performance enhancing remediation; and, 3) is a transparent and platform independent interface for representing these features across gaming platforms. This architecture is will provide a means for synthesizing and integrating the technologies under development discussed throughout this paper.

Evaluate: Assessing the impact

Traditionally, training system effectiveness evaluations address some, if not all, of the four levels proposed by Kirkpatrick (Kirkpatrick, 1987). These levels cover a range of measurements from subjective assessments of what trainees 'felt' about the training they received (Level 1) to the objective and calculated effects that the training had on the overall organization of which the trainees are a part (Level 4). A consistent challenge in performing these evaluations is determining the precise metrics to use. While there is no 'silver bullet' for doing this – every training application has its own unique user community, objectives and desired outcomes – the technologies proposed throughout this paper provide an additional set of tools through which to enrich any evaluator's metric toolkit and, consequently, should lend additional substance to the outcome of any such evaluation.

SUMMARY

Doctrine governing the role of the United States Military has undergone a profound change in recent years, shifting away from the large force-on-force engagements that typified the last century and moving towards small, localized interactions that are as likely to involve fierce and punctuated combat as they are protracted and complex negotiations. The front line for this new type of combat will be small groups of warfighters, empowered to make decisions on their own, based on their best assessments of current events. While these warfighters will undoubtedly be much better equipped than their counterparts, it is important to realize that for many of these encounters, victory is more likely to go to those who are cognitively better equipped - with the right mix of social and cultural

knowledge, skills and abilities - than those who are simply technologically better equipped. In order to enable these socially and culturally adaptable warfighters, training technologies must be developed that can rapidly adapt to the shifting human terrain of these new environments. This, in turn, requires a shift in the underlying processes through which such technologies are built. Leveraging advances in a range of technologies will enable these shifts.

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