Developing a Tool to Enhance Decision Making Skills in the PMESII Typology

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ABSTRACT

Combat profiling requires that decision makers perceive and integrate cues within a complex battle space. To facilitate the planning and decision making process, combat profilers must understand the system in which their adversary is operating. A system is comprised of dynamic, interdependent variables that interact with one another and assists military planners and intelligence analysts in determining the adversary's parameters, capabilities, and threat vulnerabilities. The approach for understanding critical vulnerabilities involves consideration of the Political, Military, Economic, Social, Infrastructure, and Information (PMESII) resources available to adversaries. The PMESII typology was explicitly developed to identify the key components of enemies and is the focal content for the Combat Hunter Training Program. Studies have linked the PMESII typology and Irregular Warfare to a decision making framework. The Combat Hunter training program is an example of these decision making processes and is informed by an understanding of both human behavior and the PMESII typology. To better train for skills within this typology, training designers must leverage the training and decision making research appropriately. To address this gap, we conducted a literature review to identify and extract best practices for developing decision making skills for combat profilers. Based upon these extractions, we mapped the content of these best practices onto applicable PMESII dimensions. To that end, there are four major aims of this paper: 1) detail our efforts of linking these best practices for developing decision making skills to specific PMESII components necessary for combat profiling, 2) provide examples of how these suggestions may be practically realized, 3) describe and showcase the most comprehensive knowledge base of PMESII tools that enable simulations that use the typology and 4) describe the development of an automated tool designed to enhance decision making skills for combat profiling that is based upon this conceptual "program of instruction".

ABOUT THE AUTHORS

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David Metcalf has a 15-year history in Web-based and mobile learning, and combines an academic grounding and continued University involvement with a strong history of industry-centered training and simulation, providing learning innovations for 3Com, Fujitsu, FedEx Ground, Tyco and many others. As a research faculty member with the University of Central Florida's Institute for Simulation and Training (UCF IST), Dr. Metcalf continues to bridge the gap between corporate learning and simulation techniques and non-profit and social entrepreneurship with the foundation of the Mixed Emerging Technology Integration Lab (METIL). Simulation, mobilization, outsourcing, visualization systems, and operational excellence are current research topics. Dr. Metcalf frequently presents at industry and research events shaping business strategy and use of technology to improve learning and human performance.

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OVERVIEW

Combat profiling is a technique of proactively identifying adversarial personnel or threats based upon prior history or behavioral patterns (Gideons, Padilla, & Lethin, 2008). It requires that decision makers perceive, attend to, make sense of, and critically integrate a broad set of cues within a complex battle space. To facilitate the planning and decision making process, combat profilers must fully understand the system in which their adversary is operating. From this perspective, a system is comprised of multiple dynamic, complex, interdependent variables that interact with one another (JP 5-0, 2005). The adoption of a systems perspective assists military planners and intelligence analysts in determining the adversary's parameters, capabilities, and threat vulnerabilities. The fundamental approach for understanding these vulnerabilities involves understanding the Political, Military, Economic, Social, Infrastructure, and Information (PMESII) resources available to adversaries. The PMESII typology was explicitly developed to identify the key interrelated systems inherent in an enemy and is a focal content area for the Combat Hunter Training Program (Arnold, 2006). The Combat Hunter Training Program is devised to enhance the cue recognition and decision making skills of individuals operating in combat situations (Gideons, Padilla, & Lethin, 2008). In other words, the training is designed to improve combat efficiency, while reducing combat casualties by effectively utilizing situation awareness, cue recognition, and decision making (Michaels, 2008). Ultimately, being a successful combat profiler is determined by an understanding of both human behavior and the PMESII typology.

To better understand and train for combat profiling skills utilizing the PMESII typology, training designers must leverage the training and decision making research appropriately. To address this gap, we conducted a literature review to identify and extract best practices for developing decision making skills for combat profilers. Based upon these extractions, we provide recommendations on how to accurately map the content of the best practices onto applicable PMESII dimensions. To that end, there are four major aims of this paper: 1) detail our efforts of linking the best practices for developing decision making skills to specific PMESII components necessary for combat profiling, 2) provide examples of how these suggestions may be practically realized, and 3) describe and showcase the most comprehensive knowledge base of PMESII tools that enable simulations that use the typology, and 4) discuss the development of an automated tool designed to enhance decision making skills for combat profiling.

METHOD

To serve as our foundation, we conducted a content analysis (i.e., method for analyzing text data; Cavanagh, 1997) of the best practices (see Table 1; Lazzara et al.., in press). The best practices were based upon the decision making, cue and pattern recognition, situational awareness, sensemaking, and critical thinking training literature, which are all of the necessary skills for effective combat profilers. For the purposes of this paper, we reviewed the content of the best practices and extracted relevant themes, patterns, and categories. Utilizing these extractions and based upon our hypotheses, we mapped the content of these general best practices onto the applicable PMESII dimensions to create a better understanding of how to execute strategies within the parameters of the PMESII typology. This work, based upon our expertise and understanding of the scientific literature, in effect, provides a conceptual "program of instruction" indicating which training best practices are most relevant and useful for the training content within the Combat Hunter Program.

The remainder of this paper is dedicated to understanding how to train combat profiling within the parameters of the PMESII typology. To accomplish this objective, this paper will first define each of the PMESII constructs and provide examples of how to apply the findings extracted from the decision making best practices. Next, the current document will describe a comprehensive knowledge base that facilitates the use of simulation within the PMESII context. Finally, the paper will detail the efforts involved in developing one exemplary automated tool specifically designed to train the skills necessary for successful profiling (e.g., decision making, cue and pattern recognition, situational awareness, etc).

Best Practice	Source
Training Design	
Design training scenarios based on the experiences of experts	Means, Salas, Crandall, & Jacobs, 1993; Salas, Cannon-Bowers, Fiore, & Stout, 2001
Match training scenarios to appropriate environmental context	Cannon-Bowers & Bell, 1997; Cohen et al., 2006, Klein, 1997; Rosen, Salas, Lyons, & Fiore, in press; Salas et al., 2001
Provide trainees with prompts	Gama, 2004; Salas et al., 2001
Information-Based Strategies	
Provide multiple methods of presenting information	Cannon-Bowers & Bell, 1997; Cohen et al., 2006; Cuevas et al., 2002, 2004; Stout, Cannon-Bowers, & Salas, 1996, 1997
Demonstration-Based Strategies	
Augment written learning objectives with videotaped behavioral demonstration	Mann & Decker, 1984
Provide demonstrations of expert behaviors	Klein, 1997; Schaw, 1998; Stout et al., 1996, 1997
Highlight subtle cues	Mann & Decker, 1984; Salas et al., 2001
Practice-Based Strategies	
Provide trainees with guided practice opportunities	Cohen et al., 2006; Means et al., 1993 Osman & Hannafin, 1992; Rosen et al. in press; Salas et al., 1995, 2001; Schaw, 1998; Stout et al., 1996/1997).
Provide multiple practice opportunities	Means et al., 1993; Norman et al., 2007; Salas et al., 2001; 2005; Schmidt, Norman, & Boshuizen, 1990; Stout, 1996, 1997; Zsambok & Klein, 1997
Present pictures and have trainees identify the relevant cues	Norman, Young, & Brooks, 2007; Shapiro, Rucker, & Beck, 2006
Feedback	
Provide feedback as the scenario progresses as well as after each training module	Behrmann & Ewell, 2003; Cohen et al., 2006; Louis, 1980; Means et al., 1993; Osman & Hannafin, 1992; Rosen et al., in press; Salas et al., 1995, 2001; Stout et al., 1996, 1997
Measurement	
Incorporate open-ended questions	Ark, Brooks, & Eva, 2006; Eva, Hatala, LeBlanc, & Brooks, 2007
Incorporate fill-in-the-blank questions	King, 1989, 1992; King & Rosenshine, 1993

Table 1. Best Practices adapted from Lazzara et al.

TRAINING PMESII CONSTRUCTS

In order to design training that effectively equips combat profilers with the ability to successfully profile according to the PMESII taxonomy, Figure 1 depicts a map of training methodologies to each of the six PMESII content areas. However, before we can discuss the specific training strategies and tools, it is imperative to fully understand the PMESII typology. Thus, the next section is dedicated to defining each of the PMESII constructs as well as providing examples on how to execute the best practices for training decision making and cue recognition within the context of the PMESII typology.

Political

The political component refers to the members or affiliations of the political authorities. Recognizing the political leadership is fundamental for executing specified goals such as targeting the political components necessary to dissolve an entire regime. By identifying the susceptibilities of the political infrastructure, the whole system becomes less effective or perhaps even extinct.

When designing training that targets the political dimension, it is important to design training scenarios based upon the experiences of experts. For example, training designers should gather first-hand information from experts who actually experienced and survived a certain situation where political leaders were the main target and use it to create a training program. In particular, it could be useful to provide the soldiers with a map of Baghdad and ask them to identify the key nodes which would have to be attacked to take down the leader and base their performance off of experiences from the Iraq War.

Military

The military facet alludes to the national armies or militia. The military utilizes intelligence, equipment, and weaponry to command operations. Establishing the weak military links is necessary to combat the opponent effectively to potentially render the entire system inoperable.

If training is targeting the military dimension, it is vital to provide demonstrations of expert behaviors. For instance, instructors could advise trainees as to proper ways of remaining calm in intense military situations, determining enemy rank based upon uniform, and assessing their surroundings under high levels of stress.

Economic

The economic aspect encompasses the production, distribution, and consumption of goods and services. There is a natural association between the economic and political link because economic systems require political support to regulate activities. For example, both the economic and political systems are necessary to run transportation systems and manufacturing industries. Therefore, targeting essential, susceptible economic areas can foster the identification of problematic political areas as well. In other words, pressure on the economic system can in turn negatively impact the political system.

When training is tapping into the economic dimension, it is critical to provide trainees with prompts. Particularly, in training scenarios for economic impact, highlight the subtle cues that trainees should attend to when predicting the economic impact of a decision.

Social

The social element is comprised of the enemy’s culture and social norms and values. Cultural awareness is crucial to comprehending the society as an entire unit. All of the other systems (e.g., political, economic, etc.) are rooted throughout with various aspects of culture, such as language and religion. By misunderstanding and misinterpreting the cultural values and norms, planning and ultimately executing a mission can be undermined and lead to fatal consequences.

If the social construct is the target of training, it is advantageous to present pictures and have trainees identify the relevant cues. To illustrate, present trainees with pictures of cues that are significant to social systems. Specifically, trainees may be presented with pictures of people wearing outfits appropriate for specific religious roles.

Infrastructure

The infrastructure of a system includes the physical and organizational structures required to operate a society. The physical structures contain systems such as transportation, communication, and water and power lines; the organizational structures comprise the infrastructure used to cultivate the production of goods and services (e.g., schools and hospitals). Clearly, the infrastructure is embedded throughout the various systems. In fact, it is said to be the most important component of PMESII because it is the most tangible portion vulnerable to kinetic weaponry (Arnold, 2006).

When training is dedicated to the infrastructure dimension, it is important that trainers provide feedback as the scenario progresses as well as after each training module. In this case, trainees would benefit from both real time feedback and full post scenario debriefing as they may underestimate enemy capabilities in a situation where the threat is considered to have a less well developed infrastructure.

Information

The information system consists of all of the data or instructions that organizations interact with on a daily basis. Since information is not only inherent in all of the other systems, it is mandatory to coordinate all of the systems. Thus, finding the weak nodes is essential to establishing the vulnerable links. In addition to targeting the fundamental information, outlets for disseminating knowledge can also be pivotal when combating adversaries.

If training targets the information component, it is beneficial to incorporate open-ended questions. To measure skill level, trainees could be asked to answer questions not only about what information is pertinent but also how the trainees would prioritize the presented information. For example, trainees could provide a list of relevant information, and then they would have to prioritize the list accordingly. This exercise would target if trainees were capable of recognizing information as well as determine if they were able to understand its importance.

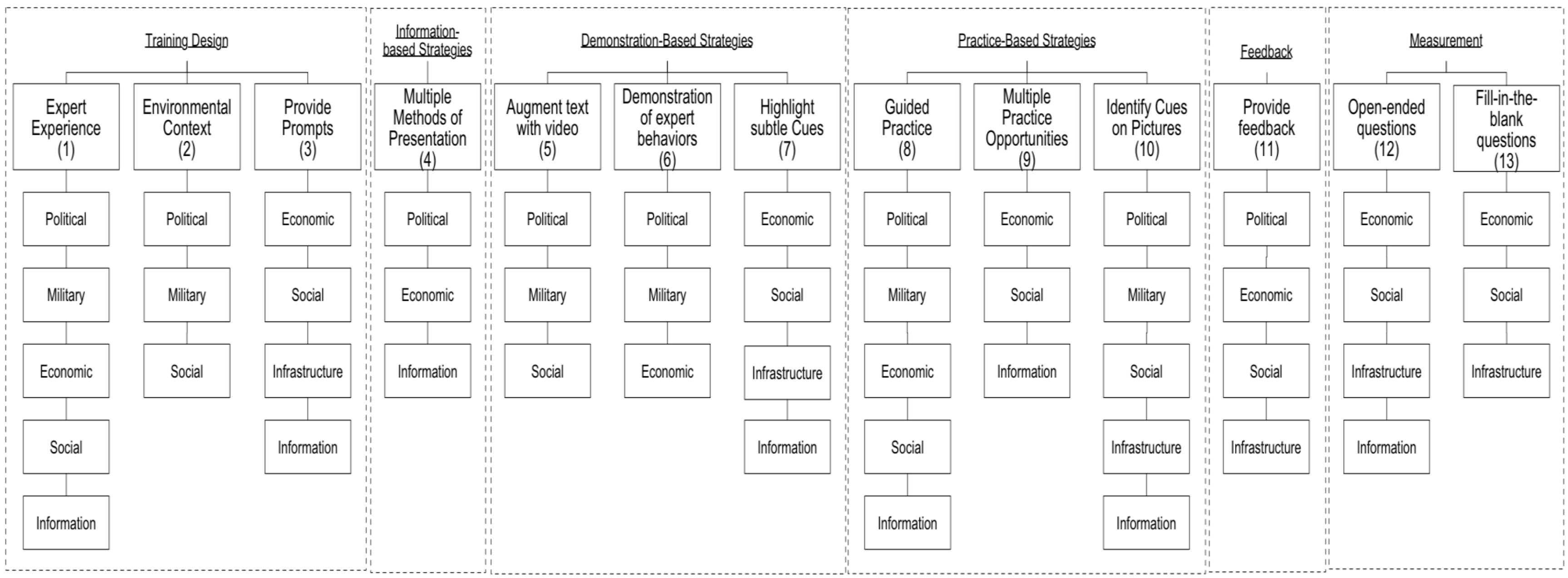

Figure 1. Map of training methodologies to PMESII content.

PMESII TOOL KNOWLEDGE BASE

The PMESII typology has been a key area of interest for developing military strategy, simulations, and training tools. The research and compiled knowledge in these areas, however, is often distributed and communication among multiple developers and military branches is fragmented. In order to mitigate this, United States Joint Forces Command requested the development of a comprehensive knowledge base covering tools and simulations relevant to the PMESII typology, which might be used by multiple military branches as well as potentially shared with outside developers and academicians. The following section will discuss the structure of this knowledge base as well as describe the development process.

Knowledge Base Structure

In order to facilitate a robust knowledge base with the capability to expand to fit content as necessary but would still be inexpensive and simple for a variable number of users to maintain, we selected a wiki platform. Specifically, we selected the MediaWiki back end, which is the same core software that runs Wikipedia (http://www.mediawiki.org). Wiki software enables small or large groups of users to collaboratively construct knowledge repositories without the need for all contributors to have web development skills; MediaWiki allows the use of a custom, simplified markup language but also provides editing functionality through buttons for common formatting. Also, the wiki framework will easily allow the knowledge base to start small and then expand to a broader community of readers and active contributors as USJFCOM determines is appropriate. If multiple members are granted editing permissions, then they can collaboratively maintain the content while the backend automatically applies version control, allowing updates to be identified and removed, if necessary. These functions together will allow the PMESII Tool Knowledge Base to organically grow and remain up-to-date.

The PMESII Tool Knowledge Base is arranged in a basic structure with tools listed alphabetically and categorized according to PMESII domain. The "Complete Tool Index" shows all items sorted alphabetically by name. Entry pages are also tagged with all relevant PMESII domains, allowing users to browse by domain and view an automatically generated alphabetical listing of all pages in that category. Along with the tool index, the site contains a "PMESII Resources" index with a listing of various books, websites, institutions, and supporting software that may be relevant to PMESII research, simulation, or development.

The indexes link to individual pages for each tool included in the knowledge base. The tool pages each follow a specified template containing: a description of the tool, how the tool maps to each domain in the PMESII typology, technical specifications required for the tool, cost details, contact information for the developer or project manager (if made publicly available), details on modification capabilities, and usability details. Usability details include how the tool is intended for use (e.g., training, mission rehearsal and strategic simulation), the target user (e.g., unit controller, training audience, and commander), security classification, operational level, speed, and setup and operation time. Key information is briefly summarized in an information box near the top of the entry along with one or more images from the program.

Content Population

As the initial wiki was being installed and configured, team members were tasked with compiling all publicly available information on tools and simulations related to the PMESII typology. In the first stage, researchers performed standard web searches and academic database searches for terms including *PMESII (and all individual domain words), simulation, game, tool, toolset, engine, and software*. Basic details on a number of commercial tools were obtained from developer sites, while published research papers offered descriptions of several military and academic projects. When possible, screenshots of the programs were added, but for many military and academic programs, existing images or demo versions were not available.

After initial information seeding, we then contacted developers and researchers in the PMESII software space to obtain additional information. In addition, we also contacted developers of PMESII tools requesting validation of our compiled information and any updated capabilities and screenshots. Through these sources, we were able to expand the knowledge base to near its current state of 144 tool entries.

Since primary population, additional work has been done to ensure consistent page and reference formatting as well as filling out tool information when possible. A sweep of all tool pages was completed to identify tools that are no longer available or actively updated; these entries were updated with a banner notifying users of their inactive status.

COMBAT HUNTER PROFILING PART-TASK TRAINER MINIGAME (CHPPTTM)

Now that we have a foundation of the research aligning decision making skills necessary for combat profiling with the PMESII typology and developing a comprehensive PMESII knowledge base, we can begin to describe one specific practical application of these findings, the Combat Hunter Profiling Part-Task Trainer Minigame (CHPPTTM). CHPPTTM is an automated training reinforcement tool targeting combat profiling within the Combat Hunter program. It is a web-based skill rehearsal and teaching mobile device designed to foster cue recognition and decision making skills central for combat profiling when utilizing the PMESII typology. Additionally, it also provides valuable flexibility to instructors in order to maintain a current, robust training information base.

CHPPTTM Features

CHPPTTM facilitates cue recognition and decision making by presenting trainees with potentially dangerous scenarios and requiring them to quickly analyze the situation, identify cues, and arrive at an action decision. Trainees are presented with a number of photographs or video clips of locations and individuals that must be assessed for potential danger (see Figure 1). Several individual images or video clips are shown in sequence, based on narrative progression or thematically similar content, to create a full scenario. Depending on the scenario, the image or video may only be displayed for a short time limit (e.g., 30 seconds).

Figure 1. Image Display Screen

After each content item is presented, trainees must identify cues that deviate significantly from the environmental baseline, classify them into one or more of six domains specific to the Combat Hunter Training Program (i.e., heuristics, atmospherics, proxemics, geographics, atmospherics, and kinesics) and make an action decision (e.g., let go, contact, capture, or kill). The tool affords for comparisons by displaying trainee and expert responses with the critical cues clearly marked alongside one another. A score is assigned by the system for each scene as well as an aggregate score for the overall scenario based on the percentage of cues that trainees are able to correctly identify.

The CHPPTTM offers a second mode for instructors to enable scenario authoring. In this mode, there are scenarios (i.e., one or more photos or videos), associated correct response keys and introductory contextual information. Stored in the application database, the instructor initially creates a scenario shell with the title and initial descriptive information, which is used to give students the situational baseline (e.g. type of area, major events that should be occurring, people expected to be in the area, etc.). Individual content items are then added into the scenario shell (see Figure 2). Each contains at least two images: the student view image and an instructor key image with marked cues and options for thermal or night vision versions of the same view. Following the scenario design, the instructor determines the correct response information for all cues in the image and assigns point values to each response item for scoring.

Figure 2. Content Authoring Screen

Design and Development Process

To fully understand this training application, it is advantageous to describe the design and development process. This tool was created by utilizing the Combat Profiling "program of instruction" discussed previously. Tool capabilities and functionalities as well as the user interface elements mapped out in the early storyboarding stage were based heavily on the research documentation. Several key features of the program were directly based on this program of instruction. First, CHPPTTM utilizes photographic images and video rather than illustrations or computer graphics based upon the recommendation that training materials were firmly rooted within real world contexts. Leveraging another training recommendation, these pictures are then used to foster cue recognition training by having trainees identify the relevant cues. Another key feature, the scenario creation mode, was developed to facilitate the recommendation that training scenarios be developed based upon knowledge held by experts, by allowing the subject matter experts to easily develop materials directly.

CONCLUSION

Clearly, the PMESII typology is a useful and vital tool for understanding irregular warfare and, in particular, combat profiling. Thus, it is imperative to design training tools and databases to effectively understand and train cue recognition and decision making within the context of PMESII. Training tools, such as the CHPPTTM, are better equipped when they leverage the best practices from the science of training and learning. Additionally, designing training that utilizes the PMESII typology is facilitated by providing a comprehensive knowledge base to foster collaboration. Although the current paper provides some insight into developing combat profiling training scientifically and understanding PMESII thoroughly, more research is needed. Said differently, this paper has provided the theoretically understanding; however, researchers should provide empirical evidence validating these relationships. Thus, we hope that this paper generates future research which explicitly investigates the specific relationships discussed.

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