



**U.S. Army Research Institute for
the Behavioral and Social Sciences**

Research Report 1896

**Flexible Method for Developing Tactics, Techniques,
and Procedures for Future Capabilities**

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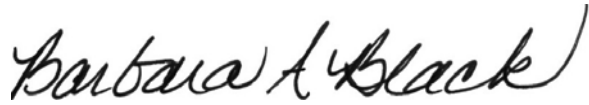
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FLEXIBLE METHOD FOR DEVELOPING TACTICS, TECHNIQUES, AND PROCEDURES FOR FUTURE CAPABILITIES

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army is transforming to a highly mobile Future Force empowered by the Future Combat Systems (FCS). As the FCS capabilities emerge, leaders and Soldiers will need new tactics, techniques, and procedures (TTP) to exploit the information-based technologies that characterize FCS. This necessitates TTP exploration and development prior to systems production. Traditional methods for developing TTP cannot readily meet this challenge. New TTP development tools must flexibly structure activities that handle a wide range of concepts and rapidly produce futuristic how-to-fight constructs. The goal of this research effort was to create an exportable TTP development method for use by Future Force and FCS developers.

Procedure:

Our research team built on an existing cognitive task analysis method (Shadrick, Lussier, & Hinkle, 2005) to create a future-focused TTP development method called Flexible Method of Cognitive Task Analysis (FLEX). We developed simulation-driven vignettes focusing on the use of FCS-related Unmanned Aircraft Systems (UAS). The team crafted knowledge elicitation (KE) tools and integrated them with the vignette materials into a comprehensive TTP development support package. We then conducted trial implementations with multiple groups of Soldiers applying the KE procedures to develop TTP for employing UAS. Each set of TTP was iteratively reviewed and revised by other groups of Soldiers. Additional Soldiers and subject matter experts (SME) integrated multiple sets of TTP to produce a final set. Measures of effectiveness along with Soldier feedback were gathered throughout.

Findings:

The KE process produced user-accepted TTP across all simulation vignettes. The participants generated more tactics and techniques than procedures. They also generated more mission-related TTP than other types (e.g., enemy-related). Increasing the number of development sessions increased the number of TTP generated, although with diminishing returns after around three sessions. An examination of the final set of TTP compiled by research team SMEs revealed that a majority of the effective vetting occurred during the first two single-source vetting sessions and the multiple-source vetting sessions. Taken together, these findings suggest that two to three development sessions, plus two single-source and one multiple-source vetting sessions, are sufficient to efficiently produce effective TTP.

The effectiveness of the KE method appeared to be relatively strong. A majority of participants and researchers rated all aspects of the KE method highly, except for technical aspects of the simulation. The low ratings for the technical aspects of the simulation were likely due to the use of an immature and procedurally complex simulation system. The data collection yielded

lessons learned and recommendations for improving the KE method and selecting simulation systems.

Utilization and Dissemination of Findings:

The FLEX method for TTP development supports the systematic implementation of a structured, interview-based, and simulation-driven approach that elicits and refines warfighting ideas from Soldiers. The products and findings of this research can benefit experts in the U.S. Army Training and Doctrine Command, especially the Future Force Integration Directorate (FFID), the Army Evaluation Task Force (AETF), and other agencies working to develop concepts and TTP for the Future Force. Those who are specifying and designing Future Force capabilities will be able to utilize the FLEX TTP method in their own TTP development efforts. Through their involvement in this effort, FFID and AETF have applied and will continue to help ARI refine the FLEX TTP method.

FLEXIBLE METHOD FOR DEVELOPING TACTICS, TECHNIQUES, AND PROCEDURES
FOR FUTURE CAPABILITIES

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FLEXIBLE METHOD FOR DEVELOPING TACTICS, TECHNIQUES, AND PROCEDURES FOR FUTURE CAPABILITIES

INTRODUCTION

With the U.S. Army's rollout of the Future Force and Future Combat Systems (FCS) over the next several years, radically new technologies will be introduced to the field (Welch, 2003). Using an integrated system of systems approach, the goal is to provide tomorrow's Soldiers with high battlefield mobility and unprecedented reconnaissance and surveillance capabilities.

The FCS family of systems will provide unprecedented capabilities for Soldiers in the U.S. Army. However, Wass de Czege and Biever (1998) state, "Combat power is not the sum of machine performance; it requires individual and organizational competence and synergy" (p. 19). Shadrick, Lussier, and Hinkle (2005) also state that, "A change in technology creates corresponding changes in the operational and cognitive systems – resulting in the transformation of existing roles, processes, and procedures and the development of new ones" (p. 1).

To maximize the effectiveness of the planned FCS capabilities, new approaches are required to develop warfighting guidance for integrating and employing the new technologies. When FCS Spin Outs are fielded with untested operational communication patterns, capabilities, and weaknesses, Soldiers must figure out the integration process by testing it in the field. By developing initial tactics, techniques, and procedures (TTP) before equipment capabilities are actually produced, a baseline of information on changes to or development of new TTP can be developed and tested. However, the Army needs an innovative method—one that is structured, flexible, and measurable—to support rapid development of initial TTP.

Traditional methods for developing TTP rely on the exploration and testing of new doctrine and training. Yet these approaches are often less effective than desired when real world implementation is impossible. To address this problem and help ensure effective Spin Out of FCS technologies, TTP development methods that provide structured activities to measure, assess, and guide the process are needed. Shadrick, Lussier, and Hinkle's (2005) flexible method of cognitive task analysis (FLEX) provides a promising approach for TTP development. The FLEX method is an iterative, interview-based, and vignette-driven approach that provides a structured process for developing future concepts. The goal of this research and development effort was to expand, implement, and document the FLEX method as a TTP development tool for future systems.

This report describes the methodology developed to support the establishment of future-focused TTP and the results of a trial implementation of the methodology. It is intended to help FCS developers as they work to make the Army's Future Force vision a reality.

Background

Shadrick, Lussier, and Hinkle (2005) have identified two primary methods of concept development traditionally used by the U.S. Army. The first method is an expert analysis of new concepts and technologies, which often provides general information about the integration and

impact of future systems. The second method involves developing a replica of a new system and testing it through either a unit exercise or a simulation.

Both of these methods pose disadvantages. With the first method, the resulting analysis is typically quite general in scope and not aimed at developing TTP. It is also limited in that it represents the views of one or few experts. Consequently, the resulting analysis does not undergo testing through implementation. The second method offers the advantage of actual implementation, but it is often expensive to conduct. Because of the expense involved, there are limited opportunities to manipulate variables related to the future systems and to iteratively develop and agree upon the impact of such systems. A method is needed that will address the disadvantages of these two systems. Such a method needs to provide a measurable process for eliciting expert knowledge that is iteratively developed and reviewed by a range of Soldiers.

Various methods for eliciting the knowledge of experts in the U.S. Army have been used (e.g., Klein, 1996), and most have focused on task analysis-based approaches. With traditional task analysis, the focus is on understanding how an expert or experts perform a job as well as the knowledge, skills, and attitudes required to perform the job (Department of Defense, 2001). Also, job performance has a specific start and end point and must be observable.

The use of cognitive task analysis (CTA) as an approach to eliciting expert knowledge (e.g., Schraagen, Chipman, & Shalin, 2000) has been increasing because the approach facilitates capturing non-observable behaviors as well as tacit knowledge and processes. This is particularly valuable with future concepts since the systems and technologies have not yet been developed. In using CTA, we can go beyond procedural knowledge and the behavioral aspects of an individual's job in order to understand the "cognitive map" that guides his/her work processes.

The FLEX method developed by Shadrack, Lussier, and Hinkle (2005) employs CTA methods to elicit Soldiers' expertise via structured processes involving interactions with simulation-based vignettes. The vignettes facilitate making decisions about how to employ future equipment in light of specific factors related to mission, enemy, terrain/weather, troops, time, and civilians (METT-TC). The decisions form the basis for developing TTP in support of future concepts. Resulting TTP are iteratively reviewed and refined until a baseline foundation for the new systems and technologies has been developed. This approach was the focus of this research.

The FLEX method was designed to consider and capture future capabilities and their implementation by Soldiers in the field who have practical warfighting experience. It harnesses knowledge elicitation (KE) methodology to examine how Soldiers would employ technologies in different types of missions. By working with Soldiers from different military occupational specialties (MOS), as well as varying years of service and types of field experience, we can develop a rich perspective of how Future Force concepts and technologies would be used, adapted, and advanced by expert Soldiers.

Developed as an iterative interview and vignette-based KE approach, the FLEX method is designed to explore future concepts. The basic features of the method are outlined below and illustrated in Figure 1.

1. Expert participants are provided with a potential future situation and are asked to solve a complex problem using the anticipated capabilities.
2. Participants are asked to verbalize their responses by thinking aloud.
3. Responses from participants are provided to subsequent participants.
4. A semi-structured interview is used to probe expert knowledge and gain a deeper understanding of the participant's reasoning.
5. Responses are reviewed and refined by subsequent participants.
6. Finally, a small group of experts is used for interactive discussions allowing for consensus building and validation.
7. The consensus outcomes can then be used to design training or write formal TTP.

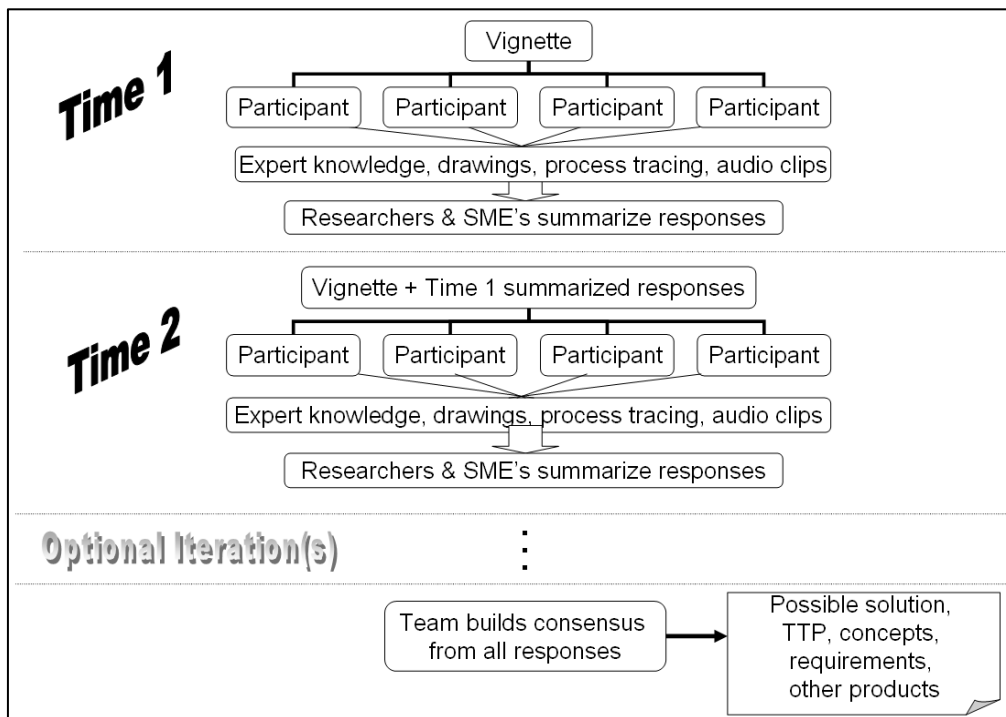


Figure 1. The FLEX process (taken from Shadrick, Lussier, & Hinkle, 2005).

Since the FLEX method is grounded in CTA approaches, the focus is on facilitating and capturing decisions made by Soldiers as they interact with complex problems and environments. Within complex systems, there are often multiple, interconnected problems and variables (Funke, 1991). Since decision makers often have to respond rapidly, typically under the pressure of limited resources and information, it can be challenging to identify how technology impacts roles, processes, and procedures. By examining decisions made for taking a specific course of action, we can also examine the decision makers' assumptions, perceptions/misperceptions, and their use and adaptation of the technologies within the larger system.

The FLEX method is similar to Map Exercises (MAPEX) and other tactical exercises without troops (TEWT) in that a small group of Soldiers is placed in a tactical scenario and required to make decisions. However, the FLEX method has many advantages over TEWTs. First, the FLEX method provides a structured, scientifically-based approach to eliciting knowledge during and after the scenario that TEWTs generally lack. Indeed, the current research has developed a number of specific instruments designed to aid in this process. Second, the iterative, feed-forward nature of the method allows for refinement of the concepts, TTP, etc., that are elicited. This does not occur in a TEWT. Third, a traditional MAPEX or sand-table exercise does not simulate the capabilities of the systems being used in the scenario. Newer forms of TEWTs do use simulation (and are therefore closer to the FLEX method), but still lack the structured KE approach and iterative, feed-forward nature of the FLEX method.

To facilitate decision making within complex environments, simulations offer powerful tools for TTP development. Because they facilitate the capability to visualize, interact with, and manipulate variables within an authentic environment (Gredler, 2004), they are used as part of the FLEX method as a way for Soldiers to “interact” with future capabilities and technologies. Since most Soldiers and even Future Force experts have not been immersed in a networked system of systems, they have limited understanding of employment and integration of these new technologies. Thus, simulations provide valuable tools for helping envision the impact of such technologies on warfighting TTP.

In summary, the design of the FLEX method provides a framework for examining variables that impact Soldiers’ employment and integration of new technologies within current approaches.

Technical Objectives

The research described in this report focused on creating an exportable TTP development method capable of supporting Future Force and FCS developers. The FLEX method served as the foundation for the effort. The following technical objectives, as refined during the execution of the project, guided the research:

- Establish a vignette- and simulation-based method for developing TTP for employing Future Force capabilities;
- Implement the method to develop TTP for employing FCS Spin Out 3 capabilities in concert with existing capabilities;
- Refine the TTP development method as appropriate based on results of the initial implementation; and
- Document the development, trial implementation, and refinement of the TTP development method.

METHOD

Overview

The goal of this project was to develop, implement, and examine the usability of a new method for developing TTP for FCS Spin Outs, as well as other system development and acquisition programs. This led to conducting the research in the following stages:

- Development of simulation vignettes;
- Development of KE process and instruments;
- TTP development and review/refinement during implementation;
- TTP finalization; and
- Assessment of the TTP development/refinement method.

The research approach combined military subject matter expertise, behavioral science knowledge, CTA expertise, and computer-based simulation expertise to execute these stages. We relied on Future Force documentation to create the simulation-based vignettes that reflected the latest concepts. The KE process was developed based on the FLEX method (Shadrick, Lussier, & Hinkle, 2005). Specific KE approaches and instruments were shaped to ensure that KE sessions were grounded in the Future Force concepts and that they would facilitate both TTP development and review/refinement. Additionally, the KE approaches were fashioned to ensure balanced contributions of individual Soldiers as well as small group interactions. The newly created method was evaluated by examining specific outcomes and variables, such as how many TTP were produced and revised, key differences between those in various roles, and the overall success factors related to the implementation of the method.

Development of Simulation Vignettes

In accordance with the proof-of-concept framework, the development of TTP-focused simulation vignettes concentrated on FCS Spin Out 3, a family of Unmanned Aircraft Systems (UAS). Vignettes focused on the company echelon and below, reflected the employment of Spin Out 3 UASs in combination with Spin Out 1 and 2 capabilities, and accommodated a variety of Soldier backgrounds and qualifications.

To provide an overall context for the vignettes, a Road to War was created to set the stage for the current tactical conditions. Descriptions of friendly and enemy forces, events, timelines, and images were provided to help participants understand the big picture. To provide a range of tactical conditions, different types of missions, units, terrain, enemy, and uncertainty of enemy knowledge were used across vignettes, as shown in Table 1. An additional vignette focusing on company security patrol served as a practice vignette before executing the ones below.

Table 1

Tactical Parameters Selected for Vignettes

| Vignette | Mission | Unit | Terrain | Enemy | Knowledge of Enemy |
|----------|---------------------|----------|---------|---------------------|--------------------|
| 1 | Cordon & Search | Bravo Co | Wooded | Attican ADA Section | No surprise |
| 2 | Raid | Bravo Co | Urban | Insurgent Squad | Surprise |
| 3 | Screen | Bravo Co | Hilly | Attican Platoons | Surprise |
| 4 | Movement to Contact | Bravo Co | Open | Attican Platoon | No surprise |

Each vignette was designed to provide approximately 15 to 20 minutes of interaction for the participants. A battalion operation order (OPORD) set the stage for the family of missions. Accompanying each vignette was a battalion fragmentary order (FRAGO) to prompt mission planning and accomplishment. Also provided were event guides for exercise controllers and terrain sketches.

Vignettes were developed using the Objective Force-OneSAF Objective System (OF-OOS) software platform (Version 1.0.2). This platform is designed to be a composable, next-generation Computer Generated Force (CGF) modeling software that represents a full range of operations, systems, and control processes from the individual combatant and platform level to brigade levels. The version of OF-OOS available during the project was immature, so the operational capabilities were fairly limited. Because of the limited capabilities and difficulty of use, simulation operators had to be used to facilitate execution of vignettes.

Ensuring the development of quality vignettes was critical for supporting an effective KE process. Thus, the research team’s SMEs analyzed TTP development needs in order to identify the types of vignettes sufficient to facilitate TTP development for FCS purposes. The vignettes were designed to provide a realistic environment and the relevant information to feed TTP development and to ensure the recommended TTP development process would be sound. We used the following steps to develop the vignettes:

- Develop vignette storyboards.
- Review and revise storyboards based on SME feedback.
- Verify suitability of revised storyboards.
- Develop tactical and simulation materials for each vignette.
- Review and revise vignette materials based on SME feedback.
- Test vignette materials in simulation.

As an important step in developing vignettes, an exemplar vignette was first drafted and submitted for review and approval. Then the remaining vignettes were constructed using an iterative develop-review-revise cycle. Each vignette was reviewed multiple times by SMEs in order to ensure quality and tactical accuracy.

Development of Knowledge Elicitation Process and Tools

The KE process and tools developed for this project were based on the stages of the FLEX method as outlined by Shadrick, Lussier, and Hinkle (2005). A CTA framework served as the central foundation for developing the KE process. The primary focus was on harnessing KE methods and developing procedures and tools that would facilitate effective TTP development and subsequent review/refinement in concert with simulation-based vignettes. The core KE facilitation techniques included:

- Interaction with simulation-based vignettes.
- Think aloud probes eliciting key decisions as participants role-played during vignettes.
- Individual TTP development or review/refinement based on METT-TC factors.
- Semi-structured interview regarding TTP outcomes.
- Group discussion of overall outcomes.

The overall KE process entailed multiple, sequential phases as described in Table 2: orientation, interaction with simulation vignette, TTP development (or review/refinement), summary review, and group debrief. The vignette-specific steps (Phases 2, 3, and 4) were iterated until all four vignettes had been completed. The complete sequence of phases was designed to be implemented in a full day, to capitalize on train-up and momentum of a group of participants and to avoid the need for a given group to return later. The multi-phase process formed a systematic, comprehensive methodology for engaging participants in tactical challenges, surfacing tacit knowledge and procedures, and leveraging the participants' expertise to construct TTP for employing UAS capabilities.

Table 2
Organization of Knowledge Elicitation Process by Phase

| Phase | Step |
|---|---|
| 1. Orientation | Welcome and introductions Participants view multimedia orientation and ask questions Conduct practice exercise |
| 2. Interaction with Simulation Vignette | Facilitators issue FRAGO, starting with the first vignette Participants conduct abbreviated troop leading procedures Participants role-play as vignette runs, directing simulation operators Facilitators deliver think-aloud probes as participants role-play Facilitators record key verbalizations, decisions, cues, and TTP |
| 3A. TTP Development (Option A) | Facilitators lead TTP development based on METT-TC factors Participants record TTP elements on structured worksheet Facilitators record notes using data collection package Facilitators record verbalizations and discussions using voice recorders Facilitators summarize major TTP outcomes |

(Table Continues)

| | |
|---|---|
| 3B. TTP Review/ Refinement (Option B) | Facilitators lead review of previously developed TTP (METT-TC focus) Participants record TTP thoughts and revisions on structured worksheet Facilitators record notes using data collection package Facilitators record verbalizations and discussions using voice recorders Facilitators summarize revised TTP |
| 4. TTP Summary Review | Facilitators lead review of TTP summary for the vignette Facilitators record revisions to TTP summary based on discussion Facilitators recap new TTP summary Participants repeat steps 2, 3A/3B, and 4 until all vignettes are complete |
| 5. Group Debrief | Facilitators lead group review of TTP for each vignette Facilitators lead group discussion of overall TTP (across vignettes) Facilitators collect all materials from participants |

The key advantage of the overall KE process as outlined in Table 2 stemmed from the use of multiple approaches supporting multiple data outputs. In addition, the process represented our goal of balancing group KE with individual KE, simulation-driven KE with discussion-based KE, and iterative TTP development with iterative TTP review/refinement.

The KE process steps rely heavily on note-taking by facilitators and hand-written constructions by participants to capture raw input for TTP development. In addition, facilitators record participants' verbalizations and discussions using digital voice recorders. The voice recordings supplement the hand-written notes and support subsequent analysis after the KE sessions are completed.

To enable consistent implementation and iteration of the KE process, we developed a family of KE tools in hardcopy format (Table 3). These tools included an orientation package for bringing the participants quickly up to speed, planning guides for facilitators, sample TTP to serve as a template for participants, and forms to facilitate data capture. The materials were designed to make a future facilitator's job easier while preserving his/her ability to adapt the process and tools to fit specific conditions and requirements.

Table 3

Tools Directly Supporting the Knowledge Elicitation Process

| Tool | Description |
|-----------------------------|---|
| 1. Participant Orientation | Overview of FCS, simulation, tactical scenario, vignettes, and TTP architecture (PowerPoint and multimedia versions) |
| 2. Implementation Plan | Description of resources, schedule, implementation overview, administrative procedures, and instructions for participants |
| 3. Iterative Session Plan | Graphic roadmap laying out a candidate sequence of development, review/refinement, and consensus building sessions |
| 4. Generic Schedule (Daily) | Notional schedule (matrix) of daily administrative, Familiarization, KE, and TTP development/refinement activities |

(Table Continues)

| | |
|-----------------------------|---|
| 5. KE Protocol | Detailed instructions and materials for KE facilitators to use in planning session activities, organized by steps |
| 6. Sample TTP | Written example of UAS-oriented TTP, illustrating key elements and level of detail, to serve as a template/guide |
| 7. Data Collection Packages | Step-by-step form for facilitators to use in capturing knowledge and procedural data during KE sessions |

We integrated the family of KE tools, along with the vignette materials, into a comprehensive developer's support package. The complete package was intended to serve as a stand-alone suite empowering future TTP developers with easy-to-use job aids.

TTP Development Procedures

When put into action, the KE process with its implementation materials enables the development of vignette-driven TTP. A TTP development session would be conducted with a small group of participants (three to four Soldiers). First, participants interact with a simulation-based vignette while playing an assigned role (e.g., Platoon Leader [PL]). During the simulation, facilitators provide think aloud probes in order to elicit each participant's key decisions as well as factors and cues related to why specific decisions were made. This occurs during the course of participants' interactions with each of the vignettes. The think aloud probes include questions such as "Can you tell me how you are using your UAS?" or "What factors influenced your decision to take this action?" Facilitators record participants' responses and audio transcripts from the sessions help ensure the quality of the data collected.

Once participants finish role-playing in a vignette, they complete a TTP development worksheet for the vignette. They individually record TTP elements specific to the factors of METT-TC. After participants complete the worksheet, the KE facilitator conducts a semi-structured interview with participants. The participants are interviewed by role, with the senior role-player (Company Commander [Co Cdr]) being interviewed as an individual, and PLs being interviewed as a small group.

After TTP development is completed for each simulation vignette, an overall TTP development session is conducted with the whole group in order to craft a list of overall TTP. These TTP serve as a more generic set that potentially applies across the various missions represented in the vignettes. Once data collection is complete, individual TTP from individual participants' worksheets for each vignette are compiled into a list representing TTP developed by all participants in the day's group. In addition, audio transcripts are analyzed to produce selective additions to the group's vignette-specific TTP lists. Also, the overall list of TTP is compiled by KE facilitators.

After vignette-specific and overall TTP are compiled into a unified set, two SMEs with extensive military experience review each TTP and edit the elements to clarify meaning and translate acronyms. The SMEs are careful to not change the meaning of any TTP, and elements that are similar or repetitive across vignettes remain on the list in their various forms. From this process, a set of TTP emerges that represents one specific group's set of TTP. Some examples of TTP that emerged from this process are:

- Tactic: Use the UAS to clear lateral routes during movement.
- Technique: Fly the UAS away from direct route of march whenever possible to avoid tipping the enemy as to your scheme of maneuver.

Additionally, participants' *considerations* of when and how to use the UAS are also documented. An example of a consideration is: Using the UAS in areas with heavy vegetation can be more difficult and may limit your ability to identify the enemy.

Because of the large number of TTP that may be developed by each group, we realized the difficulty of reviewing long lists of TTP for each vignette without some understanding of the participants' overall strategy for accomplishing the mission presented in the simulation vignette. Thus, an SME with military expertise reviewed the long list of TTP for each vignette and developed a TTP summary. The purpose of the summary was to provide subsequent participants with a TTP development group's overall strategy for accomplishing the mission. An example of such a summary follows:

TTP Summary for Vignette 1: Use UAS to support reconnaissance during movement (the technique is over the shoulder). Be sure to deconflict the air space and assign platoon sectors. Keep at least one UAS in reserve. Use the Commander's UAS for command and control. Once the cordon is established, use the UAS to identify targets on the objective and to call for fire. The UAS should observe from a maximum distance in order to avoid direct fire contact. The UAS can provide early warning on the far side of the objective during the search.

Such a summary was placed at the beginning of the list of TTP for each vignette. Also, emerging TTP as well as considerations (TTP-C) were kept in their original order, with their original vignette, and grouped by factors related to METT-TC.

TTP Revision Procedures

Two types of TTP review/refinement (vetting) sessions can be conducted—single-source and multiple-source sessions. During a single-source session, participants receive TTP that originated in a single TTP development session. During a multiple-source session, participants receive cumulative TTP resulting from all of the preceding TTP development and single-source vetting sessions.

Single-Source Vetting Sessions

The TTP review/refinement procedure mirrors much of the same process as the TTP development procedure, except that participants receive the outputs from previous groups to establish a starting point for the review/refinement process. As participants role-play during simulation-based vignettes, facilitators provide think aloud probes in order to uncover their decisions as well as why the decisions are made. The think aloud probes include questions such as “Can you tell me why you made that decision?” and “What caused you to choose that course of action?” Again, facilitators record participants' responses, and audio transcripts from the sessions later help ensure the quality of the data collected.

Following the end of a simulation vignette, the participants complete a worksheet asking them to review/refine previously developed TTP. This worksheet gives the vignette-specific TTP preceded by the TTP summary developed by a SME. Participants are asked to first review the TTP summary, rate it for acceptability, and edit it as needed. Then they are asked to review the TTP-C developed for each vignette and to specify whether they should be kept, modified, or deleted. Participants are asked to explain why the specific TTP-C:

- Is good and should be kept;
- Should be modified and how; or
- Should be deleted.

Once participants complete the worksheet, the KE facilitator conducts a semi-structured interview with participants to review each of their ratings and to come to consensus, if possible, on each TTP-C. The participants are interviewed by role, with the senior role-player (Co Cdr) being interviewed as an individual, and PLs being interviewed as a small group. After the TTP review/refinement process is completed for each vignette, participants also review the summary TTP following the same process.

When data collection is complete, results of each participant's TTP-C ratings are compiled and entered into a spreadsheet noting whether each TTP-C is to be kept, modified or deleted. Additionally, edits made by participants to specific TTP-C are compiled. Again, two SMEs with extensive military experience review the revised set of TTP-C to correct for unclear meaning or acronyms. The resulting set of TTP is again reviewed and refined one or more times during subsequent sessions (groups), until each set of TTP-C reaches a desired degree of refinement.

Multiple-Source Vetting Sessions

Multiple-source vetting sessions can be conducted to integrate cumulative TTP and build consensus. Because this approach is more detailed and takes more time to conduct, each group of participants would focus on just two vignettes in a one-day schedule.

In single-source TTP review/refinement sessions, participants review a single TTP summary for each vignette along with a list of TTP-C elements. However, in multiple-source vetting sessions, participants are first asked to review as many TTP summaries for Vignettes 1 and 2 as were produced by the previous development/refinement groups. These summaries are edited by an SME in order to ensure clear meaning. The vetting group then reviews, rates, and refines (when needed) each TTP summary. Then they write their own TTP summary by editing existing ones or by drafting their own. The participants then work together to create one team-based TTP summary that combines the best elements from other TTP summaries and adds new elements as deemed important.

In the next step, the same participants may rate multiple TTP-C developed by different development groups. The multiple TTP-C can be presented again and grouped by vignette and by specific METT-TC factors. Participants rate and review these multiple sets of TTP-C for each vignette and specify whether each one should be kept, modified, or deleted. Again, they also modify/refine any TTP-C that they decide need refinement.

In order to develop a unified set of TTP, independent SMEs can integrate the team-based TTP summaries as well as the vignette-specific TTP to create a final set. This step enhances the quality of the TTP-C so they are clear in meaning and easy to understand. Thus, SMEs who are experienced writers play a critical role in producing high quality TTP.

Assessment of the FLEX Method Implementation

To accomplish an important technical objective of the project, we planned and conducted a series of trial implementations. The resulting KE sessions applied the methods and the KE tools described in the foregoing sections, with Soldiers in the loop. Data collection efforts focused on capturing TTP and documenting the KE process for the purpose of testing the implementation of the FLEX method.

Data Collection Instruments

Table 4 lists the data collection instruments prepared for the trial implementations. These instruments served to capture data with which to gauge the effectiveness and efficiency of the KE method. The various instruments were completed by participants and research team members (serving as KE facilitators or simulation operators). Some of the instruments would be optional for future TTP development efforts (e.g., participant profile, feedback survey, problem logs).

Table 4

Data Collection Instruments Used During Trial Implementations

| Instrument | Description |
|--|---|
| 1. Participant Profile | Demographic survey completed by participants to self-report their educational background, military assignments, and knowledge of FCS capabilities |
| 2. TTP Development Data Collection Package | Detailed form used by facilitators during TTP development to record think aloud data as well as semi-structured interview responses related to UAS usage (see Appendix B) |
| 3. TTP Review/Refinement Data Collection Package | Detailed form used by facilitators during TTP refinement to record think aloud data as well as semi-structured interview responses related to UAS usage (see Appendix C) |
| 4. Worksheet: Developing UAS TTP | Form completed by participants to develop new TTP and to answer related questions (see Appendix B) |
| 5. Worksheet: Reviewing/Refining UAS TTP | Form used by participants to review and refine previous TTP and to answer related questions (see Appendix C) |
| 6. Participant Feedback Survey | Questionnaire completed by participants to provide feedback on Flex TTP process and procedures (see Appendix D) |
| 7. Procedural Problems Log | Form used by facilitators to record daily procedural problems (e.g., participant leaving early) as well as their impact |

(Table Continues)

| | |
|--------------------------------|--|
| 8. Technical Problems Log | Form used by simulation operators to record technical problems (e.g., computer problems) as well as their impact |
| 9. Master Participant List | Form used by facilitators to log participants and their identification numbers for each daily session |
| 10. Transcripts of Audio Files | Transcripts of voice recordings for each data collection session, prepared for subsequent use by investigators |

As indicated in Table 4, selected data collection instruments are contained in appendixes of this report.

Implementation Procedures

Data collection was conducted over three separate weeks at two different sites, with one site furnishing participants for two different weeks. Figure 2 shows the sequence of development and review/refinement sessions that we used to conduct our research. Each data collection period lasted 3-5 days. At the first site, armor and cavalry leaders (officers, noncommissioned officers) representing platoon and company echelons participated in three KE sessions. At the second site, Army Evaluation Task Force (AETF) leaders (Week 2) and Future Force Integration Directorate (FFID) personnel (Week 3) participated in five sessions, respectively. Each data collection session lasted 6-7 hours, with appropriate breaks provided for participants throughout the day.

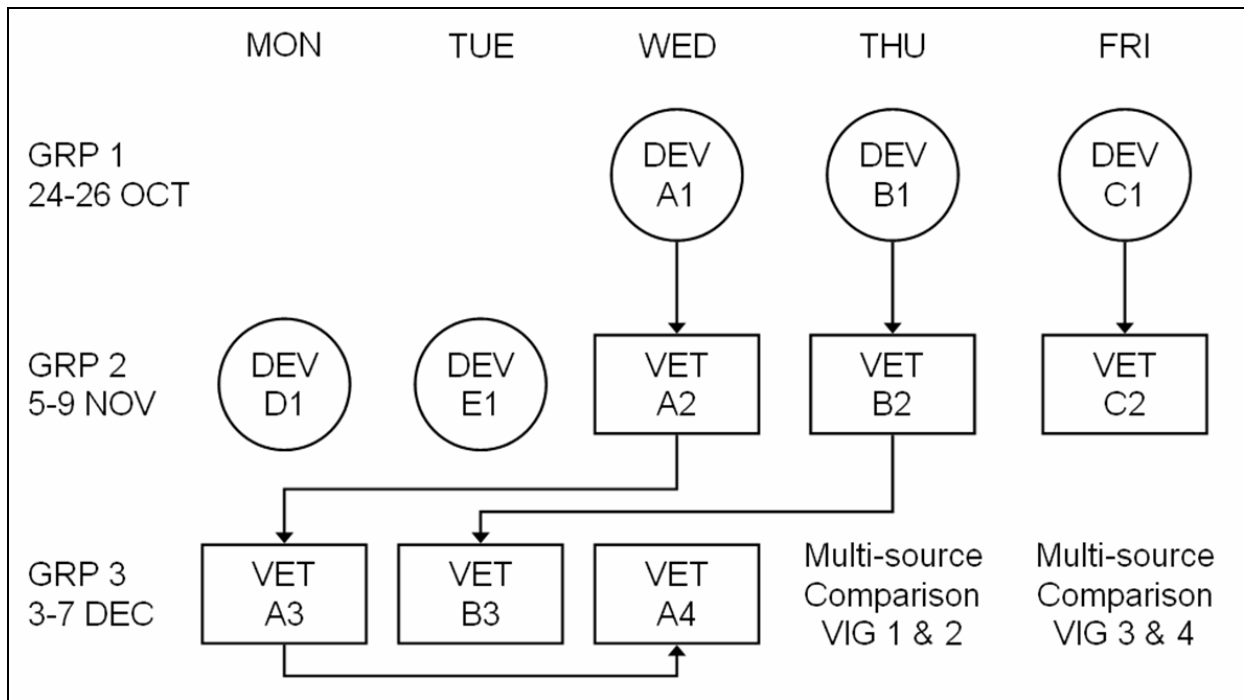


Figure 2. Research schedule of TTP development and review/refinement sessions. Circles indicate TTP development groups and squares indicate single-source review/refinement groups.

In the single-source TTP review/refinement sessions, participants reviewed a single TTP summary for each vignette in combination with a list of TTP-C for each vignette. However, in multiple-source vetting sessions, participants were first asked to review five TTP summaries for Vignettes 1 and 2 (or Vignettes 3 and 4) that were developed by five former development groups. These summaries had again been edited by an SME in order to ensure clear meaning. The summaries from development sessions one, two, and three were previously vetted three, two, and one times respectively, while the material from development sessions four and five was not previously vetted. Each group then reviewed, rated, and refined (when needed) each TTP summary. Then they were asked to write their own TTP summary by editing existing ones or by crafting their own. The KE facilitator then asked participants to work together to create one team-based TTP summary that would combine the best elements from other TTP summaries and add new elements that were important. These final TTP summaries for each vignette were recorded.

The trial implementation included five TTP development sessions, six single-source vetting sessions, and finally two multiple-source vetting sessions. Once the data collection was finished, all data were cataloged and inventoried to ensure all documentation was complete. Also, audio files were transcribed after each data collection session. All data were grouped and compiled into multiple spreadsheets. Two members of our research team entered data into spreadsheets, with random quality assurance checks performed by other team members.

In order to produce an integrated set of TTP, two of the team's SMEs independently reviewed the team-based TTP summaries as well as the vignette-specific TTP and combined them to create a final family of TTP. Because participants in this project represented different ranks, educational levels, and experience, the quality of the raw TTP-C varied greatly. Quality TTP-C need to be clear in meaning and well written. In fact, some participants expressed concern with their lack of writing and editing abilities. Thus, the role of the research SMEs in editing TTP-C as well as TTP summaries was critical to producing a quality set of TTP for each vignette and for overall purposes.

Data Analysis

To analyze the data, we used a mixed methods approach (Creswell, 2002), which incorporated both qualitative and quantitative methods. Quantitative methods were used primarily to answer key research questions, with qualitative analysis serving as a secondary method of analysis. The number of items developed/vetted was tabulated according to session number, session type, role played, METT-TC, vignette, and TTP-C. Ratings for TTP-C and KE procedures were tabulated as well. Average percentages/counts and standard deviations were calculated and used as the primary quantitative parameters.

RESULTS AND DISCUSSION

The effectiveness of the current KE method to develop TTP was assessed through multiple measures. Each measure was designed to address a separate aspect of the methodology. The following aspects of the methodology were examined:

- Participants.
- Implementation Effectiveness.
- Echelon Differences.
- Saturation Effects.
- Quality and Origin of Final TTP.
- Lessons Learned.
- Methodology Improvements.

The method of data collection, resulting data analysis, and conclusions reached by our research team will be presented for each aspect of the methodology examined.

Participants

A total of 48 participants took part in the research project with 13 assigned the role of Co Cdr and 35 serving as PLs. Military experience varied greatly between the participants in terms of rank (see Figure 3), MOS (see Table 5), and length of service. The average number of months in service was 126.90 (standard deviation [*SD*]=99.91), with the longest tenure being 420 months and the shortest 14 months. There was a positive correlation between length of service and session order, $r=.56$, $p<.001$, indicating that more experienced participants took part in the later KE sessions. The participants from development session 3 were the exception to this trend, being more seasoned in terms of years of service than other participants in the development sessions. However, three of the four participants in the third development session were supply specialists, which effectively limited their knowledge relevant to the tactical exercises. Overall, 77.27% of participants indicated they had previous experience developing standing operating procedures (SOP) or TTP, 79.55% reported they were familiar with FCS and Spin Outs, but only 9.09% noted they had prior experience with unmanned vehicles.

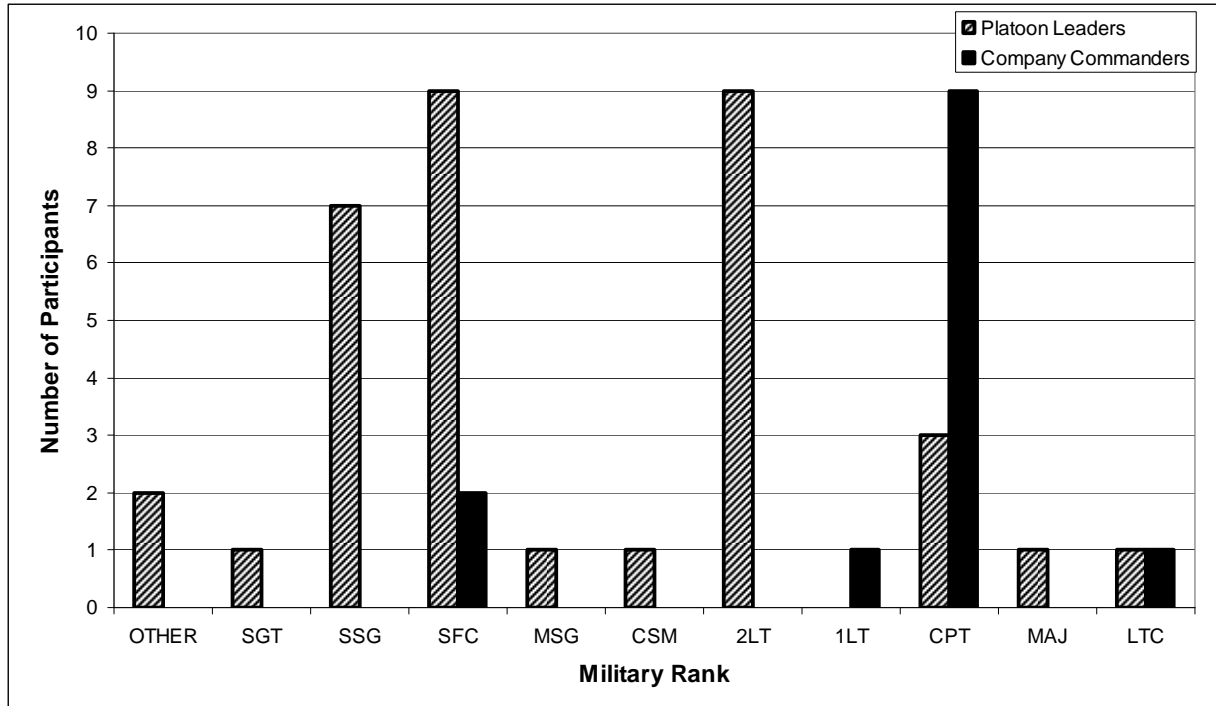


Figure 3. Participants' military rank according to role assignment.

Implementation Effectiveness

Implementation effectiveness was assessed by measuring (a) our ability to implement the methodology and (b) the perceived effectiveness of the methodology for eliciting knowledge. These dimensions were measured by:

- Tabulating significant events (procedural and technical problems recorded on daily logs) across development and vetting sessions.
- Assessing our ability to complete a KE session according to the time allotted by daily schedule.
- Gauging our ability to compile and summarize developed and vetted TTP to produce compiled materials for subsequent vetting sessions.
- Quantifying the researchers' and participants' perceptions of methodology and implementation effectiveness via rating techniques.

Data from the significant event (problem) logs were grouped according to five general areas—simulation, participants, equipment, timing, and materials. For the purpose of the project, a significant event was defined as any event that occurred during a session that deviated from the prescribed procedure and could adversely affect the data. For instance, significant events included simulation workstation crashes, participants' late arrivals or early departures, typographical errors or gaps in materials, and so forth. Information on the frequency and type of significant events is provided in the following paragraphs.

Table 5

Number of Participants According to Military Background

| MOS | Officer/Enlisted | Title | Number |
|-------|------------------|------------------------------------|--------|
| 11A | Officer | Infantry officer | 4 |
| 11B | Enlisted | Infantryman | 6 |
| 12 | Officer | Engineer officer | 1 |
| 13A | Officer | Field Artillery officer, general | 2 |
| 13F | Enlisted | Fire Support specialist | 1 |
| 14A | Officer | Air Defense Artillery officer | 1 |
| 15B | Officer | Aviation Combined Arms Ops officer | 1 |
| 19 | Enlisted | Armor CSM | 2 |
| 19A | Officer | Armor officer, general | 11 |
| 19B | Officer | Armor officer | 2 |
| 19C | Officer | Cavalry officer | 1 |
| 19D | Officer | Cavalry Scout | 3 |
| 19K | Enlisted | M1 Armor Crewman | 5 |
| 19Z | Enlisted | Armor senior sergeant | 2 |
| 21B | Officer | Combat Engineer officer | 1 |
| 35D | Officer | All Source Intelligence officer | 1 |
| 68W | Enlisted | Health Care | 1 |
| GS-12 | Civilian | Training Instructor | 1 |
| 88M38 | Enlisted | Transportation Instructor | 1 |
| 92Y40 | Enlisted | Supply specialist | 1 |
| Total | | | 48 |

Simulation-Related Events

There were two types of significant events related to the simulation—single workstation failures (57.14%) and complete system failures (42.86%). At least one significant event occurred due to simulation-related factors in 11 of 13 sessions (84.62%). Furthermore, in 8 of the 13 sessions (61.54%), multiple simulation-related significant events occurred. In at least one development session, the instability of the simulation likely led to fewer than average TTP being developed. In fact, during that session (Development 4) one of the vignettes was terminated early. The instability of the system is most likely attributable to the use of an immature version of OF-OOS to run the simulation and the demands placed on the computer systems by simulation software. As future refinements are made to the OF-OOS operating suite, the number of simulation-related issues should decrease. Alternatively, other platforms for simulations may be utilized in the future.

Participant-Related Events

Participant-related significant events occurred in 9 of 13 sessions (69.23%). A majority of these events involved participants arriving late or not showing up. While participant-related events occurred rather frequently, they did not have a major impact aside from adding some

variability in the data between sessions. We were able to complete the daily sessions by the scheduled time, indicating that there was sufficient flexibility built into the daily schedule to accommodate multiple delays.

Equipment-Related Events

Equipment-related significant events occurred in 3 of 13 sessions (23.08%). All equipment-related events involved the voice recorders, but they did not significantly affect the data collection because of redundant mechanisms.

Timing-Related Events

Late arrival by participants was the primary cause of timing-related significant events. While late participant arrivals translated into late start times in 6 of the 13 sessions (46.16%), the delays did not dramatically impact the daily schedule even when combined with delays related to the simulation. Each vignette was completed according to the scheduled time allocated (+/- 15 minutes), and each daily session was completed within the scheduled time (+/- 20 minutes). To make up time, the exercise director occasionally ended an event (such as vignette execution) early, when doing so would not materially affect tactical considerations.

Materials-Related Events

Significant events stemming from KE materials occurred in 4 of 13 sessions (30.77%). Issues related to materials tended to be typographical errors and occurred during vetting sessions of recently compiled and summarized TTP. Future KE efforts may benefit from either streamlining the TTP compilation and summarization process, or by providing more time between sessions that require compiling and summarizing TTP.

Effectiveness Ratings

Participant and researcher feedback forms were used to assess the perceived effectiveness of the current KE method. Both groups rated aspects of the KE sessions on a five-point scale (strongly disagree to strongly agree) across several dimensions. As necessary, scores on the five-point scale were transformed so that higher scores reflected positive ratings. As shown in Figures 4 and 5, a majority of participants and researchers rated the KE method positively, with the exception of the simulation. Less than half the raters in both groups gave positive ratings for the simulation. It should be noted that “neutral” responses are not represented in Figures 4 and 5.

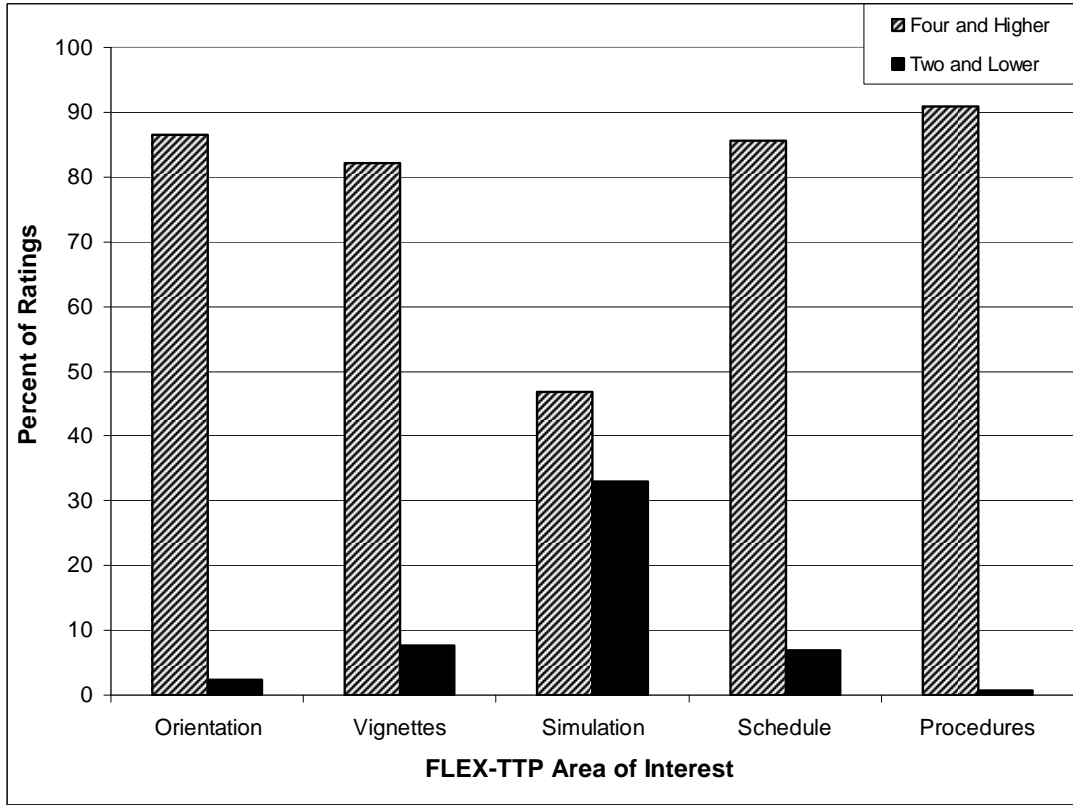


Figure 4. Participant ratings of effectiveness of various methodology components.

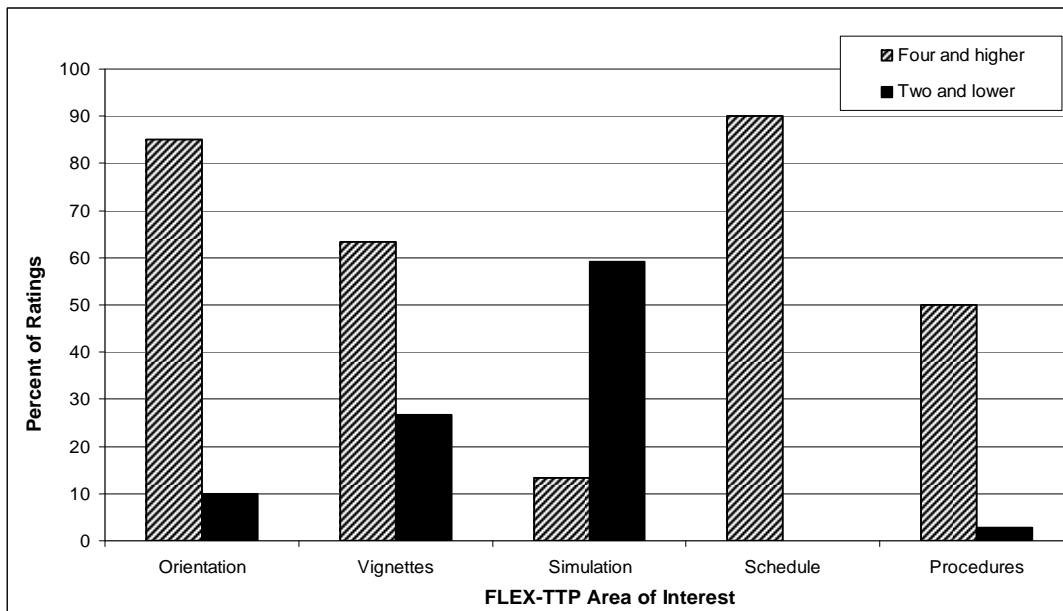


Figure 5. Researcher ratings of effectiveness of various methodology components.

TTP Production

The ability of the current KE methodology to facilitate the production of TTP was assessed by examining the distribution of TTP elements along four dimensions: vignettes (1 through 4), type of element (tactic, technique, procedure, or consideration), development session (1 through 5), and METT-TC factors (mission, enemy, terrain and weather, troops, time, and civilians). The relative frequencies of elements for each dimension are presented in Table 6. The influence of the four dimensions will be addressed in the following paragraphs.

Table 6

Multi-Dimensional Breakout of TTP Items Generated During Development Sessions

| Vignette: | One | Two | Three | Four | | |
|------------------|---------|-----------|-----------|---------------|-------|-----------|
| Average (%) | 25.00 | 31.00 | 27.00 | 17.80 | | |
| SD | 9.82 | 9.00 | 9.00 | 8.14 | | |
| TTP-C: | Tactic | Technique | Procedure | Consideration | | |
| Average (%) | 48.00 | 35.60 | 3.40 | 14.20 | | |
| SD | 16.84 | 12.90 | 4.16 | 7.46 | | |
| Session: | One | Two | Three | Four | Five | |
| Average (number) | 35.00 | 28.25 | 20.75 | 16.50 | 25.50 | |
| SD | 10.00 | 10.27 | 7.89 | 5.56 | 4.36 | |
| METT-TC: | Mission | Enemy | Terrain | Troops | Time | Civilians |
| Average (%) | 52.00 | 14.40 | 14.20 | 9.60 | 8.40 | 2.20 |
| SD | 16.66 | 1.52 | 5.63 | 5.50 | 4.56 | 1.64 |

Vignettes

Productivity of the development sessions was consistent across vignettes with the exception of a lower number of TTP items in Vignette 4. Since Vignette 4 was always the final vignette of the day, we cannot determine if vignette order or the content of Vignette 4 accounted for the reduced productivity. We considered varying the vignette order as part of the research design but decided against it to maintain continuity in the tactical storyline across vignettes. Individuals conducting KE sessions in the future may wish to vary vignette order.

TTP-C Components

Participants generated substantially more tactics and techniques than procedures or considerations. The difference may result from the facilitators instructing the participants to focus on developing tactics and techniques because of the immature stage of the UAS. The exact specifications and abilities of the Spin Out UAS have yet to be determined. Therefore, we felt it would not be fruitful to develop specific procedures for a UAS without knowing what it was capable of performing.

Development Sessions

The number of generated TTP items fluctuated across the five development sessions. While the fourth development session produced the fewest items, the difference is most likely due to the higher number of simulation-related problems that occurred during that session. The third session produced fewer items most likely due to three of the four participants having their military backgrounds in supply operations. The remaining variability between development sessions is most likely attributable to error variance produced by (a) participants with different levels of ability, military experience, and motivation, (b) number and type of significant events, and (c) other sources of natural variability.

METT-TC Factors

Participants generated more items related to “mission” than any other METT-TC element, while they generated the fewest items for the “civilian” element. The dearth of civilian-related TTP items may result from the simulation capabilities. The limitations of the OF-OOS version precluded the effective portrayal of civilian elements in the vignettes. Since civilians were absent in the simulations, they were often not factored into participants’ TTP.

Echelon Differences

Researchers assigned the participants to serve as a Co Cdr or a PL, based in part on a review of participant demographic information. The role of Co Cdr was generally assigned to the participant with the greatest level of expertise, typically based on highest rank or longest relevant military experience. The performance at each echelon was recorded separately across the development and vetting sessions to examine the effects of role assignment on TTP development and vetting. Although each development and vetting session included multiple PLs, the performance of each PL was recorded individually.

Development of TTP

The effect of the role assignment (PL vs. Co Cdr) on TTP development was assessed by calculating the average number of TTP generated per participant according to echelon across development sessions and vignettes. In addition, the TTP generated were analyzed according to the level of focus (i.e., task-specific TTP related to the “close fight” vs. higher level command and control [C2] issues).

Echelon. Participants in the Co Cdr role generated more TTP per development session on average ($M=33.80$, $SD=9.76$) than participants in the PL role ($M=25.47$, $SD=13.01$). As seen in Figure 6, the quantitative difference in favor of Co Cdrs held up across vignettes. That the magnitude of the difference varied somewhat between vignettes probably reflects measurement error.

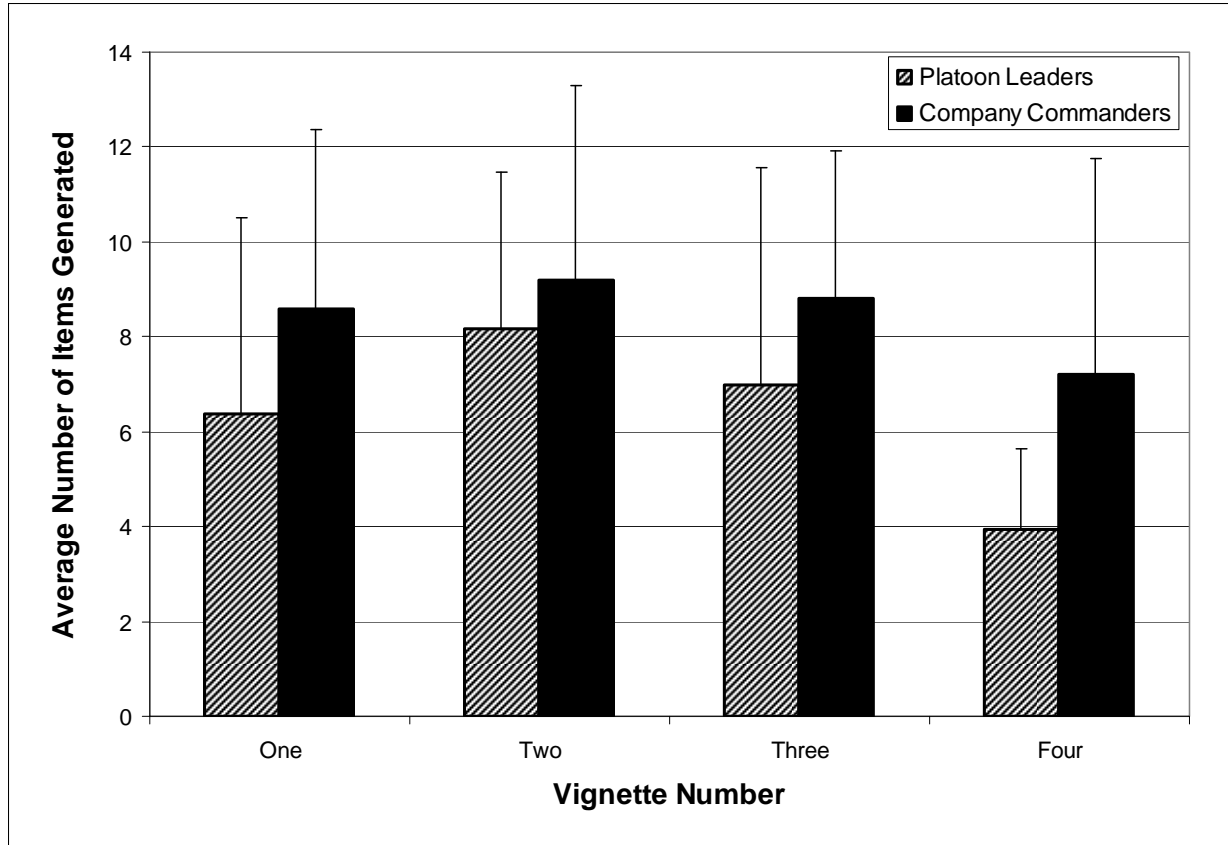


Figure 6. Average number (and SD) of items generated per vignette by participant role.

Level of focus. Participants in the Co Cdr’s role generated more TTP that focused on C2 issues and overall performance of the group. That is, Co Cdrs tended to utilize the UAS to support mission planning, coordination between subordinate units, and asset support and allocation. Conversely, PLs generated TTP that were more task-specific, focused on specifying where, when, and how the UAS should be flown. For example, PLs commented more frequently on issues such as using the UAS to reconnoiter a specific area and the flight patterns related to the reconnaissance (see Table 7).

Table 7

Average Percent of TTP Generated by Role and Focus (Task vs. C2)

| Role | Focus | Session | | | | | Average |
|--------|-------|---------|-------|-------|-------|-------|---------|
| | | One | Two | Three | Four | Five | |
| PL | Task | 81.25 | 77.46 | 83.64 | 82.61 | 86.36 | 82.26 |
| | C2 | 18.75 | 22.54 | 16.36 | 17.39 | 13.64 | 17.74 |
| Co Cdr | Task | 65.12 | 64.29 | 64.29 | 65.00 | 61.11 | 63.96 |
| | C2 | 34.88 | 35.71 | 35.71 | 35.00 | 38.89 | 36.04 |

Conclusion. Participants working in the Co Cdr's role were generally more productive during development sessions, on average generating more TTP. Further, the Co Cdr role players tended to generate TTP with the broader mission in mind. Since we deliberately tried to assign participants with the most military experience to the Co Cdr's role, we cannot clearly determine if the higher productivity and broader level of focus were byproducts of those participants being placed in the Co Cdr's role, or byproducts of their greater military experience.

Vetting of TTP

Single-source vetting. The effect of role assignment, PL vs. Co Cdr, on vetting TTP was assessed by computing the average percent of TTP items deleted or refined during single-source vetting sessions. As seen in Figure 7, participants in the Co Cdr's role were generally more active during vetting sessions, deleting or refining more TTP on average ($M=21.02$, $SD=14.21$) than participants in the PL role ($M=16.71$, $SD=6.48$). In four of the six vetting sessions Co Cdrs deleted or refined more TTP items than participants in the PL role. In two sessions the PLs vetted more TTP on average than the Co Cdrs. In one of these sessions, the participant in the Co Cdr role left the session early due to a Family emergency. In the other session the participant assigned as Co Cdr had the highest military rank, but two fellow participants had comparable or greater military experience (Co Cdr 144 months, PLs 152 and 144 months, respectively). Thus, the two instances when PLs vetted more TTP items than Co Cdrs can be explained by a participant-related significant event and a participant variable, respectively.

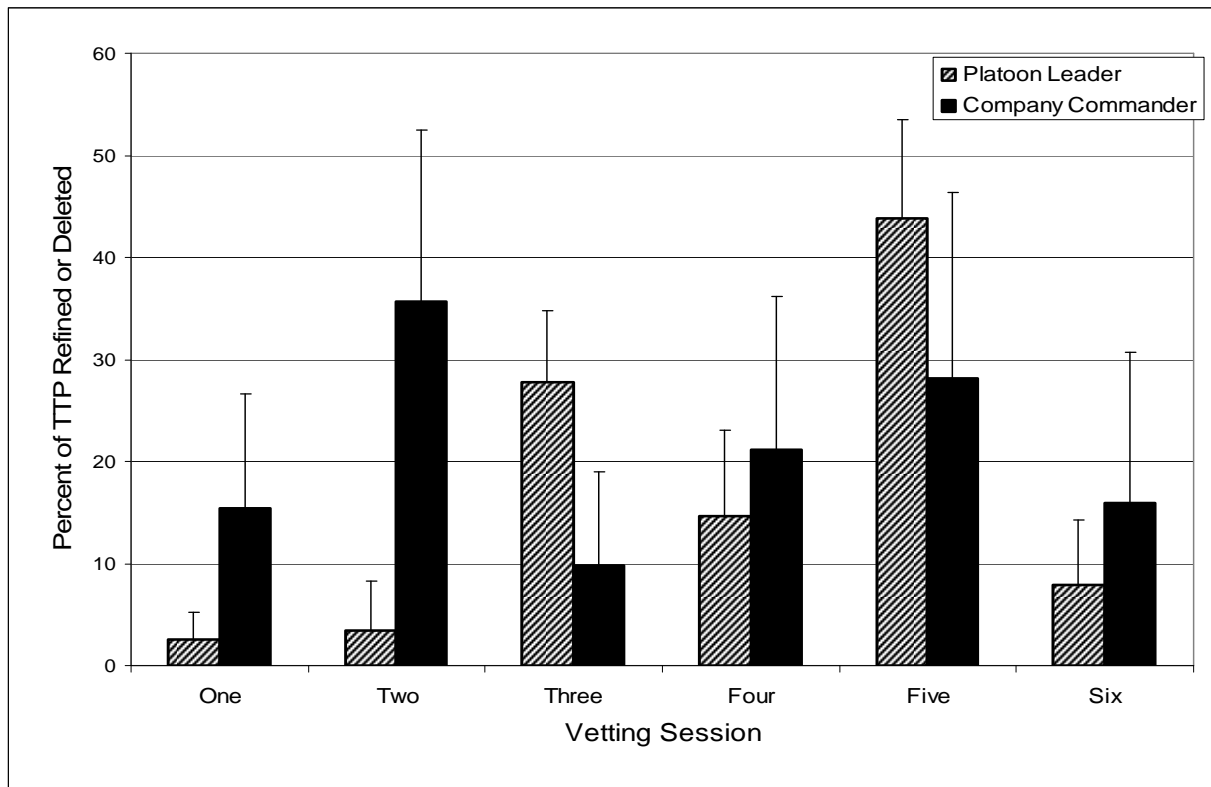


Figure 7. Average percent (and *SD*) of TTP modified or deleted during single-source vetting sessions, by participant role.

The total number of items modified or deleted varied across vetting sessions (see Figure 7). Vetting sessions one, two, and three indicate first round vettings for TTP produced in development sessions one, two, and three respectively. Vetting sessions four and five were second round vettings for development sessions one and two respectively, while the sixth vetting session was the third round of vetting conducted on TTP from development session one. The higher numbers of items vetted during the second and fifth vetting sessions most likely reflect a greater need to refine TTP produced during the second development session.

Multiple-source vetting. The analysis of TTP vetting as a function of assigned role was extended to multiple-source vetting sessions. Comparison across vetting sessions was not practical since only two multiple-source vetting sessions were conducted, during which each group received only a partial complement of TTP (Vignettes 1 and 2, or Vignettes 3 and 4). Participants in the Co Cdr ($M=22.13$, $SD=16.70$) and PL ($M=22.94$, $SD=26.75$) roles were equally active during multiple-source vetting sessions, refining and deleting similar numbers of TTP. The variability between vignettes seen in Figure 8 is consistent with the patterns seen between single-source sessions in Figure 7. An examination of the months of service for participants in multiple-source vetting sessions revealed that PLs ($M=207.20$, $SD=82.99$) had more military experience on average than Co Cdrs ($M=111.50$, $SD=37.48$). This led the authors to conclude that length of military service plays an important role in vetting productivity, and experience can potentially counteract the effects of role assignment.

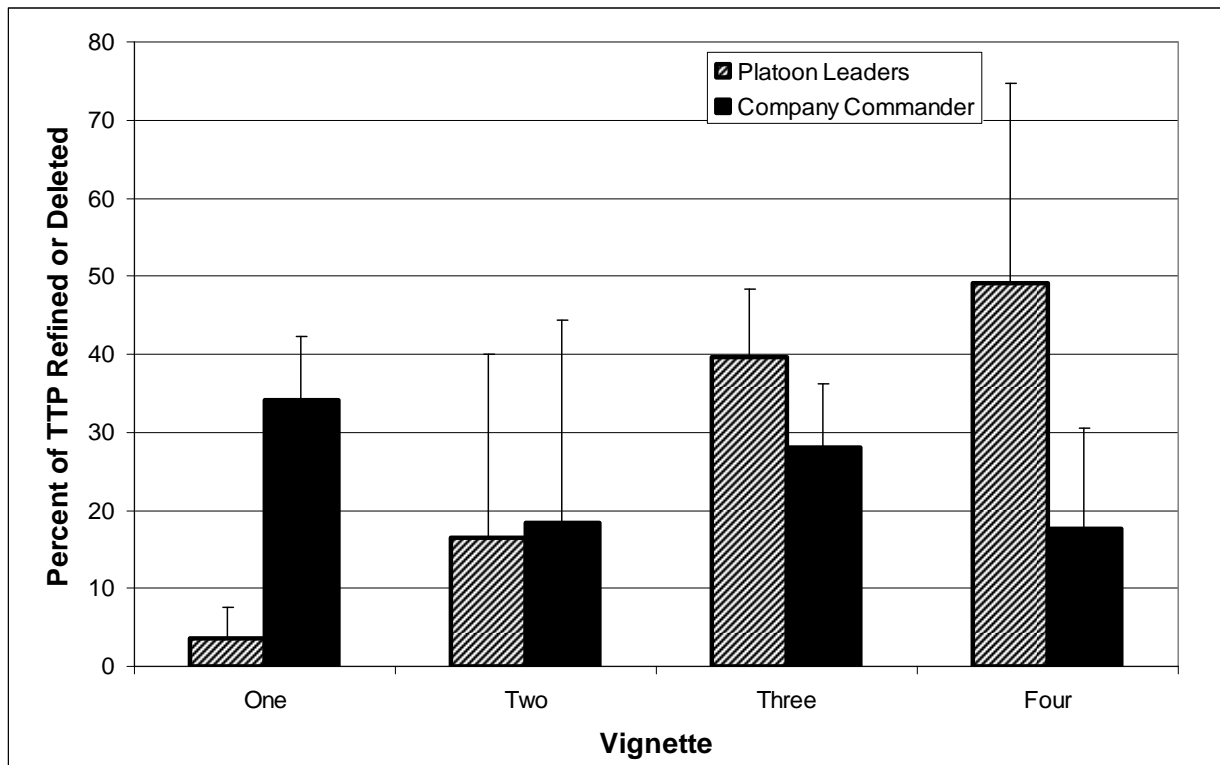


Figure 8. Average percent (and SD) of TTP modified or deleted during multiple-source vetting sessions, by participant role.

Conclusion. While Co Cdrs were sometimes more active during single-source vetting sessions, the effect was not consistent across all sessions. There was some evidence to suggest that length of military service plays a role in how active a participant was during a vetting session. In multiple-source sessions, role had less of an effect on vetting activity than length of military service. Future researchers should consider military experience as an important factor contributing to vetting performance.

Saturation Effects

Development of TTP

To determine the point of saturation (Guest, Bunce, & Johnson, 2006) for developing new TTP, we calculated the proportion of TTP items generated during a development session that did not duplicate items generated in a previous development session. For the purpose of the current project, the criterion for saturation was defined at 5%. That is, when the number of new TTP generated during a session fell below 5% the point of saturation was reached. There was no absolute justification for choosing 5% as the point of saturation. Since it is unlikely, and impractical, that all possible TTP will be developed in an infinite number of sessions, future research teams must balance the relative costs and benefits associated with the KE process to determine their own criterion for saturation.

As shown in Figure 9, by the third development session only about 8% of the TTP generated were new TTP. During the fourth and fifth development sessions the percent of new TTP dropped to 2.5% and 4.5%, respectively. Thus, under the conditions of this research project saturation was reached after three development sessions. Future research should define the point of saturation according to the objectives of the project and weigh the relative importance of any new TTP against the resources required to generate them. For example, the point of saturation might be set higher for TTP related to battlefield conditions and when lives are at greater risk, and set lower for TTP associated with less critical functions.

Vetting of TTP

Single-source vetting sessions. To determine when the point of saturation is reached for vetting TTP during single-source vetting sessions, the participants were asked to rate the TTP summaries generated/vetted for each vignette on a 100-point scale, with higher scores signaling better TTP. It is important to note that participants rated the TTP summaries presented to them, not the resulting TTP summaries they themselves generated. Thus, for single-source vetting sessions the first vetting group rated TTP which had yet to be vetted, the second vetting group rated TTP which were vetted once, and so on. We then calculated the average ratings for TTP quality according to the number of times they were vetted—zero, one, or two times. As shown in Figure 10, after two rounds of vetting the average ratings of the TTP reached 95. In fact, after two rounds of vetting 81.81% of the ratings reached 95 or above. Thus, saturation for single-source vetting sessions occurred after two vetting sessions. Future researchers should select a saturation criterion to meet the goals of the project and weigh the relative importance of any additional TTP refinement against the resources necessary to generate them.

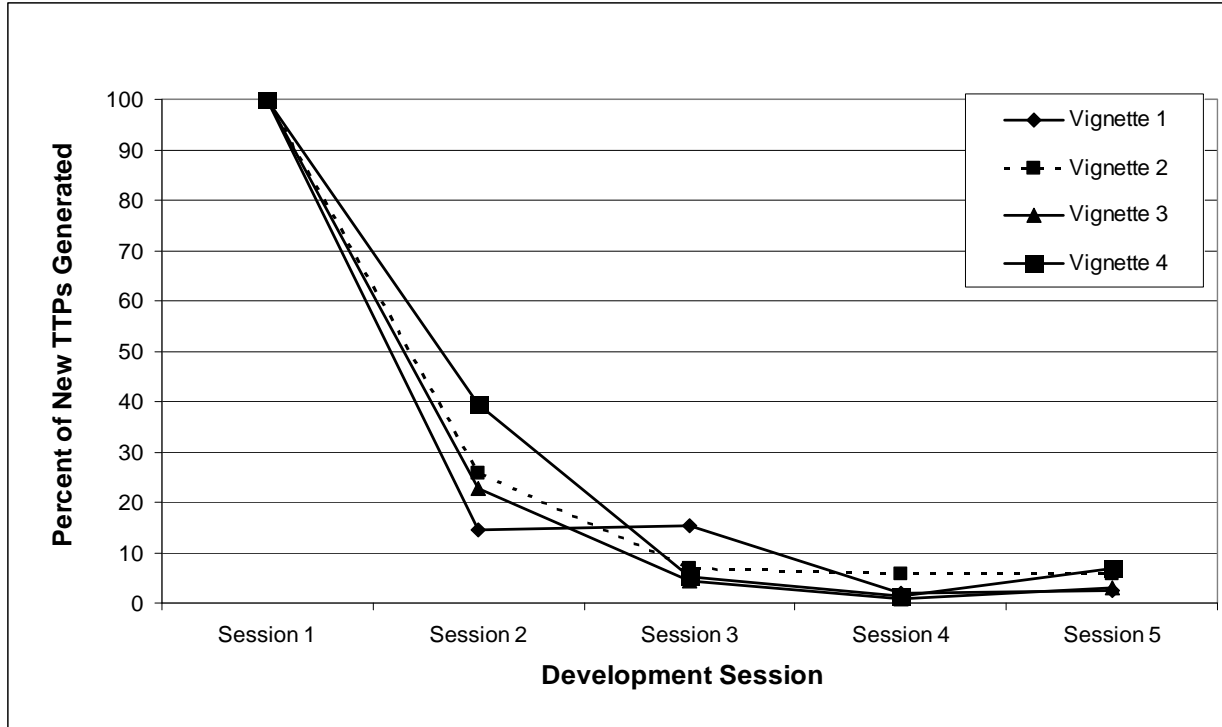


Figure 9. Percent of new TTP generated by development session.

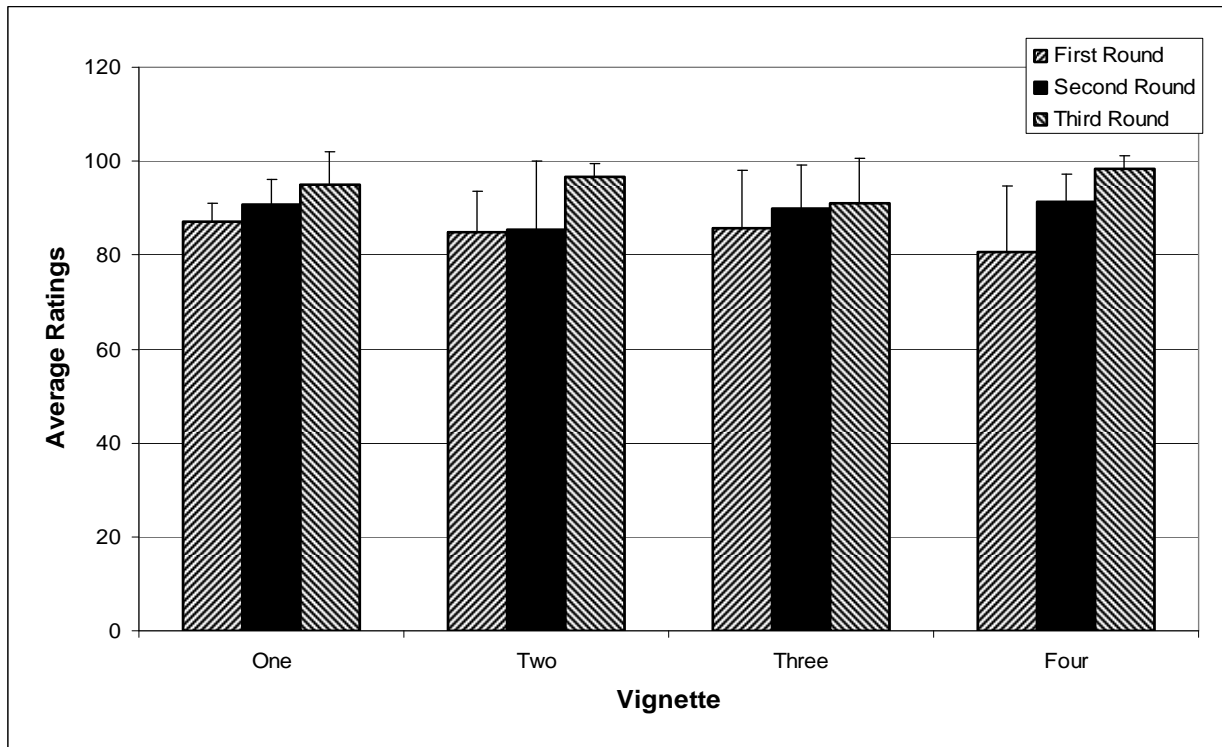


Figure 10. Average ratings (and *SD*) of single-source TTP summaries by vignette and round.

Multiple-source vetting sessions. As with single-source vetting, in multiple-source sessions the participants were asked to rate the quality of the received TTP summaries on a 100-point scale, with higher scores reflecting better TTP. However, two major differences between multiple-source and single-source vetting sessions prevented us from assessing the point of saturation for multiple-source vetting sessions.

First, in single-source vetting sessions, each participant received only one TTP summary per vignette which was previously vetted between zero and two times. In the multiple-source vetting sessions, each participant was given five different TTP summaries to vet per vignette, one from each previous development session. The TTP summaries presented in multiple-source vetting sessions had previously been vetted between zero and three times. Thus, participants in multiple-source vetting sessions received TTP summaries which were at different levels of maturity resulting from variable numbers of vettings. The variance induced by receiving several TTP at different levels of maturity prevented us from calculating a measure of saturation.

As shown in Figure 11, there were differences in TTP summary ratings across sessions and across vignettes, and between participants. The large error bars indicate a lack of agreement between the participants, with some participants assigning a relatively high rating for a TTP summary (above 90), while other participants assigned a low rating to the same TTP summary (near zero). The researchers conducting the KE session noted that the high variability between participant ratings might reflect some participants not “buying into” the procedure and remaining disengaged during the session.

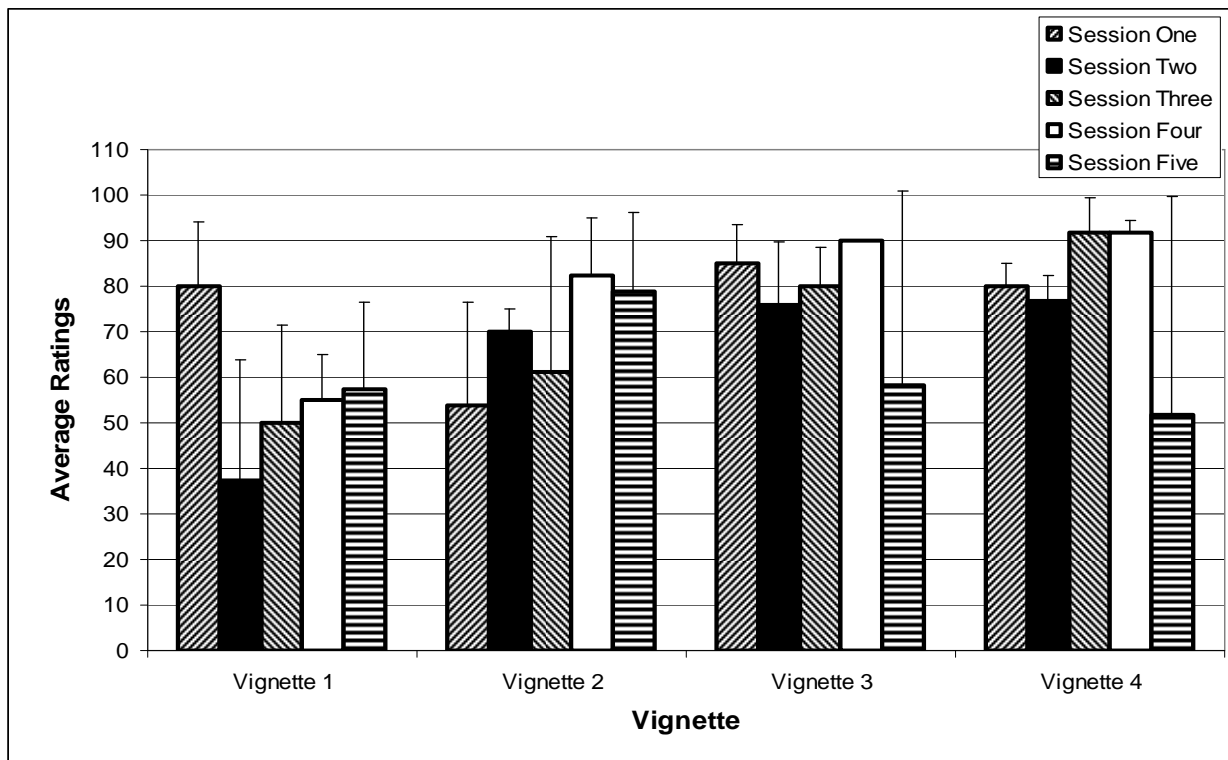


Figure 11. Average ratings (and *SD*) of TTP summaries by vignette and point of origin.

Second, each vignette was subjected to only one multiple-source vetting session as compared with six during single-source vetting sessions. Since the TTP summaries produced for each vignette underwent only one multiple-source vetting session, we could not estimate the point of saturation (i.e., ratings across sessions).

Quality and Origin of Final TTP

This subsection discusses characteristics of the final TTP that resulted from the trial implementations. The information is presented to assist future developers in determining the appropriate mix of original TTP development and single-source vetting sessions, as well as participant group composition, sufficient to maximize return on investment.

Quality of Final TTP

It would be naive to assume that all participants would universally rate any set of TTP as perfect. However, the current methodology was able to produce TTP which received perfect or near perfect ratings across several vetting sessions by experienced military personnel (see Figures 10 and 11). The TTP were then examined independently by two SMEs with over 20 years of military experience, as they assembled a final set of TTP. The SMEs reduced the number of final TTP to construct a comprehensive and congruent set of TTP for each vignette. The final TTP for each vignette included a summary statement comprised of 6 to 14 sentences, followed by separate statements for METT-TC. The final numbers of summary and METT-TC statements for each vignette were distributed as follows: Vignette 1, 50 statements; Vignette 2, 36; Vignette 3, 40; and Vignette 4, 31 statements.

Origin of Final TTP

To develop a benchmark for the number of development and vetting sessions needed, we tracked the point of origin and vetting refinements for each item of the final TTP. Figure 12 depicts the point of origin for TTP according to session and vignette. Approximately 70% of the final TTP were developed during development session one ($M=42.43\%$, $SD=8.52\%$) and development session two ($M=26.57\%$, $SD=8.83$). Following the second session there was a marked decline in the amount of final TTP produced. The third and fourth development sessions produced small contributions ($M=7.07\%$, $SD=1.05$ and $M=7.18\%$, $SD=1.86$, respectively) to the final TTP, as did session five ($M=4.32\%$, $SD=3.77$). Participants in vetting sessions also generated some original TTP, accounting for a moderate proportion ($M=12.42\%$, $SD=7.12$) of the final TTP.

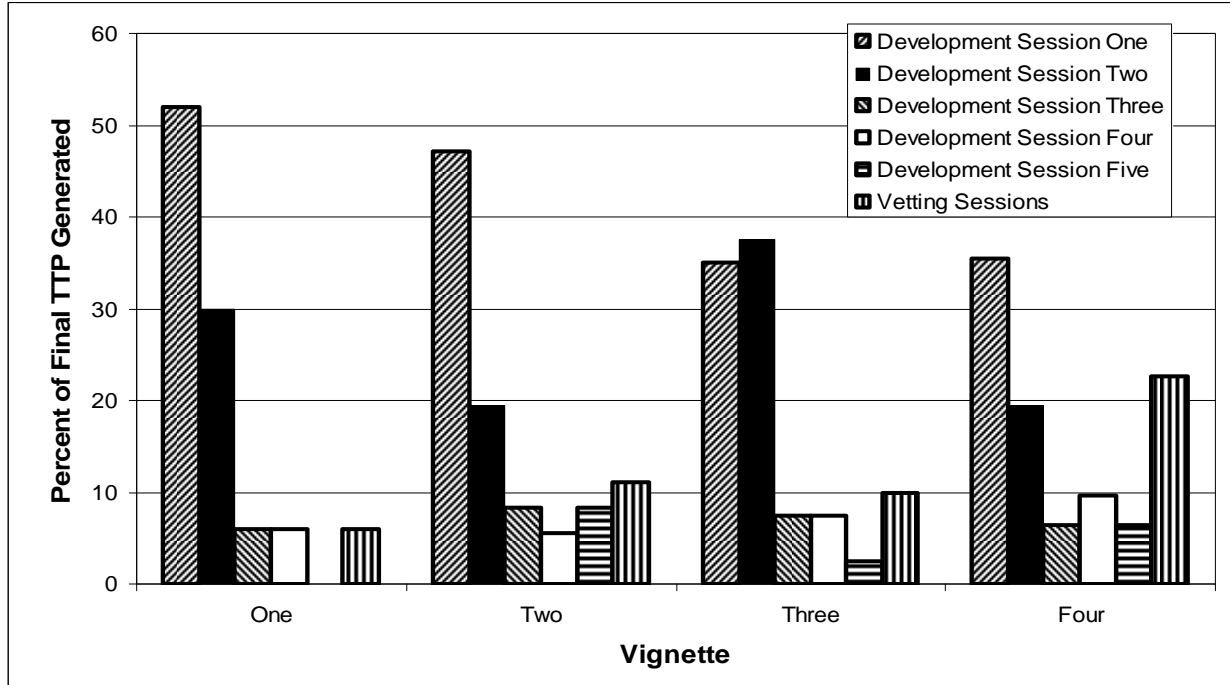


Figure 12. Percent of final TTP generated according to session number and type across vignettes.

Origin of Vetting Refinements

Nearly one-quarter (23.57%) of the final TTP were unrefined from their point of origin. That is, the final statement appeared exactly as it was proposed by the first person/group that developed it. The majority of the remaining final TTP were refined either once (43.31%) or twice (29.30%), with only a small percentage (3.19%) being refined three times. Figure 13 displays the percent of final TTP refined through vetting according to vignette and vetting session. Nearly 75% of the refinements occurred during either the first single-source vetting session ($M=43.45\%$, $SD=6.48$) or the multiple-source vetting session ($M=30.59$, $SD=6.41$). Vetting productivity began to drop dramatically between the second single-source session ($M=19.89$, $SD=3.68$) and the third single-source session ($M=6.07$, $SD=1.69$). These results indicate that single-source vetting may hit the point of diminishing returns after two sessions. Additional benefits may occur when a multiple-source session is conducted as a follow-up to two single-source sessions. Once again, it is ultimately up to the KE team members to conduct a cost/benefit analysis to determine if the additional information gained by conducting a third single-source session is worth the time and resources.

The large number of items refined in the multiple-source sessions may reflect both previously unvetted items produced in development sessions 4 and 5, and any new TTP developed during the final single-source vetting session. Alternatively, the spike in number of TTP modified may be a byproduct of the multiple-source comparison process. Providing participants with a larger and more diverse set of TTP may enable them to identify the best aspects of the various TTP and produce refinements that reflect “the cream of the crop.” In support of this second alternative, the data reveal that 78.57% of the refinements made to the

final TTP during the multiple-source sessions were revisions of previously vetted TTP, with only 21.43% of the refinements occurring on previously unvetted TTP. Thus, there is a substantial benefit of allowing participants to conduct cross comparisons during multiple-source sessions.

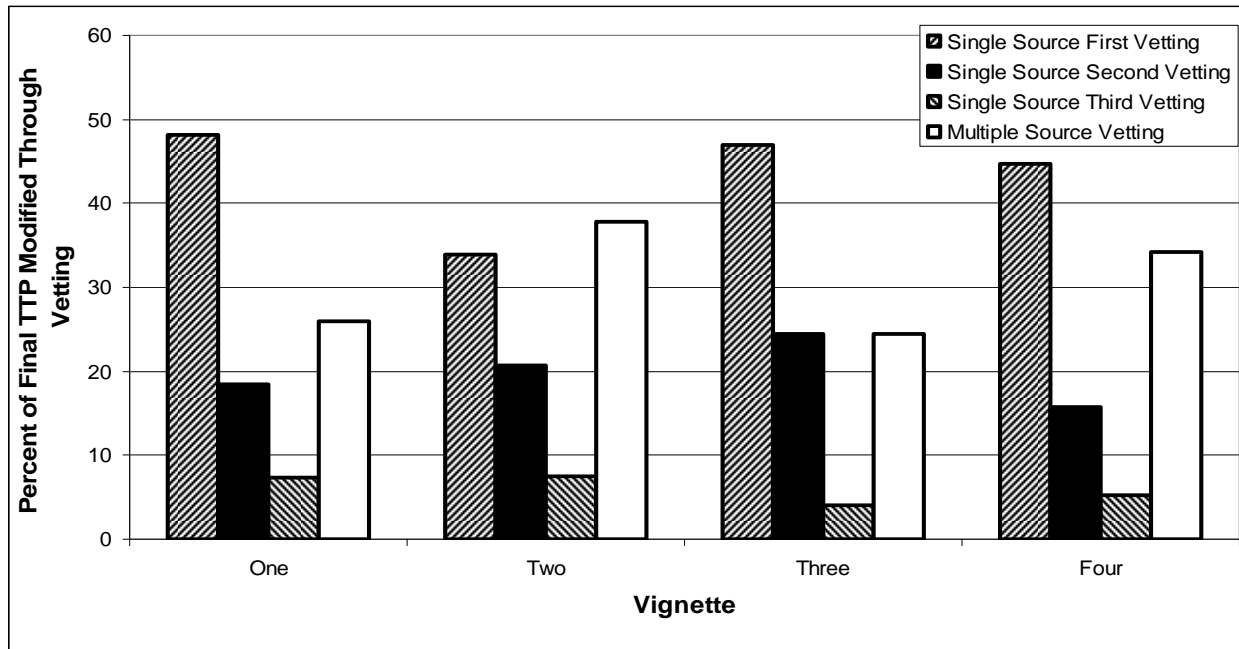


Figure 13. Percent of final TTP modified through vetting according to session and vignette.

Influence of Demographics

Some of the data suggest that participants' military background influenced the TTP development. The third development group showed a decline in total TTP production, new TTP production, and TTP quality as measured by the percent of final TTP issuing from that development session. While some of the decline is no doubt attributable to saturation effects, some is likely due to the participants' military background. Three of the four personnel who participated in development session 3 were supply personnel. Only the participant who served in the Co Cdr role had military experience outside of supply. The sharp decline may in part reflect the lack of relevant expertise by those participants. Having participants with appropriate expertise is an enabler for more fruitful TTP development sessions.

The results on the quality and origins of the final TTP shed light on the dynamics and effectiveness of the KE process. Key points for future developers include:

- The overall quality of the final TTP was rated highly by SMEs.
- Approximately 70% of the information that ultimately appeared in the final TTP originated from the first two TTP development sessions.
- Single-source vetting may hit the point of diminishing returns after two sessions.
- Nearly 75% of all TTP refinements occurred during the first single-source vetting session or during the multiple-source vetting session.

- The background and experience of the participants affect the quality of the KE process outcomes.

Lessons Learned

Lessons learned were derived from written input provided by researchers and participants on survey-style feedback forms. Table 8 summarizes the major lessons for the FLEX method, organized under five categories of interest.

Table 8

Summary of Lessons Learned by Category

| Category | Lesson Learned |
|--------------|---|
| Orientation | <ul style="list-style-type: none"> • Orientation materials should describe the KE goals, KE process, and simulation. • A practice vignette substantially enhances readiness of participants. • Guidelines for recording technical problems should be provided to operators. |
| Simulation | <ul style="list-style-type: none"> • Simulation software should provide a stable, realistic, interactive environment. • The simulation should realistically represent the features/functioning of the target system. • Simulation software should be sufficiently mature to minimize technical problems. |
| Timing | <ul style="list-style-type: none"> • Sufficient time should be allocated to troop leading procedures prior to mission execution. • A half hour is sufficient for executing simple company-platoon missions. • The daily schedule should be sufficiently flexible to accommodate delays and over-runs. • A daily schedule of 7 to 8 hours is sufficient for four vignette cycles. • A daily schedule less than 7 to 8 hours would be insufficient. • Sufficient time is needed between sessions to produce and check vetting materials. |
| Participants | <ul style="list-style-type: none"> • Motivated, fully qualified participants greatly enhance the quality of the KE products. • Participants' backgrounds should be matched to the subject matter being investigated. |
| Procedures | <ul style="list-style-type: none"> • Developing vignette-specific TTP is both feasible and necessary. • Knowledgeable and experienced SMEs working on the research team are imperative. • Participant role assignment affects the data. • Multiple development sessions are beneficial, but with diminishing returns. • Conducting both single-source and multiple-source vetting sessions is beneficial. • Direct database entry by participants can expedite data analysis and reduce data loss. • Video-taping sessions would generally be preferable to audio recording. |

Orientation

Participant performance during the first vignette was greatly enhanced by providing a brief practice session as part of the orientation. The practice session familiarized the participants with the apparatus, thinking aloud, and the verbal directions required to instruct the simulation operator. Orientation materials should be provided to participants far enough in advance to impart a frame of reference for the goals of the KE process, the procedures, and the specific vignette missions. To ensure adequate study time, the facilitators may choose to deliver the orientation materials to participants at least one day in advance.

Simulation

High quality simulations play an essential role in producing “buy-in” from participants. Stable, environmentally rich, systems-capable simulations on par with or superior to home video game simulations are needed to effectively immerse the participants in the tactical exercises.

Timing

The daily schedule provided enough time to complete the established goals without overtaxing the participants, facilitators or operators. However, sufficient time needs to be scheduled between sessions to permit the KE team to process data and prepare materials for vetting sessions. Hastily revised materials led to incorrectly formatted forms and scales, missing items, and the inclusion of incorrect items.

Participants

Participants lie at the heart of any KE session. Participants with military backgrounds congruent with the FCS are necessary to maximize the effectiveness of the KE process. At the same time, having FCS-congruent military backgrounds is not sufficient to guarantee high quality TTP. A motivated, insightful, and expressive participant is equally important.

Procedures

A KE-based, simulation-driven FLEX method can effectively and efficiently produce TTP for FCS capabilities. Between two and three development sessions, two single-source and one multiple-source vetting session should be sufficient. Production and vetting of TTP were affected by echelon (role assignment). Increasing the number of echelons represented in future TTP development sessions may enhance FCS employment by generating broader cross-echelon TTP. Some loss of data occurred due to difficulties with reading handwriting and interpreting notations. Having participants enter their responses directly into computers would assist with TTP turnaround, source tracking, avoidance of data loss and errors, and electronic backup.

Methodology Improvements

Our team made one substantive modification of the original FLEX method by formally incorporating multiple starting points through separate initial TTP development sessions. While the original method employed a single point of origin for development, we utilized a multiple-source approach. These multiple tracks of development then converge into a consensus building session that includes a multiple-source vetting session and final TTP refinement. It is important to note that this modification was not outside the original theoretical framework of the FLEX methodology, but a modification in how the methodology was implemented. We adopted the multiple-source process over concerns that the outcome of a single-track approach could be limited by the simple fact of its narrow origins. Theoretically, multiple starting points would (a) lead to a variety of distinct solutions, each valuable and mature in its own right, or (b) confirm the validity of a single, common outcome achieved with multiple, independent sources. Figure

14 illustrates a multiple-track framework with each track originating at an independent starting point.

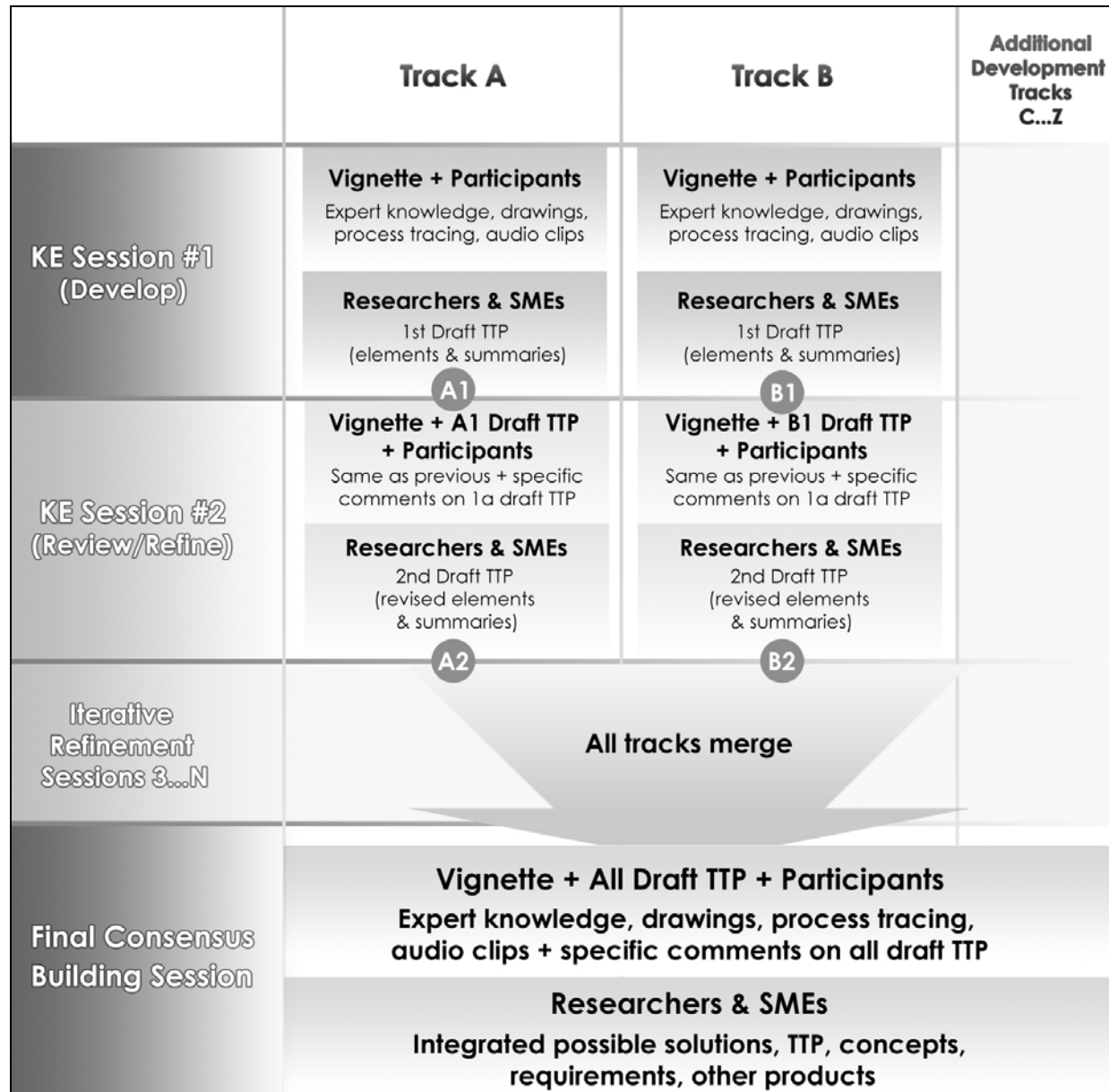


Figure 14. A multiple-track FLEX process.

For the purposes of this research, the initial development tracks numbered five. For future implementation, we recommend a minimum of two development tracks, each followed by a minimum of one single-source vetting session, yielding a “2-by-2” matrix as shown in Figure 14 above. Depending upon the TTP developer’s expectations and objectives, as well as the availability of resources to support TTP development, the matrix can be expanded vertically or horizontally to achieve greater resolution, potential variety, and/or more confidence in the results. Figure 15 illustrates how expanding the matrix could impact outcomes.

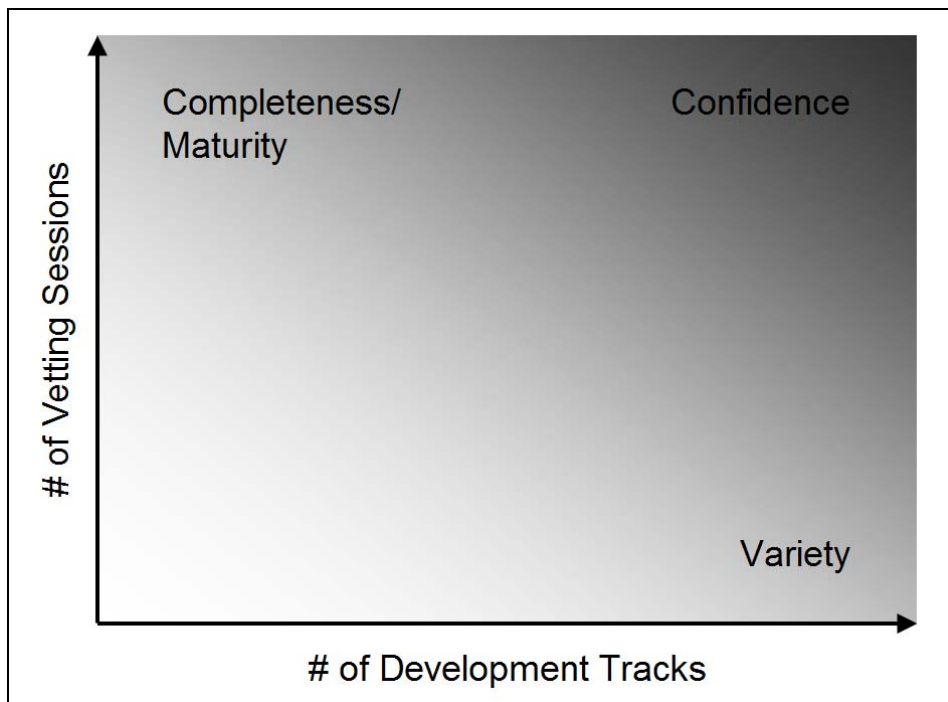


Figure 15. Conceptual outcomes of an expanded FLEX process.

Our implementation approach intentionally kept each TTP track separate until the final consensus-building step, in theory to allow each set of TTP to fully mature without external influence. Alternatively, the outputs from each KE session could be shared across tracks, effectively making every vetting session a multiple-source session. While this variation has merit, we did not test it during this effort.

In all cases, the final step of consolidating and integrating previous outputs is essential to produce one coherent, complete, and feasible TTP or solution.

CONCLUSIONS AND RECOMMENDATIONS

Future forces empowered with FCS will require streamlined, cost effective, and time efficient methods for developing new TTP. The primary goal of the current research was to develop a simulation-based KE method for forging TTP and to assess the effectiveness of the methodology as a general framework for future TTP development. The results indicate that the KE-based, simulation-driven FLEX method can produce effective TTP as rated by Soldiers. The FLEX method enables researchers to gain the perspective of how the real users, the Soldiers in the field, would employ the technologies in real-world missions. By working with Soldiers from different MOSs, as well as levels and types of field experience, investigators can develop a rich perspective of not only how these new technologies would be perceived but also how they would be used, adapted, and advanced by Soldiers.

Future forces will require integrated TTP to guide the employment of FCS capabilities. Coordinated, cohesive actions across and within echelons will be imperative. In this project,

Soldiers with different MOSs typically employed the UAS in a manner reflecting their own MOS, assigned role, level of expertise, and type of experience. Elicitation processes that include multi-echelon role players will facilitate the coordinated efforts that future forces need. Perspectives from several echelons and unique applications should be represented in the final TTP, providing both specific and generalized guidelines for employing FCS capabilities.

Established METT-TC factors will remain relevant after the advent of FCS-enabled operations. The manner in which future forces handle METT-TC factors will be greatly affected by FCS technologies that dramatically enhance warfighting capabilities. With the expected number of improvements, innovative approaches will be needed to develop and test the new technologies. Simulation vignettes provide a stable, cost effective environment to explore concepts that involve complex problem solving. They are capable of presenting many of the same types of challenges as real-world environments in real time. In fact, simulations, especially simulation-based games, are powerful learning tools because they enable learners to interact with and engage with environments that pose complex, ill-structured problems. Learners are able to visualize, interact with, and manipulate systems and variables within a complex, authentic environment (Gredler, 2004).

The flexible methodology presented in this report enables effective TTP development sessions to support future forces. The report outlines a CTA-based KE protocol that has been shown capable of producing effective TTP for FCS. It provides benchmarks for the number and type of KE sessions required to develop effective TTP. Naturally, future researchers and developers will always need to consider their specific requirements when creating a TTP development plan. They must take into account their goals, the complexity of the system being assessed, the blending of current and FCS, the likely level of participants' expertise, and other considerations.

This report provides a “proof of concept” and general framework for conducting KE sessions to develop TTP for future capabilities. The following recommendations are offered to promote effective utilization and expansion of the findings.

- ARI should take steps to disseminate the findings of this report and make the information readily available to Future Force developers.
- The Developer's Support Package should be expanded to include a comprehensive user's guide. The package should be made available to researchers and TTP developers.
- Researchers must carefully select a suitable simulation to support TTP development using the FLEX method. Mature traditional simulations or even modified game-based commercial applications may offer advantages over immature simulation software.
- Future TTP developers must screen for and select experienced, insightful, expressive participants to optimize TTP production.

- Future developers should ensure that participants understand what comprises effective TTP, including the level of detail required.
- Additional research should be conducted to examine TTP development using the FLEX method at higher echelons (e.g., battalion level).
- Researchers should explore alternative ways to examine and evaluate the quality of TTP developed during simulation-based KE sessions.
- Future research should be conducted to determine whether TTP could be developed simultaneously for multiple FCS systems/capabilities during the same KE session to accelerate the development of cohesive TTP for the Future Force.

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Appendix A

Acronyms

| | |
|---------|---|
| AETF | Army Evaluation Task Force |
| ARI | U.S. Army Research Institute for the Behavioral and Social Sciences |
| C2 | Command and Control |
| Cdr | Commander |
| CGF | Computer Generated Force |
| Co Cdr | Company Commander |
| CTA | Cognitive Task Analysis |
| FCS | Future Combat Systems |
| FFID | Future Force Integration Directorate |
| FLEX | Flexible Method of Cognitive Task Analysis |
| FRAGO | Fragmentary Order |
| KE | Knowledge Elicitation |
| M | Mean |
| MAPEX | Map Exercise |
| METT-TC | Mission, Enemy, Terrain/Weather, Troops, Time, and Civilians |
| MOS | Military Occupational Specialty |
| OF-OOS | Objective Force-OneSAF Objective System |
| OOS | OneSAF Objective System |
| OPORD | Operation Order |
| PC | Personal Computer |
| PL | Platoon Leader |
| SD | Standard Deviation |
| SME | Subject Matter Expert |
| SO3 | Spin Out 3 |
| SOP | Standing Operating Procedure |
| TEWT | Tactical Exercises without Troops |
| TTP | Tactics, Techniques, and Procedures |

TTP-C Tactics, Techniques, Procedures, and Considerations

UAS Unmanned Aircraft System

Appendix B

TTP Development Data Collection Package

NOTE TO FACILITATOR: This package is for use with participants who are conducting **TTP development ONLY**. If you are working with a group that is **reviewing/refining previous TTPs**, please use the alternate package entitled *TTP Review/Refinement Data Collection Package*.

About This Document

- This package gives facilitators an integrated set of materials to use in controlling activities and capturing data.
- Please consult the basic *Implementation Plan* for specific directions regarding the overall KE process.
- The goal of the KE process is to focus participants' attention on relevant aspects of a vignette to foster development of TTPs. (A vignette is a brief scenario designed to run in simulation and elicit participants' thoughts, actions, and decisions).
- The KE process involves multiple steps that take the participants through a tactical situation and capture their ideas regarding appropriate TTPs.
- The questions in this protocol are designed to elicit information about cues, planning factors, critical decisions, and warfighting TTPs.
- This package structures your note-taking activities. Please record all observations, comments, and key points on the pages of this package.
- Be sure to use the Procedural Problems Log to record circumstances that may impact interpretation of the data, such as missing participants.

Date _____ Facilitator _____

Installation _____ Group # _____

Group Function: Dvlpt / Vetting Sub-group Role: Commander (Cdr) /
PLs

**Place Participants'
ID label(s) here**

Step 1: Complete Checklist and Equipment Testing

NOTE TO FACILITATOR: Be sure to complete this step early enough to resolve any issues prior to participant arrival.

FLEX TTP Checklist for Materials and Equipment Testing

General Materials

- _____ Three-hole punch
- _____ Watch or clock
- _____ Backup drive for audio files
- _____ Software for audio recorders
- _____ Digital camera capable of downloading images via Universal Serial Bus cable
- _____ Digital audio recorders (2-4), batteries and microphones; recorder-to-PC cable
- _____ Previous files downloaded
- _____ Tested, volume adjusted

Materials for Technical Support Team

- _____ Technical Problems Log (hardcopy)
- _____ Five networked OneSAF objective system (OOS) workstations
- _____ Tactical Vignette Materials including OOS files
- _____ Vignettes cued, volume adjusted

Materials for Participants

- _____ Tactical communication emulators tested and volume adjusted
- _____ Poster paper/easel for participants to use in developing TTPs
- _____ Pens and/or markers
- _____ Participant Binders (x4), each containing:
 - _____ Tactical Vignette Materials (hardcopy)
 - _____ Orientation (project overview, FCS/Spin Out (SO)3 intro, UAS capabilities, etc.)
 - _____ Schedule of events
 - _____ Participant Profile Questionnaire
 - _____ Sample TTP
 - _____ TTPs from previous sessions (Refinement groups only)
 - _____ Participant worksheets for writing TTPs
 - _____ Participant Feedback Questionnaire
 - _____ Blank paper for writing notes

Materials for Facilitators

- _____ Master Participant Chart (one hardcopy)
- _____ Participant ID labels (4 sets)
 - _____ Placed on appropriate booklets and forms
- _____ Session Schedule (x2)
- _____ Knowledge Elicitation Protocol (x2)
- _____ Data Collection Package (x2)
- _____ Procedural Problems Log (x2)

Step 2: Welcome Participants

1. **WELCOME:** Exercise director says, “Welcome to the Army Research Institute’s future-focused TTP development project. My name is ____ and my associates are ____, ____, and _____. The goal of this project is to develop tactics, techniques, and procedures, or TTPs, for employing an FCS unmanned aircraft system, or UAS. You will learn more about UASs in your orientation materials. Part of ARI’s research program supports transformation. To develop the UAS TTPs, we are asking you to role-play your assigned position in several scenario-based simulation vignettes. While watching a vignette play out on a computer workstation, you will direct the workstation operator on the course of action to take for a given situation. Simultaneously, we want you to share with us aloud your thoughts and decisions regarding a chosen course of action and how a UAS could best be employed to assist you in completing your mission. We may ask you questions from time to time. Overall, the session will take approximately 8 hours of your time. We would like to thank you upfront for your participation in this important project. Our ultimate goal is to enhance force effectiveness in the Global War on Terror. Do you have any questions?”

If you open your binder you will see a brief overview of today’s schedule:

| Schedule | Tasks |
|-----------|------------------------------|
| 0830-0900 | Welcome |
| 0900-1030 | Orientation/Practice Session |
| 1030-1130 | Complete Vignette 1 (break) |
| 1130-1230 | Complete Vignette 2 (break) |
| 1230-1330 | LUNCH |
| 1330-1430 | Complete Vignette 3 (break) |
| 1430-1530 | Complete Vignette 4 (break) |
| 1530-1630 | Summary Review |
| 1630-1645 | Wrap Up |

“We will have regular breaks, and the location of the restrooms are _____. If you have other specific needs, please let us know.”

Step 3: Complete Participant Profile Questionnaire

INSTRUCTIONS TO FACILITATOR: Familiarize the participants with their binders. Start with the list of contents and talk them through the Tabs, including the Worksheets and blank paper at the end. Answer any questions.

Instructions to Participants: *“Please turn to the Participant Profile Questionnaire in your binder. This questionnaire asks you for information on specific types of training and experiences you have had in the Army. Please respond with as much detail as you can, and let me know if you have questions.”*

NOTE TO FACILITATOR: Be sure to review participant responses to verify that the information is complete. If some of their responses are incomplete, ask them to respond orally and record their responses.

Step 4: Orientation

NOTE TO FACILITATOR: The *Vignette* and *Orientation* materials in the participant binders are for their use at any time. The materials include tactical materials (e.g., OPORD, maps, FRAGOs), project overview, FCS/SO3 introduction, list of UAS capabilities, agenda, etc.

Instructions to Participants: *“The materials in your binder are available for your use as you work through the simulation vignettes. Right now, we want you to view the multimedia Orientation on your workstation and ask questions as you go along.”*

The workstation operators help each participant start the Orientation and answer questions as they arise. After the last participant finishes, the exercise director asks for questions.

Once all participants' questions have been answered, the exercise director provides the following directions for the vignettes.

- a. *“You are going to watch several simulation vignettes in which an FCS UAS could be employed. As you role-play your assigned position, please describe your reactions, thoughts, and decisions as you work to complete the mission while you direct the workstation operator. We are supplying devices to emulate tactical communication. We will be audio recording your verbal responses and analyzing the content. It is important that you think aloud as you work and try to explain your decisions and actions throughout the vignette.*
- b. *Feel free to consult the materials in your binders as needed. There is no time limit, but please move along in order to stay on schedule.*
- c. *Immediately following each vignette, we will conduct a brief review and ask you to develop (or review and vet) some TTPs.*

- i. For those participants who are developing TTPs: “*You have a sample set of TTPs in your binder materials. Please use them as a model to develop your own. Take a moment to review them now before we begin.*” (See Step 1 of KE Protocol)
 - ii. For those participants who are reviewing/refining TTPs: “*You have a set of previously developed TTPs for UASs in your binder materials. You will be reviewing and refining these based on your own experience in the simulation vignettes. Take a moment to look over these now before we begin.*” (See Step 1 of KE Protocol)
- d. Do you have any questions? (Facilitators respond to questions.)

Step 5: Practice Vignette

Instructions to Participants: To familiarize you with the vignettes, we’re going to conduct a practice event. Feel free to ask questions as we go along. As you execute your assigned role, remember to verbalize your thoughts and actions so we know what you’re doing and why. When I ask a question, try to answer it as best you can. Please be thinking about the TTPs that would be appropriate, even though we won’t be developing TTPs for this practice vignette.

NOTE TO FACILITATOR: Let the participant(s) get a feel for the simulation for the first 10 minutes, then start asking questions from the list below. Help them understand the simulation environment and their role in the TTP development process. Record notes about things you want to explain at the end of the practice event.

1. What are you paying attention to in this situation? (*observations/cues*)
2. What factors are you considering as you plan a course of action? (*factors*)
3. What is the best course of action to take at this point and why? (*key decision*)
4. What is influencing the approach you take? (*tactic*)
5. What technique/s are you using at this point to achieve the mission? (*technique*)
6. Is there a specific procedure that you would follow at this point? (*procedure*)

At the end of the practice event:

- Facilitator asks the participant(s) what questions they have about the simulation, the vignette, their tactical role, or thinking aloud.
- Facilitator uses notes made during the vignette to clarify or explain how the participant(s) should be role-playing and thinking aloud.
- Give the participant(s) a 5-minute break while the research team prepares for the first TTP development run.

Step 6: Think-Aloud Prompts for Vignette 1

Facilitator's Action: Turn on audio recorder! State date, installation, group number, and vignette number.

Instructions to Participants: We are now ready to work through the first simulation vignette. Your job is to role-play in character and verbalize your thoughts and actions so we can better understand your warfighting process. I may ask you a few questions to help you think aloud. If you find it hard to respond to a question while you are engaged with the simulation, continue working through the vignette and answer at a later time that works best for you.

NOTE TO FACILITATOR: Be sure to cycle through each of these questions as the participant reaches key decision points. Record the participant's responses to each question on this form. While interactions/dialogue will be audio-recorded, having your notes will speed the data analysis process. **Make sure recorder(s) are on!**

1. What are you paying attention to in this situation? (*observations/cues*)
2. What factors are you considering as you plan a course of action? (*factors*)
3. What is the best course of action to take at this point and why? (*key decision*)
4. What is influencing the approach you take? (*tactic*)
5. What technique/s are you using at this point to achieve the mission? (*technique*)
6. Is there a specific procedure that you would follow at this point? (*procedure*)

KE Think-Aloud Data Collection Form

| <i>Vignette 1</i> | <i>Think Aloud Data</i> |
|---|-------------------------|
| <ol style="list-style-type: none"> <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <ol style="list-style-type: none"> <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <ol style="list-style-type: none"> <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <p><i>Notes:</i></p> | |

Step 7: Developing UAS TTPs for Vignette 1

Instructions to Participants: “In your binders you will find the sample TTP and a worksheet for Vignette 1 (Handout). Please take about 5 minutes and brainstorm a set of TTPs for employing the UAS. In developing your TTPs, you should use the sample but not be limited by its format or structure. Please develop a set of TTPs that would enable you to optimally employ a UAS in the situation simulated in this vignette. Also, please consider the factors listed in your worksheet as they relate to employing a UAS in the situation simulated in this vignette. After you write down your ideas, we will discuss them together.”

INSTRUCTIONS TO FACILITATOR: When the participant(s) finish writing, discuss the details of their TTPs using the following questions.

- 1a. What are the TTPs you just brainstormed for this vignette?
- 1b. How do these TTPs differ from what you planned at the start of the vignette?
2. How would the following factors influence the TTPs?
 - a. Time available
 - b. Troops available
 - c. Different types of terrain
 - d. Presence and location of enemy
 - e. Presence and location of civilians
 - f. Other factors identified by the participant(s)
3. Given the mission you just completed, what are some negative outcomes that might result from using a UAS? How could these be avoided?
4. Looking at your TTPs in light of the factors just discussed, what would you add or change?
5. What capabilities and/or attributes does the UAS need to support mission accomplishment?

INSTRUCTIONS TO FACILITATOR: Summarize the TTPs for the participant(s) and ask for final adjustments. Then assemble all participants for a short AAR.

Facilitator's Action: Turn off audio recorder.

NOTE: Materials for Steps 8-13 (Vignettes 2-4) are identical to those for Steps 6-7 (Vignette 1) and are omitted from this document for the sake of brevity.

You have completed all vignettes.

Step 14: Summary Review

INSTRUCTIONS TO FACILITATOR: This stage of the process follows completion of the last vignette. Please assemble all participants into one group and discuss the following questions.

1. How will the use of a UAS vary by:
 - a. Different types of missions?
 - b. Time available?
 - c. Different types of terrain?
 - d. Troops available?
 - e. Presence and location of enemy?
 - f. Presence and location of civilians?
2. What capabilities should the UAS be equipped with to allow it to optimally perform in the field?
3. Should there be some overlap from one UAS sweep to another? If so, how much?
4. Is there a specific order in which areas should be observed by the UAS? If so, what should this order be?
5. What factors determine or influence the surveillance sequence?
6. What type of target location method(s) would be optimally suited for a UAS? (Examples include grid coordinates, polar coordinates, shift from known point, or other.)

7. Would there be a difference in how a UAS would be used by a platoon versus a company?
8. What are the key concepts a leader must be aware of for optimal use of the UAS?
9. If you were provided with a UAS, in what situations would you use it? In what situations would you hesitate to use it or even avoid using it?
10. What else would you consider in using a UAS? Why?
11. Please briefly review the TTPs you developed for each vignette. Would you make any changes to the TTPs? If yes, what would you change?
12. Do you have any comments on the TTP development method or this session in general?

Step 15: Participant Feedback Questionnaire

Instructions to Participants: “If you would now turn in your binder to the FLEX TTP Participant Feedback questionnaire, please fill out the questionnaire. It should take only a few minutes but we would really appreciate it if you would take your time and provide us with thoughtful responses.”

Step 16. Wrap Up

- Facilitators collect all materials from participants.
- Exercise director answers final questions and explains research payoff.
- Exercise director thanks participants and releases them.
- KE facilitators download digital audio files to computer and turn off recorders.
- Facilitators label and file all paperwork in appropriate folders.

End of Session

Development Worksheet (Participant)

Worksheet: Developing UAS TTPs for Vignette 1 (Cordon & Search)

Instructions: Now that you have completed the vignette, we would like you to write down your TTPs for employing the UAS. The following steps will help you do this.

1. First examine the sample TTP. In developing your TTP, you should use this model but not be limited by its format or structure. Please write down the TTPs that would enable you to optimally employ a UAS in the situation simulated in this vignette.

The TTPs you develop should address the following factors as well as any other factors you consider to be important.

- a. Time available
- b. Troops available
- c. Different types of terrain
- d. Presence and location of enemy
- e. Presence and location of civilians

2. Given the goal of the mission you just completed, what are some negative outcomes that might result from using a UAS? How might these be avoided?

3. What would you add or change at this point?

4. What capabilities and/or attributes does the UAS need to support mission accomplishment?

NOTE: Participant worksheets for Vignettes 2-4 are identical to those for Vignette 1 and are omitted from this document for the sake of brevity.

Appendix C

TTP Review/Refinement Data Collection Package

NOTE TO FACILITATOR: This package is for use with participants who are conducting **Single-Source or Multi-Source TTP review/refinement ONLY**. If you are working with a group that is doing **TTP Development**, please use the alternate package entitled *TTP Development Data Collection Package*.

About This Document

- This package gives facilitators an integrated set of materials to use in controlling activities and capturing data.
- Please consult the basic *Implementation Plan* for specific directions regarding the overall KE process.
- The goal of the KE process is to focus participants' attention on relevant aspects of a vignette to foster development of TTPs. (A vignette is a brief scenario designed to run in simulation and elicit participants' thoughts, actions, and decisions).
- The KE process involves multiple steps that take the participants through a tactical situation and capture their ideas regarding appropriate TTPs.
- The questions in this protocol are designed to elicit information about cues, planning factors, critical decisions, and warfighting TTPs.
- This package structures your note-taking activities. Please record all observations, comments, and key points on the pages of this package.
- Be sure to use the Procedural Problems Log to record circumstances that may impact interpretation of the data, such as missing participants.

Date _____ Facilitator _____

Installation _____ Group # _____

Group Function: Dvlpt / Vetting Sub-group Role: Cdr / PLs

**Place Participants'
ID label(s) here**

Step 1: Complete Checklist and Equipment Testing

NOTE TO FACILITATOR: Be sure to complete this step early enough to resolve any issues prior to participant arrival.

FLEX TTP Checklist for Materials and Equipment Testing

General Materials

- _____ Three-hole punch
- _____ Watch or clock
- _____ Backup drive for audio files
- _____ Software for audio recorders
- _____ Digital camera capable of downloading images via USB cable
- _____ Digital audio recorders (2-4), batteries and microphones; recorder-to-PC cable
- _____ Previous files downloaded
- _____ Tested, volume adjusted

Materials for Technical Support Team

- _____ Technical Problems Log (hardcopy)
- _____ Five networked OOS workstations
- _____ Tactical Vignette Materials including OOS files
- _____ Vignettes cued, volume adjusted

Materials for Participants

- _____ Tactical communication emulators tested and volume adjusted
- _____ Poster paper/easel for participants to use in developing TTPs
- _____ Pens and/or markers
- _____ Participant Binders (x4), each containing:
 - _____ Tactical Vignette Materials (hardcopy)
 - _____ Orientation (project overview, FCS/SO3 intro, UAS capabilities, etc.)
 - _____ Schedule of events
 - _____ Participant Profile Questionnaire
 - _____ Sample TTP
 - _____ TTPs from previous sessions (Refinement groups only)
 - _____ Participant worksheets for writing TTPs
 - _____ Participant Feedback Questionnaire
 - _____ Blank paper for writing notes

Materials for Facilitators

- _____ Master Participant Chart (one hardcopy)
- _____ Participant ID labels (4 sets)
 - _____ Placed on appropriate booklets and forms
- _____ Session Schedule (x2)
- _____ Knowledge Elicitation Protocol (x2)
- _____ Data Collection Package (x2)
- _____ Procedural Problems Log (x2)

Step 2: Welcome Participants

2. **WELCOME:** Exercise director says, “Welcome to the Army Research Institute’s future-focused TTP development project. My name is ____ and my associates are _____, _____, and _____. The goal of this project is to develop tactics, techniques, and procedures, or TTPs, for employing an FCS unmanned aircraft system, or UAS. You will learn more about UASs in your orientation materials. Part of ARI’s research program supports transformation. To develop the UAS TTPs, we are asking you to role-play your assigned position in several scenario-based simulation vignettes. While watching a vignette play out on a computer workstation, you will direct the workstation operator on the course of action to take for a given situation. Simultaneously, we want you to share with us aloud your thoughts and decisions regarding a chosen course of action and how a UAS could best be employed to assist you in completing your mission. We may ask you questions from time to time. Overall, the session will take approximately 8 hours of your time. We would like to thank you upfront for your participation in this important project. Our ultimate goal is to enhance force effectiveness in the Global War on Terror. Do you have any questions?”

If you open your binder you will see a brief overview of today’s schedule:

| Schedule | Tasks |
|-----------|------------------------------|
| 0830-0900 | Welcome |
| 0900-1030 | Orientation/Practice Session |
| 1030-1130 | Complete Vignette 1 (break) |
| 1130-1230 | Complete Vignette 2 (break) |
| 1230-1330 | LUNCH |
| 1330-1430 | Complete Vignette 3 (break) |
| 1430-1530 | Complete Vignette 4 (break) |
| 1530-1630 | Summary Review |
| 1630-1645 | Wrap Up |

“We will have regular breaks, and the location of the restrooms are _____. If you have other specific needs, please let us know.”

Step 3: Complete Participant Profile Questionnaire

INSTRUCTIONS TO FACILITATOR: Familiarize the participants with their binders. Start with the list of contents and talk them through the Tabs, including the Worksheets and blank paper at the end. Answer any questions.

Instructions to Participants: *“Please turn to the Participant Profile Questionnaire in your binder. This questionnaire asks you for information on specific types of training and experiences you have had in the Army. Please respond with as much detail as you can, and let me know if you have questions.”*

NOTE TO FACILITATOR: Be sure to review participants' responses to verify that the information is complete. If some of their responses are incomplete, ask them to respond orally and record their responses.

Step 4: Orientation

NOTE TO FACILITATOR: The *Vignette* and *Orientation* materials in the participant binders are for their use at any time. The materials include tactical materials (e.g., OPORD, maps, FRAGOs), project overview, FCS/SO3 introduction, list of UAS capabilities, agenda, etc.

Instructions to Participants: *“The materials in your binder are available for your use as you work through the simulation vignettes. Right now, we want you to view the multimedia Orientation on your workstation and ask questions as you go along.”*

The workstation operators help each participant start the Orientation and answer questions as they arise. After the last participant finishes, the exercise director asks for questions.

Once all participants' questions have been answered, the exercise director provides the following directions for the vignettes.

- a. *“You are going to watch several simulation vignettes in which an FCS UAS could be employed. As you role-play your assigned position, please describe your reactions, thoughts, and decisions as you work to complete the mission while you direct the workstation operator. We are supplying devices to emulate tactical communication. We will be audio recording your verbal responses and analyzing the content. It is important that you think aloud as you work and try to explain your decisions and actions throughout the vignette.*
- b. *Feel free to consult the materials in your binders as needed. There is no time limit, but please move along in order to stay on schedule.*
- c. *Immediately following each vignette, we will conduct a brief review and ask you to review and refine some TTPs developed by earlier Soldiers. You have a set of previously*

- d. *developed TTPs for UASs in your binder materials. You will be reviewing and refining these based on your own experience in the simulation vignettes. Take a moment to look over these now before we begin.*” (See Step 1 of KE Protocol)
- e. *Do you have any questions?* (Facilitators respond to questions.)

Step 5: Practice Vignette

Instructions to Participants: To familiarize you with the vignettes, we’re going to conduct a practice event. Feel free to ask questions as we go along. As you execute your assigned role, remember to verbalize your thoughts and actions so we know what you’re doing and why. When I ask a question, try to answer it as best you can. Please be thinking about the TTPs that would be appropriate, even though we won’t be developing TTPs for this practice vignette.

NOTE TO FACILITATOR: Let the participant(s) get a feel for the simulation for the first 10 minutes, then start asking questions from the list below. Help them understand the simulation environment and their role in the TTP development process. Record notes about things you want to explain at the end of the practice event.

1. What are you paying attention to in this situation? (observations/cues)
2. What factors are you considering as you plan a course of action? (factors)
3. What is the best course of action to take at this point and why? (key decision)
4. What is influencing the approach you take? (tactic)
5. What technique/s are you using at this point to achieve the mission? (technique)
6. Is there a specific procedure that you would follow at this point? (procedure)

At the end of the practice event:

- Facilitator asks the participant(s) what questions they have about the simulation, the vignette, their tactical role, or thinking aloud.
- Facilitator uses notes made during the vignette to clarify or explain how the participant(s) should be role-playing and thinking aloud.
- Give the participant(s) a 5-minute break while the research team prepares for the first TTP review/refinement run.

Step 6: Think-Aloud Prompts for Vignette 1

Instructions to Participants: We will work with TTPs that have been developed by another group of Soldiers. Briefly study these TTPs, as you will be reviewing and refining them after you complete the simulation vignette.

Facilitator's Action: Turn on audio recorder! State date, installation, group number, and vignette number.

Instructions to Participants: We are now ready to work through the first simulation vignette. Your job is to role-play in character and verbalize your thoughts and actions so we can better understand your warfighting process. I may ask you a few questions to help you think aloud. If you find it hard to respond to a question while you are engaged with the simulation, continue working through the vignette and answer at a later time that works best for you.

NOTE TO FACILITATOR: Be sure to cycle through each of these questions as the participant reaches key decision points. Record the participant's responses to each question on the following page. While interactions/dialogue will be audio-recorded, having your notes will speed the data analysis process. **Make sure recorder is on!**

1. Have the TTPs accounted for all of the important factors/cues associated with this situation? (*observations/cues*)
2. Have the TTPs outlined the best course of action to take at this point and why? (*key decision*)
3. What is influencing the approach you take? (*tactic*)
4. Are the technique/s outlined in the TTPs enabling you to achieve the mission at this point in time? (*technique*)
5. Are the procedures that you are following according to the TTPs at this point effective? (*procedure*)

KE Think Aloud Data Collection Form

| <i>Vignette 1</i> | <i>Think Aloud Data</i> |
|---|-------------------------|
| <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <i>1. Observations/Cues</i> <i>2. Factors Considered</i> <i>3. Key Decision</i> <i>4. Tactic</i> <i>5. Technique</i> <i>6. Procedure</i> | |
| <i>Notes:</i> | |

Step 7: Review/Refinement of Previous TTPs for Vignette 1

Instructions to Participants: “In your binders you will find a Worksheet to use for recording your thoughts about the previously generated TTPs for Vignette 1. As you review the set of TTPs, please consider the actions you took in the simulation vignette and determine how you would change or add to this set of TTPs. After you write down your ideas, we will discuss them together.”

INSTRUCTIONS TO FACILITATOR: When the participant(s) finish their worksheet, discuss their ideas using the following questions.

1. What are your main thoughts about the TTPs?
2. Do the TTPs adequately address:
 - a. Time available?
 - b. Troops available?
 - c. Different types of terrain?
 - d. Presence and location of enemy?
 - e. Presence and location of civilians?
 - f. Other factors identified by the participant(s)?
3. What are your primary suggestions for improving the TTPs?
4. Given the mission you just completed, what are some negative outcomes that might result from using a UAS? How could these be avoided?
5. What capabilities and/or attributes does the UAS need to support mission accomplishment?

INSTRUCTIONS TO FACILITATOR: Summarize the discussion and ask for final adjustments. Then assemble all participants for a short AAR.

Facilitator's Action: Turn off audio recorder.

NOTE: Materials for Steps 8-13 (Vignettes 2-4) are identical to those for Steps 6-7 (Vignette 1) and are omitted from this document for the sake of brevity.

You have completed all vignettes.

Step 14: Summary Review

INSTRUCTIONS TO FACILITATOR: This stage follows completion of the last vignette. Please assemble all participants into one group and discuss the following questions.

1. How will the use of a UAS vary by:
 - a. Different types of missions?
 - b. Time available?
 - c. Different types of terrain?
 - d. Troops available?
 - e. Presence and location of enemy?
 - f. Presence and location of civilians?
2. What further thoughts do you have about attributes/components needed by the UAS to fully support mission accomplishment?
3. Is there a specific order in which areas should be observed by the UAS? If so, what should this order be?
4. What factors play into or influence the surveillance sequence?
5. What type of target location method(s) would be optimally suited for a UAS? (Examples include grid coordinates, polar coordinates, shift from known point, or other.)
6. Would there be a difference in how a UAS would be used by a platoon versus a company?

7. What are the key concepts a leader must be aware of to optimally use the UAS?
8. If you were provided with a UAS, in what situations would you use it? In what situations would you hesitate to use it or even avoid using it?
9. Consider the following procedural aspects of UAS employment:
 - a. What conditions determine whether to use a UAS or not?
 - b. How many do you fly; how high does it fly; how fast does it move; what flight pattern do you program; and who controls the UAS during execution of a mission?
 - c. Where should the UASs be located in relation to ground forces?
10. What else would you consider in using a UAS? Why?
11. Please briefly review your revised TTPs for each vignette. Would you make further changes? If yes, what would you change?
12. Do you have any comments on the TTP development method or this session in general?

Step 15: Participant Feedback Questionnaire

Instructions to Participants: “If you would now turn to the Participant Feedback questionnaire, please fill out the questionnaire. It should take only a few minutes but we would really appreciate it if you would take your time and provide us with thoughtful responses.”

Step 16. Wrap Up

- Facilitators collect all materials from participants.
- Exercise director answers final questions and explains research payoff.
- Exercise director thanks participants and releases them.
- KE facilitators download digital audio files to computer and turn off recorders.
- Facilitators label and file all paperwork in appropriate folders.

End of Session

Review/Refinement Worksheet (Participant)

NOTE TO FACILITATOR: This worksheet is for use with participants who are conducting **Single-Source or Multi-Source TTP review/refinement ONLY**. If you are working with a group that is doing **TTP Development** please use the alternate data collection package found in Development Data Collection Package.

Mission 1: Cordon & Search

Original TTP Summary:

Following the simulation, please specify if the following TTP should be:

K-kept as is

M-modified

D-deleted

If you want to **Keep** the item as is, specify why. What factors make it good?

If you want to **Modify** the item, just below that item explain why it needs to be changed. How does changing it improve it?

If you want to **Delete** an item, specify the shortcomings of that item.

Please circle one

1. Mission:

a. Tactic: _____

K M D

b. Technique: _____

K M D

c. Procedure: _____

K M D

d. Consideration: _____

K M D

2. Enemy:

a. Tactic: _____

K M D

b. Technique: _____

K M D

c. Procedure: _____ **K M D**

d. Consideration: _____ **K M D**

3. Terrain:

a. Tactic: _____ **K M D**

b. Technique: _____ **K M D**

c. Procedure: _____ **K M D**

d. Consideration: _____ **K M D**

4. Troops:

a. Tactic: _____ **K M D**

b. Technique: _____ **K M D**

c. Procedure: _____ **K M D**

d. Consideration: _____ **K M D**

5. Time:

a. Tactic: _____ **K M D**

b. Technique: _____ **K M D**

c. Procedure: _____ **K M D**

d. Consideration: _____ **K M D**

6. Civilians:

a. Tactic: _____ **K M D**

b. Technique: _____ **K M D**

c. Procedure: _____

K M D

d. Consideration: _____

K M D

Please rate the overall effectiveness of these TTPs (1-100%): _____

Explain your rating:

New TTP Summary:

List desired capabilities:

NOTE: Participant worksheets for Vignettes 2-4 are identical to those for Vignette 1 and are omitted from this document for the sake of brevity.

Appendix D

Flex TTP Participant Feedback Questionnaire

Date _____ Participant # _____ Group # _____ Role: Cdr / PL Development / Vetting

Instructions: The questions below ask for your opinions about the materials and tools you used today to develop future-focused TTPs. Write-in comments, both positive and negative, are encouraged. Please use a separate sheet of paper if you need additional space.

| 1. How much do you agree or disagree that the <u>Orientation</u>: | Circle One for Each Item | | | | |
|--|--------------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| a. Set the stage well for the session? | 1 | 2 | 3 | 4 | 5 |
| b. Provided everything I needed to know about the method? | 1 | 2 | 3 | 4 | 5 |
| c. Contained accurate information about FCS Spin Out 3 capabilities? | 1 | 2 | 3 | 4 | 5 |
| d. Was clearly presented and easy to understand? | 1 | 2 | 3 | 4 | 5 |
| Comments and Suggestions: | | | | | |
| | | | | | |

| 2. How much do you agree or disagree that the <u>Vignettes</u>: | Circle One for Each Item | | | | |
|--|--------------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| a. Set realistic conditions for thinking thru UAS employment? | 1 | 2 | 3 | 4 | 5 |
| b. Caused me to consider and decide among courses of action? | 1 | 2 | 3 | 4 | 5 |
| c. Covered a reasonable mix of missions? | 1 | 2 | 3 | 4 | 5 |
| d. Portrayed realistic enemy organizations and doctrine/tactics? | 1 | 2 | 3 | 4 | 5 |
| e. Provided sound tactical materials (road to war, OPORD, FRAGOs)? | 1 | 2 | 3 | 4 | 5 |
| f. Were clearly presented and easy to understand? | 1 | 2 | 3 | 4 | 5 |
| Comments and Suggestions: | | | | | |
| | | | | | |

| 3. How much do you agree or disagree that the <u>Simulation</u>: | Circle One for Each Item | | | | |
|---|--------------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| a. Portrayed the tactical environment with sufficient realism? | 1 | 2 | 3 | 4 | 5 |
| b. Demonstrated the UAS capabilities adequately? | 1 | 2 | 3 | 4 | 5 |
| c. Represented enemy elements and capabilities realistically? | 1 | 2 | 3 | 4 | 5 |
| d. Gave me enough control and flexibility of my unit's behaviors? | 1 | 2 | 3 | 4 | 5 |
| e. Enabled me to visualize the battlefield well? | 1 | 2 | 3 | 4 | 5 |
| f. Adequately supported tactical communications? | 1 | 2 | 3 | 4 | 5 |
| Comments and Suggestions: | | | | | |
| | | | | | |

| 4. How much do you agree or disagree that the <u>Schedule</u> : | Circle One for Each Item | | | | |
|---|--------------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| a. Took too long for the TTPs we developed? | 1 | 2 | 3 | 4 | 5 |
| b. Asked me to do too much in the time I had available? | 1 | 2 | 3 | 4 | 5 |
| c. Allocated the right amount of time for the various activities? | 1 | 2 | 3 | 4 | 5 |
| d. Enabled me to spend my time efficiently? | 1 | 2 | 3 | 4 | 5 |
| e. Organized my activities in the right sequence? | 1 | 2 | 3 | 4 | 5 |
| f. Gave me enough break time when I needed it? | 1 | 2 | 3 | 4 | 5 |
| Comments and Suggestions: | | | | | |
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| 5. How much do you agree or disagree that the <u>Procedures</u> : | Circle One for Each Item | | | | |
|---|--------------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| a. Facilitated development of sound TTPs? | 1 | 2 | 3 | 4 | 5 |
| b. Encouraged me to explore all aspects of the TTPs? | 1 | 2 | 3 | 4 | 5 |
| c. Achieved a good balance between role-playing and thinking aloud? | 1 | 2 | 3 | 4 | 5 |
| d. Enabled me to work effectively with the right focus? | 1 | 2 | 3 | 4 | 5 |
| e. Captured my thoughts and insights accurately? | 1 | 2 | 3 | 4 | 5 |
| f. Gave me a chance to fully express myself? | 1 | 2 | 3 | 4 | 5 |
| g. Took advantage of group interaction and collaboration? | 1 | 2 | 3 | 4 | 5 |
| Comments and Suggestions: | | | | | |
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| 6. What are your general impressions of the TTP development method you used today? |
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| 7. How would you improve the TTP development method you used today? |
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