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THE USE OF ADVANCED WARFIGHTING EXPERIMENTS TO SUPPORT ACQUISITION DECISIONS

by

Kenneth W. Strayer

December 1999

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This research effort focused on the use of Advanced Warfighting Experiments (AWEs) to support acquisition decisions. Specifically, the thesis evaluated the effectiveness of the Army Task Force XXI AWE in providing information to support investment decisions and refinement of requirements for information age technologies.

A detailed analysis of the 1997 Operational Test and Evaluation Command (OPTEC) Live Experiment Assessment Report identified program developmental recommendations. Data were collected from appropriate program offices and user representatives to determine the perceived utility of the recommendations and level of implementation. Qualitative data detailing why specific recommendations were or were not implemented were used to determine the contributing factors to a program's ability to benefit from participation in the experiment.

Overall, fifty-two percent of the OPTEC recommendations were reported as either fully or mostly implemented. Other potential benefits of AWE participation were identified to include (1) marketing and exposure of program, (2) refinement of user requirements, and (3) information on integration, interfaces, and interoperabilty. Risks from participation in the AWE included (1) a poor return on investment, (2) potential negative exposure, and (3) extensive changes in requirements. Recommendations to enhance the value of participation in AWEs are included.

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THE USE OF ADVANCED WARFIGHTING EXPERIMENTS TO SUPPORT ACQUISITION DECISIONS

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I. INTRODUCTION

> The principle of science, the definition, almost, is the following: *The test of all knowledge is experiment.* Experiment is the *sole judge* of scientific 'truth.' But what is the source of knowledge? Where do the laws that are to be tested come from? Experiment, itself, helps to produce these laws, in the sense that it gives us hints. But also needed is *imagination* to create from these hints the great generalizations—to guess at the wonderful, simple, but very strange patterns beneath them all, and then to experiment to check again whether we have made the right guess. [Feynman, 1995, p2]

A. BACKGROUND

From March 1996 through October 1997, the Army conducted the Task Force XXI Advanced Warfighting Experiment (TF XXI AWE), culminating with a live exercise at the National Training Center, during Rotation 97-06, March 1997. The purpose for conducting the AWE was to provide sufficient data to validate digitizing the battlefield and support credible assessments on which to base future procurement decisions. The TF XXI AWE was meant to be a tool for resolving issues and reducing risk early in the program development process and determining the adequacy of requirements, design, and new system capabilities before committing major resources. A total of ninety-three TF XXI new technology initiatives were initially included in the AWE.

The stated TF XXI AWE objectives include experimenting with advanced technologies and concepts that leverage capabilities of information age technologies and providing information to support investment decisions on the most promising initiatives [ECC, 1996]. The AWE was also meant to help the U.S. Army Training and Doctrine Command (TRADOC) refine requirements and develop solutions for Force XXI. The final Live Experiment Assessment Report, prepared by the U.S. Army Operational Test and Evaluation Command, included full assessments of most participating TF XXI initiatives. OPTEC provided observations and specific developmental recommendations for each initiative. AWE documentation does not directly address the purpose and goals of the experimental process as it relates to the acquisition program manager. This thesis attempts to partially define goals and objectives for the program manager to consider when presented with the opportunity to participate in an AWE.

B. PURPOSE

This thesis studies the use of Advanced Warfighting Experiments to support material acquisition decisions. Specifically, the thesis evaluates the effectiveness of the Army Task Force XXI Advanced Warfighting Experiment (TF XXI AWE) objective of providing information to support investment decisions and refinement of requirements for information age technologies. Research includes a detailed analysis of the 1997 Operational Test and Evaluation Command (OPTEC) Live Experiment Assessment Report to identify program developmental recommendations. Data were collected from appropriate program offices and user representatives to determine the perceived utility of the recommendations and level of implementation. Subjective data detailing why specific recommendations were or were not implemented were used to determine the contributing factors to a program's ability to benefit from participation in the experiment. The thesis includes recommendations on how to best use Advanced Warfighting Experiments to support the acquisition program manager.

C. SCOPE

The scope of this thesis is limited in that it concentrates on the 1997 Task Force XXI Advanced Warfighting Experiment and no previous or subsequent experiments. Only initiatives with detailed recommendations provided by OPTEC were considered. The research does not include an analysis of the Joint Venture XXI doctrinal initiatives or organizational change initiatives but only the developmental program recommendations. This thesis will not determine the advantages or disadvantages of the AWE process beyond the support of acquisition decisions. The results of the research do not determine the overall success or failure of the TF XXI AWE. However, it concentrates on material acquisition issues, the immediate use of OPTEC recommendations for initiative development, and the contributing factors behind the use or non-use of those recommendations.

D. RESEARCH QUESTIONS

1. What were the objectives of the Army's Task Force XXI Advanced Warfighting Experiment, what was the structure of the experiment, and how was information gained from the experiment used in making acquisition decisions?

2. Were the specific recommendations derived from the Task Force XXI Advanced Warfighting Experiment (AWE) used to support investment decisions and to refine requirements of participating initiatives?

3. What were the contributing factors to a program's ability to benefit from participation in the Advanced Warfighting Experiment?

4. What are the characteristics of programs that are best positioned to gain valued investment and requirements information from participation in Advanced Warfighting Experiments?

E. METHODOLOGY

The methodology used in this thesis will consist of the following steps.

1. Conduct a literature search of books, magazine articles, CD-ROM systems, internet and other library information resources.

2. Conduct a thorough review of the TF XXI AWE Experiment Plan and OPTEC Live Experiment Assessment Report.

3. Creation of tailored surveys for each program initiative and dissemination to each applicable program office and user.

4. Follow up interviews of pertinent program managers, users, and test officials.

5. Conduct a statistical analysis of collected data regarding implementation of initiative recommendations.

6. Conduct an analysis of collected comments on contributing factors to a program's ability to benefit from participation in the Advanced Warfighting Experiment.

7. Conduct an analysis and develop a summary description of the characteristics of a program that is best positioned to participate in future AWEs.

F. THESIS OUTLINE

I. Introduction. This chapter provides information on the scope, methodology, and purpose of the thesis.

II. AWE Structure and Literature Review. This chapter reviews the background and structure of the Army's experimental process and reviews the literature addressing experimental research methods.

III. Empirical Study Description. This chapter details the design of the survey instrument and the analysis strategy.

IV. Findings on the Use of Derived Information in Supporting Acquisition Decisions. This chapter provides a statistical analysis and conclusions from gathered data on the implementation of specific recommendations derived from the AWE.

V. Analysis of Contributing Factors to Benefiting from Advanced Warfighting Experiments. This chapter addresses the subjective comments made by survey participants and interviewees and illustrates lessons learned on the contributing factors to benefiting from the AWE. It also describes the characteristics of a program that is best positioned to gain from participation in future AWEs.

VI. Conclusions and Recommendations. This chapter summarizes lessons learned from the thesis and makes recommendations to enhance the AWE process to support the acquisition manager.

G. EXPECTED BENEFITS OF THIS THESIS

This thesis provides the acquisition manager with information necessary to make decisions about participation in Advanced Warfighting Experiments. The thesis assists acquisition managers in gaining maximum benefit from participation in future experiments. The research assists planners in tailoring future experiments to better benefit participating material programs.

II. AWE STRUCTURE AND LITERATURE REVIEW

A. THE TASK FORCE XXI ADVANCED WARFIGHTING EXPERIMENT

1. Background

In February 1995, the Chief of Staff of the Army approved the Army Force XXI concept. The Force XXI concept served to modernize and redesign equipment and procedures to meet the emerging twenty-first century threat. Battlefield digitization was the central theme for the envisioned Force XXI. Digitization includes the linking of all weapon platforms and vehicles at the brigade level and below into a tactical internet capable of sharing a vast amount of information. Digitization was expected to provide improved situational awareness and command and control capabilities. The Army designed the Advanced Warfighting Experiment to find the most promising technologies to lead the Army to Force XXI. [Lickteig, 1996]

The Army labeled its effort to modernize to Force XXI as "Joint Venture." Joint Venture was an iterative cycle of concept development, force design, and experimentation [Lickteig, 1996]. The Army's senior leadership described the Joint Venture Campaign Plan as "a comprehensive approach to redesign the force—organized around information—to be inherently more versatile and flexible" [Lickteig, 1996, p3]. Through the initial efforts of Joint Venture, the Army discovered it needed a more pragmatic and responsive research method that would clearly provide relevant and credible analysis to validate the premise of Force XXI [TRADOC, 1996]. The Army developed the Advanced Warfighting Experiments (AWE) as the focal effort in establishing Force XXI. The AWEs were based on "an iterative sequence and mix of warfighting simulations—live, constructive and virtual—in which soldiers and units conduct realistic tactical operations" [Lickteig, 1996, p6].

The Task Force XXI AWE was one of a series of AWEs designed to implement the Joint Venture plan. The Joint Venture Experimentation Plan is detailed in Figure 1 and illustrates the path from the current brigade, division, and corps design to the modernized Force XXI. The AWE series began with the Focused Dispatch (FD) AWE. Focused Dispatch consisted of a heavy battalion task force conducting simulated

exercises from February 1995 through August 1995. FD AWE focused on developing digitized training support packages and validating doctrine and techniques for digitizing heavy forces. The FD AWE was followed by the Warrior Focus (WF) AWE. Warrior Focus was conducted from May 1995 through November 1995 using a light infantry brigade and culminated with a training exercise at the Joint Readiness Training Center (JRTC) at Fort Polk, Louisiana. The WF AWE assisted in the Army developing tactics, techniques, and procedures (TTPs) in operating and equipping a digitized light infantry battalion. The TF XXI AWE was followed by the Division (DIV) AWE held in November 1997. The Army designed the DIV XXI AWE to provide insights on echelons above division and joint digitized operations. [ECC, 1996]

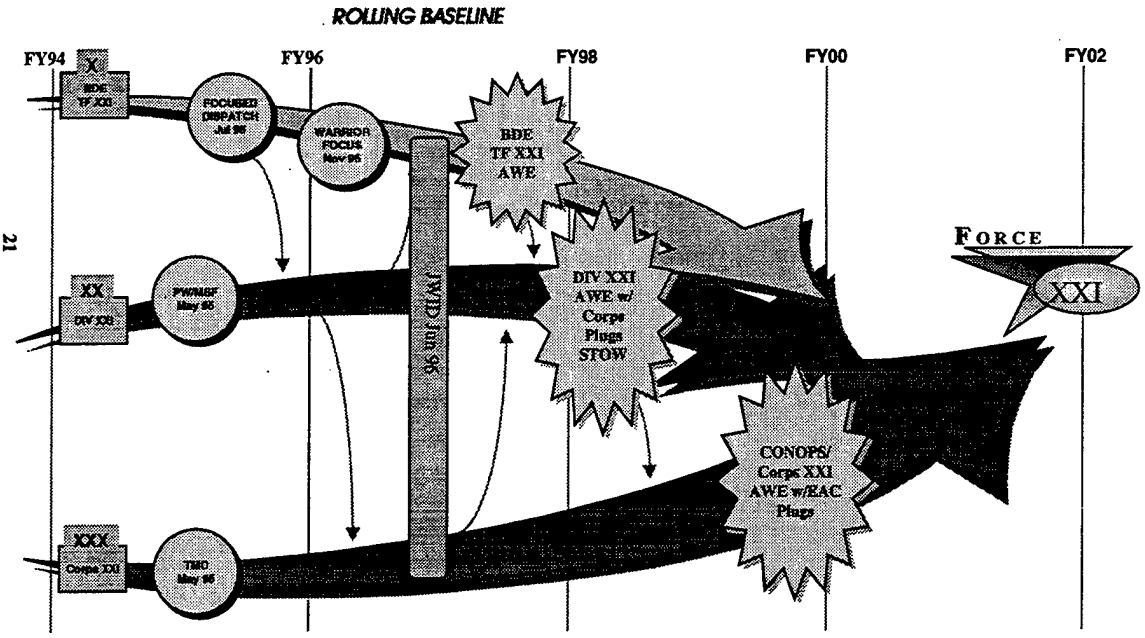

Figure 1. Joint Venture Experimentation Plan [PM FBCB2, 1995]

2. Purpose and Goals

The central hypothesis of the TF XXI AWE was developed by the Army's Training and Doctrine Command and states "that if information-age battle command capabilities and connectivity exists across all battlefield operating system (BOS) functions in a brigade task force, then increases in lethality, survivability, and tempo will be achieved" [ECC, 1996, 1.b.1]. The overall objective of the AWE was to "focus

modernization efforts on the most promising technologies...that have the greatest potential for enhancing force capabilities" [ECC, 1996, 1.c.1].

The Experiment Directive published five specific objectives for the AWE:

a. Assess Force XXI Battle Command Brigade and Below (FBCB2) Applique and Tactical Internet capabilities to refine FBCB2 requirements.

b. Assess digitized brigade combat service support concept.

c. Experiment with advanced technologies and concepts that leverage capabilities of information age technologies.

d. Refine digitized tactics, techniques, and procedures (TTP) for brigade operations.

e. Provide information to support investment decisions on the most promising initiatives. [ECC, 1996]

Fundamental to the Army's process of Joint Venture is the concept that development involves "continuous experimentation, discovery learning, and iterative refinement" [Lickteig, 1996, p4]. The rapid advance of technology has resulted in an inherent inability for Army leadership to predict the eventual composition and organization of its force. Information technology is providing an unprecedented level of capability to provide a common picture of the battlefield situation to all participants. The defining purpose of the AWE is to provide a forum to implement continued, iterative improvements.

AWE documentation does not directly address the purpose and goals of the experimental process as it relates to the acquisition program manager. This thesis attempts to partially define goals and objectives for the program manager to consider when presented with the opportunity to participate in an AWE.

3. AWE Scope and Methodology

a. Scope

The TF XXI AWE initially consisted of thirty-six Joint Venture issues and ninety-two new technology initiatives. The Joint Venture issues were proposed research questions regarding organizational doctrine, tactics, procedures, leader development, organization, and information management. The new technology initiatives included advanced technology products in various stages of development [ECC, 1996]. Officials

reduced the number of participating technology initiatives prior to the experiment based on the ability of the initiative to contribute to the overall goals of the experiment. The experiment plan focused on the initiatives central to digitization, such as the Applique (now titled Force XXI Battle Command Brigade and Below – FBCB2) and those initiatives that contributed to the full exercise of these central programs. This thesis concentrates on these initiatives and does not conduct an analysis of the value obtained from study of the Joint Venture issues.

The live exercise consisted of platoon, company, battalion, and brigade sized units conducting train-up and simulated combat operations against an aggressive opposing force. The experiment used pre-digitization exercises to develop a baseline to measure the effects of the digital enhancements and the resulting increases in unit effectiveness. The TF XXI AWE was designed to measure the holistic effect of synchronizing all elements of a combined arms team and to replicate "the same free flow operations and decisions that would be expected on the battlefield" [ECC, 1996, 1.c.8].

b. Initiative Selection Procedures

TRADOC selected initiatives to participate in the TF XXI AWE based on their ability to contribute to the objectives of the exercise. Some initiatives were logically included because they formed the basic infrastructure of the Army's overall digitization plan, such as Applique/FBCB2 and the Tactical Internet. TRADOC selected other systems because of their ability to contribute to the data flow required to exercise the digitization backbone, such as the Longbow Apache Helicopter and the Linebacker Air Defense Artillery system. Emerging technologies that were new concepts to the Army in terms of doctrinal employment and capabilities determination formed a third group, such as the Stingray Combat Protection System and the Lightweight Video Reconnaissance System (LVRS). Finally, even though they did not directly support the goals of the experiment, a fourth group of initiatives were included because of their status as emerging technologies. It is unclear how formal and rigorous the selection process was for the TF XXI AWE. However, from the results and lessons learned from the AWE, the Army has developed a structured system for initiative selection in future AWEs that is designed to insure that each system constructively supports the goals and objectives of the experiment.

The formal issue and initiative submission and review process conducted by TRADOC for the 1999 Joint Contingency Force AWE includes four phases: (1) submission of proposed issues to the TRADOC Analysis Center (TRAC) and the appropriate battle lab, (2) consolidation and initial review of issues and initiatives at the TRADOC level, (3) approval of issues and initiatives by the selection committee, and (4) the continuous monitoring and refinement of the approved issues and initiatives. The main criteria for selection include four components: (1) the initiative's relationship to an AWE hypothesis or objective, (2) the availability of the initiative by the designated "Everything-in-Place Date", (3) the availability of the initiative to be integrated into the architecture of the AWE, and (4) the ability of the submitting agency to bear the complete costs associated with participation. The submitting agency must also explain the impact of the issue or initiative on the Army's DOTMPL framework. The DOTMPL framework is a structured method the Army uses to discuss the effects of new concepts in terms doctrine, organization, training, materials, people, and leadership. [TRADOC JCW-AWE, 1998]

c. Data Collection

During the 1997 TF XXI AWE, automated instrumentation collected digital data while audio recording equipment was used to capture voice message traffic on FM radio nets. Real time casualty assessment (RTCA) instrumentation collected data on force effectiveness and movement rates. Simulated Area Weapons Effects-Multiple Integrated Laser Engagement system (SAWE-MILESII) provided results of unit engagements. Most significantly, Subject Matter Experts (SMEs) provided direct input to qualitatively measure initiative contribution to force effectiveness. The use of SMEs was essential in understanding the complex interactions between initiatives [OPTEC, 1997]. The primary emphasis for the experiment were those initiatives that directly contributed to situational awareness improvements. Most other technological initiatives were considered of secondary importance and were not measured quantitatively. These individual system contributions were not analyzed individually but as part of the total digitization package [ECC, 1996].

d. Analysis Plan

Training and Doctrine Command Analysis Center - White Sands Missile Range (TRAC-WSMR), the Operational Evaluation Command (OEC), and the Test and Experimentation Command (TEXCOM) jointly developed the analysis plan for the TF XXI AWE. The analysis plan detailed issues, measures of effectiveness (MOEs), and analysis techniques to be used during the live simulation [ECC, 1996]. TEXCOM's representative for the live portion of the experiment was the Army's Operational Test and Evaluation Command (OPTEC). The analysis team, combined with the Army Battle Labs, invested a significant effort to complete a set of coordinated, finalized initiative assessment plans [OPTEC, 1997].

4. Limitations

The planning documentation for the TF XXI AWE acknowledges the inherent limitations to the Army's study. "The planned TF XXI experiments do not follow the formal study process, the traditional test and evaluation process, nor do they follow the strict procedures of a laboratory experiment" [ECC, 1996, 1.c.16]. The attempt to combine training with assessment of digitization does not allow a controlled, repeatable experiment. Because of the training focus of the exercise, data collection efforts must be unobtrusive. This requirement limits the control of factors and conditions required to support analysis [ECC, 1996].

a. Repeatability

The free-play nature of the experiment limited the ability to repeat the results of any particular scenario. The sheer number of variables makes this tasks infeasible. Data collection failures due to instrumentation or equipment malfunctions were identified risk areas that could not be mitigated.

b. Data Collection

Data collection on all systems besides the Applique, tactical internet, and electronic interfaces was limited to SME observations and user surveys. The experiment directive spoke directly to the data collection limitations. "The majority of the initiatives will not have objective data to support milestone decisions. The SME and user data on

these second priority initiatives will be most useful in refining requirement documents and highlighting potential strengths and weaknesses" [ECC, 1996, 1.c.16]. Lessons learned from previous AWEs demonstrated to the TF XXI planners that SME insights and observations were the most meaningful in terms of reliability and significance. "Attempting to isolate the individual contributions of each experimental system to overall unit performance is impossible" [ECC, 1996, 2.b.1.a].

The non-intrusive data collection required of an experiment overlaid on training significantly limited the ability to gather meaningful information. Data collection over its entire process lifecycle from conception to termination requires a resource commitment that is infeasible in a free-play environment. The effects of specific actions and their ramifications on other variables could not adequately be measured with the limitations of the experiment [OPTEC, 1997].

c. Interactions

The large number of interacting initiatives participating in the AWE combined with uncontrolled and random variations lead to hopelessly confounded results that could not be isolated to demonstrate respective contributions. In true laboratory experiments, variables are modified individually or according to specific patterns that provide an ability to decipher impacts of variation. The nature of an experiment overlaid upon a training exercise prevents the direct control required to limit corruption of data by variable interaction. The large effects of interactions cause the subjective SME observations to represent a significant level of importance.

d. Small Sample Size

The relatively small sample of focused iterations during the live experiment coupled with the large number of initiatives involved provide for statistically insignificant results. Sufficient time and resources are not available during the AWE to develop statistically meaningful data. This small sample sizes make it very difficult to "prove" hypotheses as true. [ECC, 1996]. The RAND corporation has years of experience conducting research at the National Training Center and has significant expertise in conducting effective quantitative and qualitative experiments. The National Training Center conducts monthly "rotations" lasting 14 days, training a new brigade-sized unit each month. The TF XXI AWE consisted of one single NTC rotation. RAND

admits that the single-rotation AWE concept is limited in what quantitative results it can provide. RAND has found that at least twelve rotations' worth of data is required to provide statistically meaningful results. RAND does go on to state that AWEs can readily provide significant qualitative results. [Grossman, 1995].

e. System Immaturity

As stated in the experiment directive, some new systems participating in the experiment were immature, surrogate in nature, and did not have the capability to demonstrate actual or desired performance [ECC, 1996].

5. Results

Official press releases after completion of the AWE labeled the exercise nearly a complete success. The commanding officer of TRADOC, General William W. Hartzog, stated that about eighty-five percent of the prototypes performed to requirements. Of the rest, ten percent needed improvements to be useful and five percent were "ideas whose times have not yet come" [TRADOC PAO, 1997].

The primary feedback mechanism for the AWE was Operational Test and Evaluation Command's Live Assessment Report. The report provided summations for most participating initiatives as well as specific recommendations for improvements in technology. Additionally, the assessment report summarized the achievements of the AWE.

a. Better definition and understanding of future requirements.

b. Early identification of systems having potentially high payoff capabilities, as well as systems needing significant developmental work.

c. Independent assessment to the Army's senior leadership.

d. Early feedback to program managers.

e. Acceleration of the normal acquisition process by placing prototype systems into the hands of soldiers. [OPTEC, 1997]

In its final report, OPTEC also identified significant lessons learned from the AWE process. While OPTEC recognized that the AWE offered excellent opportunities for the identification and refinement of system requirements, the combination of experiment and training does not support operational testing requirements. In order to gain beneficial test data, training effectiveness would be reduced. However, OPTEC did

acknowledge that the AWE was an excellent opportunity to identify critical operational issues and criteria (COIC) that would be beneficial for use in future formal tests and evaluations [OPTEC, 1997].

B. DEFINING THE PROCESS: TRAINING, TESTING, ASSESSMENT, DEMONSTRATION, OR EXPERIMENT

1. Overview

The Army leadership has spent considerable effort in defining the task and purpose of their experimentation. Planners initially chose the word "experiment" to differentiate the exercise from two different categories of activities that had already been labeled "test" and "demonstration." A presentation for a past AWE stated that leadership should "reinforce experiment versus demonstration versus test" [Lickteig, 1996]. The Advanced Warfighting Experiment had a central hypothesis and attempted to apply a rudimentary scientific method but was criticized, as described in the next section of this thesis, as not being a true scientific study.

Concepts and terms used in the development of an experiment or evaluation plan often have a "richness of meaning" [Babbie, 1990, p119]. That is, they contain a variety of elements that attempt to summarize complex phenomenon. To permit rigorous research, such general concepts must be reduced to specific, empirical indicators. These indicators must be reduced to simplified, precisely defined terms. In the case where concepts cannot be precisely defined, the outcomes cannot be measured precisely. A tenet of scientific research is that data are not collected but rather created. The creation of data is highly dependent on the definition of variables and attributes [Babbie, 1993].

The AWE experiment directive used terms such as "gathering information", "making decisions", "gaining insight", "evaluation", "validation" and "assessment" without clearly defining the application of the terms. It is unclear how the Army initially applied the term experiment and how experimentation would interact with the other developmental activities already in place. The AWE analysis plan also identified that there would be a wide range of analytical rigor in the assessment of initiatives. A final complication introduced by the designers of the AWE was the overlay of the event on a pre-established training exercise at the National Training Center (NTC), Fort Irwin, California. The NTC is commonly referred to as the Army's most highly rated training

opportunity for mechanized forces. The description of the AWE as a training event additionally confounded the purpose of the exercise.

Through the experience gained in the TF XXI AWE, following exercises, and detailed studies of the Army's experimentation process, the Army has more clearly defined its experimental method, the terms used in its analysis plans, and the interaction experimentation plays with other developmental activities. The Army has determined that future exercises must be based on sound, integrated, all-inclusive analysis methodology.

2. Training

The Army defines training as "the instruction of personnel to individually and collectively increase their capability to perform specific functions or tasks" [CALL, 1999]. OPTEC stated in the TF XXI AWE Live Simulation Assessment Plan that "the primary objective of the exercise is training" [ECC, 1996, Annex C, Appendix B, para. 2.3.1]. The Army's National Training Center was founded with the purpose of providing the most realistic training exercises possible short of actual war. Secondarily, the NTC was designed to provide "lessons learned" for the Army.

The NTCs training mission emphasis has a significant implication on its ability to serve as an environment for an Advanced Warfighting Experiment. Although NTC rotations approximate actual combat, they do not exactly replicate it. Even with extensive improvements in technological capability, the environment of the NTC is designed such that it is unlikely that the evaluation force will achieve victory in any one engagement. The NTC also focuses on certain missions and battlefield operating systems. Those initiatives not realistically exercised in the training environment should not be included in the experiment. The situation has added complexity in that training is combined with the introduction of new equipment. It is difficult to separate problems related to training and problems related to new initiatives. Actual effects of applied initiatives may also be limited due to the need to continue the exercise in a proper force correlation to serve the training objective. [Grossman, 1995]

3. Testing

Testing in the Army is divided between developmental and operational activities. Both are designed to be assessments of an item's ability to meet designed requirements

and parameters. Operational testing is an official requirement to conduct independent analysis of equipment prior to production. While the live simulation assessment plan included in the experiment directive a dendritic of functional issues, measures of effectiveness (MOE), measures of performance (MOP), and data sources as normally seen in an operational test and evaluation plan, representatives from the Army's Test and Evaluation Command were adamant that the exercise was not a "test" and would not replace proper operational test and evaluation of any initiative.

The live simulation assessment plan stated that the planned Task Force XXI experiments would not follow the traditional operational test and evaluation process. Because of the severe limitations imposed by the nature of the experiment combined with the needs of the training exercise, any data collected would be insufficient in drawing any conclusions required for a true operational test [ECC, 1996]. The NTC is not designed as a test and evaluation center. Although the NTC observer/controllers are extremely beneficial in the conduct of AWEs, they will not compromise their training function [Grossman, 1995]. In a personal interview, a representative from the Headquarters of OPTEC stated that while the AWE did not count as operational testing for any developmental item, it was included in the spectrum of "continuous evaluation." He went on to state that developmental and operational testing are merging and that if proper actions are taken by the developmental community after the AWE, that the system might require less testing and scrutiny when the time for operational testing arrives.

4. Assessment

The Army defines assessment as "the determination of the overall effectiveness" [CALL, 1999]. The term "assessment" was not clearly defined in the TF XXI experiment directive. However, future AWE frameworks clearly define the term "assess" as "to analyze critically and judge definitely, the nature and merit of mature systems, technologies, and procedures" [TRADOC JCF-AWE, 1998, A-1]. The analytical rigor of the term "assess" is considered very high.

Assessment plans developed for the TF XXI AWE were a result of "a collective effort between the proponent and OPTEC" [ECC, 1996, Appendix B, Annex 1]. Initiative proponents provided draft assessment plans to OPTEC. OPTEC revised the plans to match the available collection assets and also added issues of their own.

Proponents for initiatives were normally the specific Battle Lab that had responsibility for that particular area of interest

5. Demonstrations

The term "demonstration" was clearly defined for experiments following the TF XXI AWE as a hierarchical experimental term that recognizes the level of maturity of a system.. "Demonstrate & Deploy" was defined as "to show by virtual, simulated, or actual operation a potential capability for prototype systems, technologies, and procedures" [TRADOC JCF-AWE, 1998, A-1]. The analytical rigor for demonstrations is considered high.

The Army conducts two different demonstration programs, Advanced Technology Demonstrations (ATDs) and Advanced Concept Technology Demonstrations (ACTDs). The primary objective of the ACTD process is to "accelerate and facilitate application of mature advanced technologies to solve important military problems" [USAMRMC, 1997, p1]. ACTDs conduct realistic and extensive military exercises to provide the user an opportunity to evaluate utility and gain experience with mature technologies. ACTDs are funded by participating initiatives, supplemented by funding from the ACTD funding line. ATDs demonstrate the potential for enhanced operational capability and help to speed the maturation of advanced technologies. They are funded by initiative Research, Development, Test, and Evaluation (RDT&E) funds. [USAMRMC, 1997]

The need to properly label the activities that would become Advanced Warfighting Experiments as something separate from demonstrations was evident early in the program development process. General Gordon Sullivan, the architect for Joint Venture stated "first we called them demonstrations, and that didn't fly because we knew if it was a demonstration, that wouldn't be satisfactory for any of us. It would be an experiment" [Lickteig, 1996].

6. Experiments

Experiment connotes discovery learning. Experiments are "formative exercises to see what works and what doesn't" [Lickteig, 1996, p15]. The strict application of the scientific method to experimentation is a precisely controlled research method. The original term of Advanced Warfighting Demonstrations was changed to Advanced

Warfighting Experiments to show the application of more realistic conditions that tasked soldiers and equipment to wartime levels. [Lickteig, 1996]

The Army's Advanced Warfighting Experiment appears to be based on a strictly scientific model. The Army has developed hypotheses and emphasized the validation of models against baselines. The Army has also stated in briefings that "the scientific method paradigm must be adapted" [Lichteig, 1996, p8].

The U.S. Army Research Institute recommended that the Army implement a formative evaluation method that focuses on exploration, explanation, and improvement. The Army has developed an analytic method it refers to as Model-Experiment-Model-Validate (MEMV). Models are initially developed by battle labs and experimented through simulation. The models are then adjusted based on derived experimental data and validated through live exercises. The role of the AWE in the Army's experimental model is discussed in the following section. [Lickteig, 1996]

Advanced Warfighting Experiments are not the Army's only experimental activity. The Army's Battle Labs also conduct their own warfighting experiments. The Battle Lab Warfighting Experiments (BLWE) are smaller, more focused assessments of a single battle dynamic. [Lickteig, 1996]

7. Other Key Definitions

a. Validate

The term validate has been defined for future AWEs to mean "confirm" or "substantiate". "It is not used in the strict experimental sense where there is a comparison of alternatives" [TRADOC, 1996, 2.e].

b. Gain Insights

The term "gain insights" has been defined for future AWEs as an experimental term that recognizes the level of maturity for a concept. The term "gain insights" is defined "to obtain a clear and immediate understanding of emerging concepts, systems, technologies, and procedures" [TRADOC JCF-AWE, 1998, A-1].

c. *Objectives*

Objectives are specific, operational statements detailing the desired accomplishments of a program. The planning and implementation of programs are predicated on the need to reduce the gap between objectives and reality. Effectively stated objectives use strong verbs, state only one purpose or aim, specify a single end-product or result, and specify the expected time for achievement. [Rossi, 1993]

C. EXPERIMENTAL RESEARCH METHODS

"Scientific research has two primary goals: description and explanation. Researchers measure the empirical distribution of values on variables (description) and the associations between variables for purposes of explaining the distribution of values" [Rossi, 1993]. A wide spectrum exists on the application of a strict scientific model on warfighting experiments. The U.S. Army Research Institute believes that research objectives should determine research methods [Lickteig, 1996]. The complex nature of the AWE may not be facilitated by a strict experimental model. Basic research theory demonstrates that proving a true difference among two states is much more difficult than proving no difference [Lickteig, 1996]. AWEs will not benefit from lessons learned in a "no difference found" environment. The Army has admitted that it is "experimenting about experimenting" [Lickteig, 1996, p15].

1. The AWE Application of the Scientific Method

The scientific method of experimentation is a precisely controlled research method. Scientists experiment by randomly assigning participants to an experimental and control group and strictly control factors "extraneous to the causal variable of interest" [Lickteig, 1996, p15]. Multiple studies have criticized the Army's use of the scientific method in experimentation and recommended more structured and applicable methods. The AWEs have neither random assignment of participants nor strict control over variables. For the TF XXI AWE, the experimental and control group were the same, equipped differently. The wide range of variability in the exercise fuels debate on the validity of any of the conclusions reached.

According to a study done by the U.S. Army Research Institute, the Army has recognized the limitations in its implementation of the scientific method but may not have adequately addressed them.

> Rather than empirical control over conditional differences, or a systematic design to reduce variation, the plan proposes to document such differences (e.g., issues, design, structure, equipment) and conditions unique to each exercise, in a relational data base. The documentation of all exercise conditions is essential for interpretation of findings. However, it is no substitute for the controls required to establish commensurate conditions, systematic changes in treatment, and definitive or validated outcome improvements. [Lickteig, 1996, p16]

The Research Institute proposes that AWEs do not prevent designers from controlling strict controls on variables. The necessary control might be achieved by dedicating a portion of the experiment to small, detailed sub-experiments. The results of the scientific study should also focus on providing solutions rather then identifying failure. [Lickteig, 1996]

2. Formative Versus Summative Evaluations

The U.S. Army Research Institute published its findings on appropriate research methods for Advanced Warfighting Experiments and believes that the overarching research strategy should consist of a balance between formative and summative evaluations [Lickteig, 1996]. Formative and summative evaluations differ in their focus and role.

Formative studies are defined as "evaluative activities undertaken during the design and pretesting of programs to guide the design process [Rossi, 1993, p104]. These formative studies may be simple or "as complex and comprehensive as full-blown evaluations" [Rossi & Freeman, 1993]. Formative evaluations focus on intermediate goals and play a productive role in their achievement. Formative evaluations are conducted in developmental stages to help form or improve the system for the user [Lickteig, 1996].

Summative evaluations address final goals as opposed to the intermediate goals of formative evaluations. Summative evaluations address the success or failure of goal

achievement as opposed to taking an active roll in their achievement. Summative evaluations generally provide information for an external audience. [Lickteig, 1996]

While both formative and summative evaluations can be conducted during AWEs, an emphasis on formative issues may avoid a complete conclusion of failure driven by summative evaluations. The macro-level focus of AWEs can better be served by the formative evaluation model. Summative evaluations require exacting methods that cannot be facilitated in the free-play, training environment of the AWE. The Joint Venture concept of iterative, continual improvement also models formative evaluations more directly. Since Joint Venture is formative in nature, the belief that AWEs cannot satisfy the requirements for operational test and evaluation is supported due to the summative nature required for operational testing. Finally, the premature focus on summative results of individual initiatives might lead to the faulty conclusion that advanced technology devices are not beneficial to the force as a whole. [Lickteig, 1996]

3. The Credible Uses Framework

In 1998, the RAND Corporation published its findings on the application of the "Credible Uses" (CU) framework to Advanced Warfighting Experiments [Lucas, Banks, Vye, 1998].

The CU framework, originally documented by James A. Dewar (et al.) [Dewar, et al.1996], is based on a decision-to-experiments ladder (DEL) that directly links experiments to decisions [Lucas, Moore, Vye, 1998]. Advanced Warfighting Experiments are limited in their ability to predict real world outcomes. Experimental data comes from single or few unrepeatable events. Safety restrictions, lack of realism, and unknown composition of future threats make AWE's "weakly predictive" at best. Analysis of these "weakly predictive" models cannot produce quantitatively significant data. Dewar's study of weakly predictive models demonstrated how the CU framework could be used to adjudicate clearly defined hypothesis. Lucas has stated that significant up-front analysis is required to maximize experimental results from an AWE. Decisions on important issues require an objective and traceable link from experimental results to decisions. [Lucas, Banks, Vye, 1998]

The decision-to-experiment ladder is clearly founded in the scientific method. With it, experiments are designed to affect decisions and those decisions are based on experiment outcomes. The decision-to-experiment ladder includes: issues, decisions to

be made, argument to support the decisions, hypotheses to be adjudicated, experiments to resolve hypotheses, and analysis and measures to implement decisions [Lucas, Banks, Vye, 1998]

a. Issues

While using the weakly predictive model presented in AWEs, the primary issues to be addressed must be strictly limited. How many issues, and to what extent they may be examined, will be defended by the successful completion of the decision-to-experiment ladder of the CU framework. [Lucas, Banks, Vye, 1998]

b. Decisions to be Made

The CU process includes specific decisions that can be resolved by an analytical process, specifically by experimentation. Potential decisions made within the decision to experiment ladder must explicitly stated. Specificity in stating issues is critical to experimental design. Decisions must be stated precisely enough so that experiments can be properly designed to test them. [Lucas, Moore, Vye, 1998]

c. Argument to Support the Decisions

When using the CU framework, users must identify tentative arguments that are needed to support the decisions to be made [Lucas, Moore, Vye, 1998]. By referencing how the issues relate to the decisions to be made, analysts know exactly the strength of the argument needed to make the decision. Where strong prior belief exists in the decision to be made, very little experimental evidence may be required to make the decision. Where substantial evidence is required, it may not be possible to resolve the decision given the limited resources of the experiment. Arguments must be "sufficient and succinct. Superfluous arguments lead to added complexity and the identification of unmanageable amounts of experiments" [Lucas, Moore, Vye, 1998, p8]. This identification of arguments to support decisions is critical in the design of the experiment and is much more productive than conducting the experiment and then deducing what can be inferred from the evidence. [Lucas, Banks, Vye, 1998]

d. Hypotheses to be Adjudicated

In the CU framework, AWEs must be designed to test specific hypotheses that support credible arguments. By definition, a hypothesis is "an assumption used as a basis for an argument or investigation or a theory that explains a set of facts and can be tested by further investigation" [Lucas, Banks, Vye, 1998, p18]. According to Lucas, the hypotheses used in the TF XXI AWE were faulty in that they were either obviously true or were not specific enough to be subject to experimental test. [Lucas, Banks, Vye, 1998]

e. Experiments to Resolve Hypotheses

The experiment used to resolve the hypotheses must include what things will be varied and what data will be extracted. The experiments in the AWE process can be live, virtual, or constructive, as required to satisfy the needs of the hypothesis. To maximize the analysis capability from the experiment, significant up-front analysis must be completed. Care must be given in choosing the exact variables and scenarios for the experiment. It might be determined that the requirements of the hypothesis are not feasible within the given constraints of the exercise. Experiments should be as objective as possible. Subjective data can produce erroneous conclusions. According to the study by Lucas, the Army has historically been effected by subtle biases that have prevented its adaptation to new technologies [Lucas, Moore, Vye, 1998]. An analysis of the experiment and its assumptions is key to the eventual credible use of the resulting data. [Lucas, Banks, Vye, 1998]

f. Analysis and Measures to Implement Decisions

For the experiment to be used credibly, it must be designed to support decisions. Because of the limited data gathered from AWEs, there must be an "objective and traceable link from experimental results to decisions on important issues" [Lucas, Banks, Vye, 1998, p16]. The procedures and products of the experiment must be explicitly stated to ensure consistency, traceability, and credibility. [Lucas, Banks, Vye, 1998]

D. UTILIZATION OF EVALUATIONS

The Advanced Warfighting Experiments are evaluations of effectiveness and efficiency of combat operations. No matter the complexity or integrity of the scientific process of the exercise, "in the end, the worth of evaluations must be judged by their utility" [Rossi, 1993]. To achieve maximum benefit from experiments, the actual evaluation must be tailored to the specific program, the stage of activity in the program, and the needs of the stakeholders in the program. The evaluation of innovative programs, such as the digitization of the Army, may require leadership to rethink some aspects of the program, including the program objectives, characteristics, and outcome measures. [Rossi, 1993].

The ability of an organization to achieve its objectives is measured by three criteria: (1) the extent that measurable objectives have been specified, (2) the plausibility and testability of assumptions that link the application of resources to the program activities, and (3) the level at which those in charge of the program have the motivation, ability, and authority to manage and implement change. Research has shown that the results of evaluations might not be used to refine and modify programs because leadership may resist, be uncooperative, or fail to grasp the purpose of the studies. Often, while programs may have a number of objectives, they may not be sufficiently well defined to be managed to desired endstates, may not have valid assumptions, or may be invalidated by management's inability to implement change. [Rossi, 1993].

The way that evaluations are used can be classified in three categories. First, direct or instrumental use of evaluations means that the specific findings and recommendations are directly documented and implemented. Second, conceptual utilization refers to the general use of evaluations to influence thinking about issues. Conceptual utilizations do not lead to the adoption of specific programs or policies but provide evidence that supports general methods and approaches. Finally, persuasive utilization applies findings to support or refute beliefs or to attack the status quo. [Rossi, 1993].

Five factors affect the utilization of evaluation findings: (1) relevance to the problem, (2) communication between researchers and users, (3) information processing by users, (4) plausibility of research results, and (5) user involvement or advocacy. Also, leadership will be influenced by the perceived truthfulness of the evaluation. Management will measure truthfulness by determining if the research was conducted by

proper scientific methods and if the results are compatible with their experience, knowledge, and values. [Rossi, 1993].

The extent that the data obtained from the TF XXI AWE was utilized by the Army program managers involved will be the central point of investigation in this theses.

E. CHAPTER CONCLUSIONS

A review of the goals, objectives, and limitations of the TF XXI AWE overlaid on a background study of the role of experiments in the Army, the various analyses and recommendations of experimental research methods, and the theoretical utilization characteristics of evaluations, raises questions about the possible utility of the information derived from the TF XXI AWE for the program manager. This background information will be considered and applied to the results of the objective and subjective study that follows.

One product from the TF XXI AWE was a performance analysis of the participating new technology initiatives. OPTEC provided specific recommendations for each initiative in its Live Experiment Assessment Report. These recommendations detailed changes to user requirements, desired technology improvements, and integration issues. This thesis studies the utility of the AWE to program managers, as discussed by Rossi, by investigating the levels at which these recommendations were implemented and the factors affecting utilization including relevance to the problem, communication between participants, information processing by users, the plausibility of research results, and user involvement [Rossi, 1993]. The thesis also investigates the extent to which the AWE was a formative evaluation by measuring its impact on the programs it was directed to improve.

III. EMPIRICAL STUDY DESCRIPTION

A. RESEARCH AND APPROACH

1. Research Focus

The thesis research focused on gathering ratings from program managers and user representatives as to the degree of implementation of the Operational Test and Evaluation Command's specific initiative recommendations relative to their specific program. These recommendations were derived from the Live Experiment Assessment Report for the TF XXI AWE. Secondly, a research survey was conducted on the perceived validity of the recommendations and to identify contributing factors towards a program's ability to benefit from participating in the Advanced Warfighting Experiment.

2. Research Approach

Research began with a comprehensive review of literature addressing the goals, purpose, techniques, and results of the Army's experimental process. A detailed review of the TF XXI AWE Experiment Plan and OPTEC's Live Experiment Assessment Report contributed to the understanding of the Army's experimental program. Background research included general research and evaluation methods and the utilization of evaluations. Surveys were tailored for each program initiative and disseminated to each applicable program office and user representative. Research included follow-up interviews of pertinent program managers and users. Analysis was then conducted to draw conclusions relevant to the research focus.

B. SAMPLING

1. Included Initiatives

This research does not include an analysis of the Joint Venture XXI doctrinal initiatives or organizational change initiatives but only the new technology developmental programs participating in the TF XXI AWE. Of the ninety-two emerging technology

initiatives included in the experiment, thirty-six initiatives were included in the research. Certain initiatives were excluded from the research for the following reasons: (1) the initiatives was not evaluated by OPTEC during the AWE, (2) OPTEC did not provide any substantive recommendations by which to measure implementation, (3) initiative was a doctrinal or organizational change with no material program, (4) program was subsequently terminated after the AWE and no representatives could be found to provide input towards the research. Of the thirty-six initiatives selected, surveys were issued to thirty-four. One initiative was subsequently excluded because no willing participants could be found.

2. Selection of Respondents

Seventy-two respondents were identified to participate in the survey. First, a representative from the responsible program management office was identified for each of the thirty-six initiatives. Program managers were selected based on their direct experience with the AWE and their ability to provide programmatic insights into the process and results of the AWE. Secondly, a user representative was identified, in most cases the combat developer responsible for the program. Of the seventy-two identified offices, surveys were administered to sixty-seven.

C. SURVEY DESIGN AND INSTRUMENT

1. Survey Design

The survey was designed to collect both objective and subjective data. The objective survey items were designed to collect data on the specific level of implementation of recommendations made in the Live Experiment Assessment Report. Subjective items were included to gather perceptions and opinions from specific program offices and user representatives. The subjective items were structured from the RAND Corporation's application of the "Credible Uses" (CU) framework to Advanced Warfighting Experiments as explained in detail in Chapter II of this thesis [Lucas, Banks, Vye, 1998].

The CU framework, originally documented by James A. Dewar (et al.) [Dewar, et al.], is based on a decision-to-experiments ladder (DEL) that directly links experiments to decisions [Lucas, Moore, Vye]. Advanced Warfighting Experiments are limited in their

ability to predict real world outcomes, since experimental data generally comes from single or few unrepeatable events. Safety restrictions, lack of realism, and unknown composition of future threats make AWE's "weakly predictive" at best. Analysis of these "weakly predictive" models cannot produce quantitatively significant data. However, Dewar's study of weakly predictive models demonstrated how the CU framework could be used to adjudicate clearly defined hypothesis [Lucas, Banks, Vye]. The items in the subjective portion of the survey are framed on the decision-to-experiment ladder to allow participants to demonstrate through their responses the extent to which this decision ladder was implemented during the AWE.

2. Survey Instrument

The survey instrument utilized a combination of ordinal measurements reflecting the level of implementation achieved for each OPTEC recommendation and factors affecting implementation, as well as open-ended questions designed to gain subjective perceptions about the AWE process. The survey contained four sections.

a. Section One

Section one asked respondents to rate the level of implementation of the specific recommendations made for their program initiative by the Army Operational Test and Evaluation Command's Live Experiment Assessment Report. Each survey was tailored to include only those specific recommendations applicable to the initiative in question. The complete list of specific OPTEC recommendations is included as Appendix A. Participants were asked to indicate the term that best described the extent that the recommendation was implemented: FULLY, MOSTLY, LIMITED, NOT AT ALL. Participants were also asked to provide narrative comments explaining the factors that influenced the degree of implementation.

b. Section Two

Section two contained questions about the included program's experiences in the 1997 TF AWE. Participants were asked to rate, using a five-point scale (1=high, 5=low), questions that were derived from the decision-to-experiment ladder [Lucas, Moore, Vye, 1998]. The questions covered all of the applicable components from issue development to analysis and implementation. Respondents were given the opportunity to

give a brief narrative explanation of each rating. In addition to the objective ratings, open-ended questions were included (see questions one, six, and seven in Figure 2) to gather contributing factors and characteristic description of programs best positioned to benefit from AWEs. The specific questions contained in Section Two are listed in Figure 2.

Part 2:

The following questions gather information on your program's experience in the 1997 TF XXI Advanced Warfighting Experiment. In the area given, please provide your perceptions and opinions. Where applicable, please circle the appropriate rating that best answers the given question. Please provide as much detailed information as possible. You may use the back of this form or attach additional pages.

1. What were the specific developmental ISSUES being addressed on your program at the time of its participation in the AWE and what DECISIONS were to be made from gathered data?

Explain:

2. To what extent were you able to tailor or influence your program's specific activities in the AWE to relate to the issues and decisions you faced as an acquisition manager?

(High) [1] [2] [3] [4] [5] (Low)

Explain:

3. How valuable were the data and recommendations gained from participation in the AWE in making decisions as an acquisition manager? Explain.

(High) [1] [2] [3] [4] [5] (Low)

Explain:

4. To what extent did your program benefit from participating in the AWE? How?

(High) [1] [2] [3] [4] [5] (Low)

Explain:

6. What were the contributing factors to your program's ability to benefit from participation in the AWE?

Explain:

7. Based on your program's experience in the 1997 AWE, describe the characteristics of a program that would best be situated to benefit from participation in a future AWE.

Explain:

Figure 2. Section Two of Survey Instrument

c. *Section Three*

Section three gathered respondent opinions on reasons why recommendations made by the 1997 Advanced Warfighting Experiment were or were not fully implemented. The questionnaire attempted to include an exhaustive list of potential impediments or positive factors for implementation. Participants were asked to rate each of the items on a scale of one to five. A rating of one signified a highly significant factor on the degree of implementation. A rating of five signified that an item was NOT an influencing factor. Participants were also asked to place a mark next to the most critical factor. Section three of the survey is shown as Figure 3.

Part 3:

The following section gathers your opinion on reasons why recommendations made by the 1997 Advanced Warfighting Experiment were or were not fully implemented. Please rate each of the items below on a scale of 1 to 5. A rating of 1 signifies a highly significant factor on the degree of implementation. A rating of 5 signifies that an item was NOT an influencing factor. Please place a * next to the most critical factor. The first set of items are possible impediments to implementation. The second are possible positive factors for implementation.

Reasons for less than full implementation.	Highly Significant		-		Not Significant
1. Lack of money to implement recommendations from AWE.	[1]	[2]	[3]	[4]	[5]
2. Lack of time to implement recommendations from AWE.	[1]	[2]	[3]	[4]	[5]
3. Test data and recommendations from AWE were not valid.	[1]	[2]	[3]	[4]	[5]
4. AWE evaluators did not understand user's requirements.	[1]	[2]	[3]	[4]	[5]
5. AWE data and recommendations were not accurate.	[1]	[2]	[3]	[4]	[5]
6. AWE recommendations were not technically feasible.	[1]	[2]	[3]	[4]	[5]
Factors supporting implementation.	Highly Significant		-		Not Significant
1. Issue was considered high priority by users.	[1]	[2]	[3]	[4]	[5]
2. Issue was considered high priority by program office.	[1]	[2]	[3]	[4]	[5]
3. Issue had strong political backing.	[1]	[2]	[3]	[4]	[5]
4. Recommended actions were fully funded.	[1]	[2]	[3]	[4]	[5]

Figure 3. Section Three of Survey Instrument

d. Section Four

In section four, respondents were asked to provide any additional comments on their program's participation in the AWE including any information that might assist acquisition managers in gaining maximum benefit from participation in future experiments or that would assist planners in tailoring future experiments to better benefit participating programs.

D. DATA COLLECTION

First, potential respondents from the selected offices were contacted by email to explain the survey and its purpose. The thesis topic and potential derived benefits were explained. Potential respondents were asked if they had both the necessary background experience in the TF XXI AWE and the estimated time of one hour to complete the survey. Surveys were then administered to participants by issuance and submission of Microsoft Word documents via electronic mail.

Interviews were conducted in person with seven representatives from the Army's Night Vision Reconnaissance Surveillance and Target Acquisition Office at Fort Belvoir, Virginia and two representatives from the Program Management Office for Bradley Systems at the Army's Tank, Automotive, and Armaments Command (TACOM) in Detroit, Michigan. Interviews were conducted face-to-face during a combined one week on-site visit from August 24 - 27, 1999. These interviews were designed to solicit more detailed information addressing the same questions included in the administered survey. A sample of questions used in the interviews is shown in Figure 4.

All respondents to the written survey and personal interviews were informed that the research would be conducted on a non-attribution basis and that participants would remain anonymous. It was believed that anonymous input would result in a more candid disclosure of information.

E. LIMITATIONS OF RESEARCH DESIGN

The following is a description of the major factors identified prior to the survey administration that could limit the study.

1. As a material developer and acquisition manager, what is your overall perception or impression of the AWE process?

2. What kind of specific feedback did you receive on your program's performance in the AWE? Was it valid? Could you take advantage and utilize the feedback.

3. Has your program undergone any major changes since the AWE?

4. How did the maturity of your program effect its performance at the AWE?

5. Were you able to tailor the analysis plan for your program with OPTEC?

6. How did your program benefit from participating in the AWE?

7. What were the risks involved with participating in the AWE? How were those risks mitigated?

8. What amount of effort was involved in participation in terms of resources, time, manpower, or dollars? How does the cost of participation compare to the benefits received?

9. What role did politics play in outcomes and perceptions of programs?

10. To what extent was the AWE a marketing effort for PMs?

11. How would you characterize a program that would stand to significantly benefit from participation?

Figure 4. Sample Interview Questions

1. Scope

The research was limited to programs participating in the TF XXI AWE and no other Army experiments. The available programs may not represent the full breadth of possible outcomes of the AWE process. Subsequent Army AWEs may have been refined to invalidate any conclusions resulting from this study. The sample of included programs might not be representative and may limit the relevance and validity of conclusions.

Some program offices have been disbanded subsequent to the TF XXI AWE. Representatives for certain initiatives were not available to contribute to the study. High levels of personnel turnover in Army agencies might lead to the conclusion that respondents did not have relevant experience to evaluate the AWE. In some cases, details of the planning process and results of the AWE were not documented and were therefore unavailable for the study.

2. Reliability

Reliability is "a matter of whether a particular technique, applied repeatedly to the same object, would yield the same result each time" [Babbie, 1990, p132]. Although every effort was made to conduct the research in a rigorous manner, the study relied on data from multiple sources with unknown biases. All data were based on opinions and perceptions that were not independently verified. Depending on the amount of data actually collected and agreement across the sample, levels of confidence can be measured to qualify conclusions.

3. Validity

Validity is "the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration" [Babbie, 1990, p133]. The inclusion level participating AWE initiatives studied is sufficient to create valid conclusions on the outcomes of the TF XXI AWE. However, any derived conclusions might not be applicable to programs participating in future AWEs due to changes in the acquisition process since 1997.

F. RESPONSE STATISTICS

Sixty-seven surveys were administered to both program managers and user representatives of thirty-five different AWE initiatives. A total of thirty-eight respondents returned completed surveys for a response rate of 56.7%. Only twenty-eight of the thirty-five originally included initiatives had survey responses. The remaining seven initiatives were subsequently excluded from the thesis. Of the twenty-eight included initiatives, only ten had responses from both the program manager and user representative. While the cumulative level of response was adequate to reach general conclusions on the acquisition use of derived AWE data, there was an inadequate level of response to compare program manager and user representative input or to measure if any significant differences existed between the two perspectives.

Both program management and user representative offices participated in the survey. Completed surveys were received from nineteen program management offices and nineteen user representative offices. The program management office surveys were completed by program, project, or product managers. The users were represented by the

appropriate Directorate of Combat Developments (DCD) or other offices to include TRADOC System Managers (TSMs) and Subject Matter Experts (SMEs) from branch specific doctrine offices. Respondents included military, Department of Defense (DoD) civilians, and support contractors. Military respondents ranged from Major (O-4) to Colonel (O-6) and had an average of 1.9 years experience on the program in question. Civilian respondents ranged from GS-12 to GM-15 and had an average of 7.5 years experience on their program. The minimum amount of time any respondent had with their program was 12 months. Also included were four civilian contractors who directly supported program offices or user agencies.

Data were collected on the maturity of programs at the time of participation in the AWE. Respondents were asked to indicate their "phase of development" at the AWE. Responses were then transcribed into five categories to be used in analysis. Program maturity is summarized in Table 1.

Table 1. Reported Maturity of Programs at the AWE

Maturity	Responses
Concept Exploration (CE) or Advanced Technology Demonstration (ATD)	13
Program Definition and Risk Reduction (PDRR)	4
Engineering and Manufacturing Development (EMD)	2
Limited Production (LP) or Low Rate Initial Production (LRIP)	4
Production, Full Rate Production (FRP), or Full Scale Production (FSP)	5

Overall, given the scope, reliability, and validity of the response demographics, the data are adequately representative of the TF XXI AWE participating program managers and user representatives. The collected data are sufficient to reach findings on the use of AWEs to support acquisition decisions.

G. ANALYSIS STRATEGY

The thesis survey asked respondents to subjectively rate recommendation implementation and perceptions about the AWE using a number scale. For this analysis,

the provided numeric ratings were inverted (5=high; 1=low). Arithmetic means, medians, and modes were computed for each question to determine relationships and effects. Mean is defined as the average and was computed by dividing the sum of the terms by the number of the terms. The median term is defined as that value of an ordered set below and above which there are an equal number of values. Mode is defined as the most frequent value of a set of data. A confidence interval was computed that should include the true value of the parameter 95% of the time. The confidence interval was computed as plus or minus 95% of the area under a standard normal curve multiplied by the value of the standard deviation and divided by the square root of the sample size. For most analysis, medians were used for comparison so that outliers would not have a significant impact on results.

Median results for the various collected factors are compared against one another and analyzed to determine trends and overall effects on the ability to benefit from the AWE. The Kruskal-Wallis method is used to determine a P value, or level of equality, of the various factor medians. The Kruskal-Wallis method is computed on multiple samples as a nonparametric alternative to one-way analysis of variance. A nonparametric analysis implies that there is no assumption of a specific distribution for the population.

The Kruskal-Wallis hypotheses are: H0: the population medians are all equal versus H1: the medians are not all equal. Kruskal-Wallis H is calculated on the basis of sums of ranks for combined groups. Data from all samples are ordered, letting n be the number of observations in any particular sample and N is the number of observations in all samples combined. The data are renumbered from 1 to N, with 1 corresponding to the lowest score. Using these rank scores, data for each sample are listed by rank. These rank scores are added up for each sample, and the sums are the r scores in the formula below. Also, let k be the number of samples. The Kruskal-Wallis H is computed as: $H = 12/(N(N + 1))^* \text{SUM}(r^2/n) - 3(N + 1)$ and degrees of freedom = k - 1. H is distributed approximately as chi-square. H is then used in a chi-square table with (k - 1) degrees of freedom. If the critical value of chi-square for the desired significance level is equal to or less than the computed H value, then the researcher rejects the null hypothesis that the samples do not differ on the criterion variable. In the analysis that follows, the significance level for each Kruskal-Wallis test is given. [Garson, 1999]

The planned method of analysis included a review of the respondent surveys to identify the following:

1. The average level of implementation of all included initiative recommendations.
2. The overall perception of the programs ability to tailor or influence the initiatives specific activities in the AWE.
3. The overall perceived value of the data and recommendations gained from participation in the AWE as acquisition managers.
4. The overall perceived benefit gained from participating in the AWE.
5. If recommendations reflected trends related to
   - level of program maturity
   - extent to which program was able to tailor or influence the initiative's activities in the AWE
   - perceived value of the data and recommendations gained
   - the perceived benefit received from the AWE
6. A hierarchy of reasons why recommendations made were or were not fully implemented.

Finally, the collected subjective comments were analyzed to draw conclusions to answer the primary and secondary research questions and develop a characteristic description of programs that are best positioned to gain valued investment and requirements information from participation in Advanced Warfighting Experiments.

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IV. FINDINGS ON THE USE OF DERIVED INFORMATION IN SUPPORTING ACQUISITION DECISIONS

A. INTRODUCTION

This chapter presents the summaries of the subjective ratings gathered from the thesis survey. Section A of this chapter discusses the statistical measures gathered from the survey to include:

- the level that OPTEC recommendations were implemented
- the extent to which managers could tailor or influence their program's participation in the AWE
- the perceived value of recommendations gained from the AWE
- the level that programs benefited from participation
- the factors influencing implementation or lack of implementation

Section B provides an analysis of recommendation implementation based on the above program issues. Section C summarizes this chapter.

B. FINDINGS

1. Implementation of Recommendations

Respondents were asked to indicate the term that best described the extent that specific recommendations made by the OPTEC Live Experiment Assessment Report were implemented by their respective programs. The survey corresponding with each program included from two to seven recommendations derived from the Assessment Report. The total number of recommendations evaluated was one hundred. Possible responses included "Fully", "Mostly", "Limited", or "Not at All." For analysis purposes, the response choices were given an ordinal value such that the number four represented "Fully" and the number one represented "Not at All." The included survey instruments provided one hundred total recommendations to be evaluated. Where differences existed between the perceived level of implementation as reported by the program manager and that reported by the user representative, an average score was used.

The average level of reported implementation was 2.52, translating into a rating between "Limited" and "Mostly". The median response was 3.0, signifying "Mostly" implemented. A histogram of reported levels of implementation is shown as Figure 5. Of all the included recommendations, 52% were either fully or mostly implemented. It is important to note that there was a fairly even split between those recommendations that were fully or mostly implemented and those with limited or no implementation.

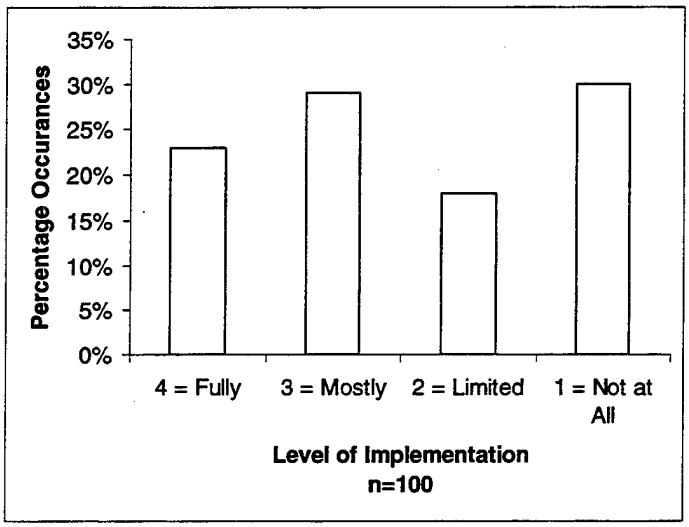

Figure 5. Reported Levels of Recommendation Implementation

2. Ability to Tailor or Influence a Program's Activities in the AWE

Respondents were asked to rate to what extent they were able to tailor or influence their program's specific activities in the AWE to relate to the issues and decisions they faced as acquisition managers. Examples of possible tailoring included modifications of scenarios to insure data availability for specific issues, influence over tactics and techniques used by participants in the experiment, and contribution to the data collection or analysis plan. For the purposes of analysis in this thesis, the gathered data were converted to a numerical scale from one to five with five being a high ability to tailor or influence and one being a low ability. A total of twenty-eight responses were evaluated. Ten respondents chose not to answer the question.

The average level of ability to tailor or influence activities was 2.14 on a scale of one to five, translating into a rating slightly lower than the middle of the range. The median response was 1.0, signifying a very low ability to tailor their activities. The mode of responses was also 1.0. A histogram of reported levels of implementation is shown as

Figure 6. It is important to note that 54% of all respondents reported a very low ability to tailor or influence activities.

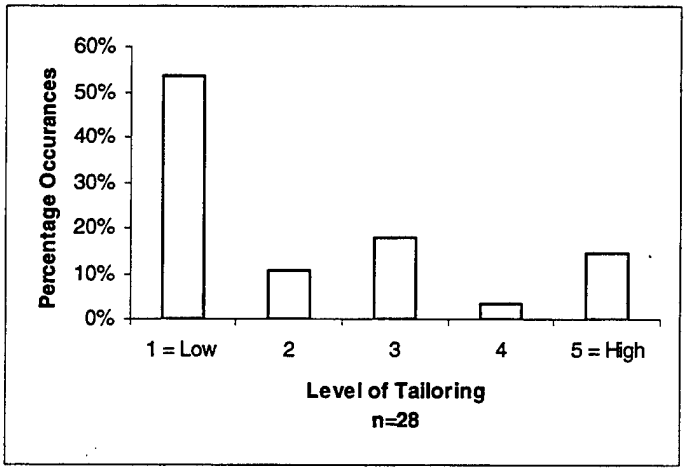

Figure 6. Reported Ability to Tailor or Influence a Program's Activities in the AWE

3. Perceived Value of Data and Recommendations Gained from Participation in AWE

Respondents were asked to rate the value of the data and recommendations gained from participating in the AWE in making decisions as acquisition managers. For the purposes of analysis, the gathered data was converted to a numerical scale from one to five with five signifying that the data was of high value and one signifying low value. A total of thirty-one responses were evaluated. Seven respondents chose not to answer the question.

The average perceived value of the data and recommendations from the AWE was 3.10 on a scale of one to five, translating into a rating directly midpoint of the range. The median response was also 3.0. The responses had no significant mode. A histogram of reported perceived values is shown as Figure 7. The collected data indicate that 42% of the included programs considered the value of the data and recommendations gained as highly valuable (rated 4 or 5) while 39% perceived the value as very low (rated 1 or 2). The degree of perceived value varied significantly among initiatives.

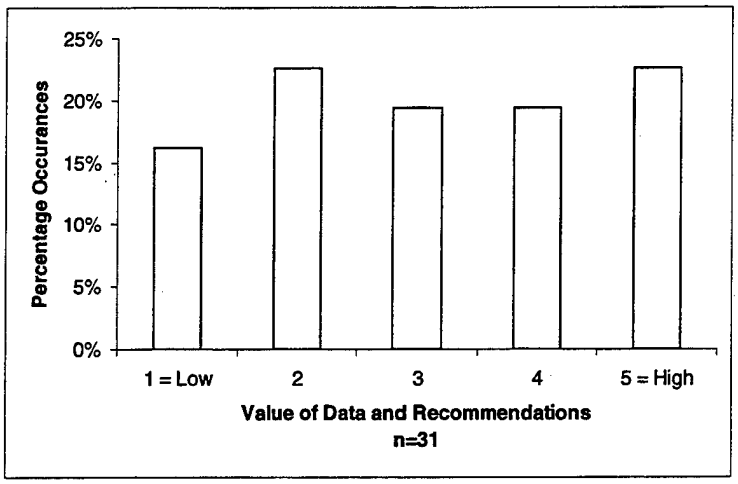

Figure 7. Reported Value of Data and Recommendations Gained from AWE

4. Perceived Benefit from Participating in AWE

Respondents were asked to rate to what extent their program benefited from participating in the AWE. For the purposes of analysis, the gathered data were converted to a numerical scale from one to five with five signifying the AWE was highly beneficial and one signifying that it was less beneficial. A total of thirty-four responses were evaluated. Four respondents chose not to answer the question.

The average perceived extent of benefiting from the AWE was 3.21 on a scale of one to five, translating into a rating slightly above the midpoint of the range. The median response was also 3.0. The responses were bimodal at 3.0 and 5.0, signifying a varying degree of benefiting. A histogram of reported perceived values is shown as Figure 8. The data indicates that 45% of included programs benefited from the AWE (rated 4 or 5). However, 33% of programs reported little to no benefit (rated 1 or 2).

5. Factors Affecting the Implementation of Recommendations

Respondents were asked to rate the extent that specific factors supported the implementation of AWE recommendations and also the extent that specific factors represented reasons why recommendations were not fully implemented. The collected data was converted to a numerical scale from one to five with five indicating that the factor was highly significant and one indicating that the item was not a significant factor. Six items were presented to the respondents as reasons for less than full implementation. A total of thirty-six responses were evaluated for reasons for less than full

implementation. Two respondents chose not to rate any factors. Four items were presented to the respondents as factors supporting implementation. A total of thirty-four responses supporting implementation were evaluated. Four respondents chose not to rate any factors supporting implementation.

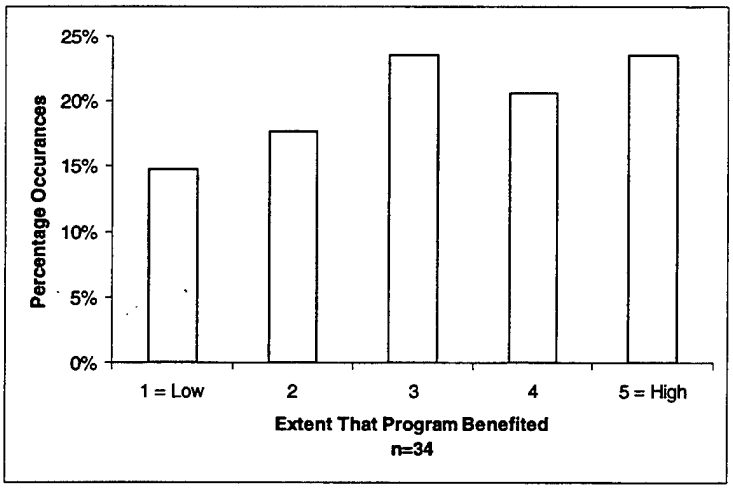

Figure 8. Reported Extent that Program Benefited from Participation in the AWE

a. Reasons for Less Than Full Implementation

As shown in Figure 5, seventy-five percent of the one hundred included recommendations were not fully implemented. A summary of the medians and associated 95% confidence intervals for the factors inhibiting full implementation are illustrated in Figure 9. According to the survey, a lack of money was the most significant reason that recommendations derived from participation in the AWE were not fully implemented. This factor had a median rating of 4.0 with a rating of five meaning the item was highly significant. This factor rated far above any other item, including the second most cited reason, that test data and recommendations were not valid. The least significant item, according to respondents, was that the recommendations were not technically feasible. Other items, to include a lack of time to implement, AWE evaluators not understanding the user's requirements, and data and recommendations not being accurate, were not reported as significant factors.

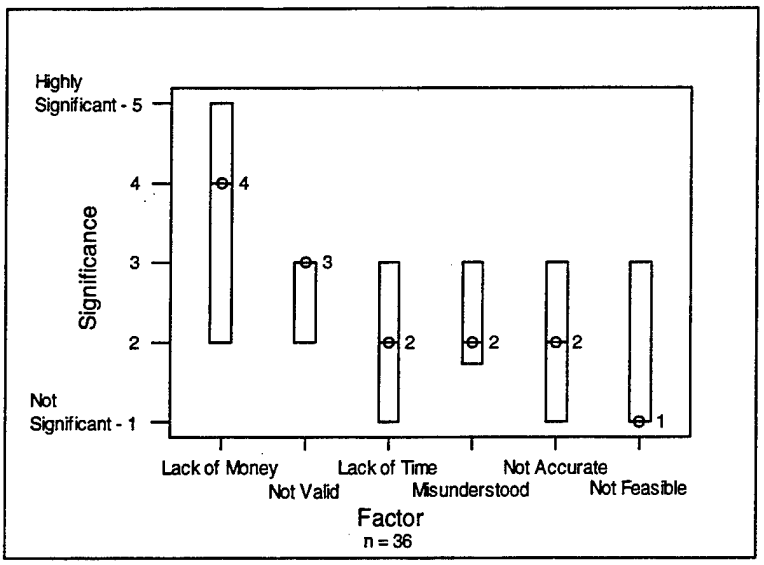

Figure 9. Median Values of Reasons for Less Than Full Implementation

b. Factors Supporting Implementation

As shown in Figure 5, fifty-two percent of the one hundred included recommendations were either fully or mostly implemented. The most significant factor supporting implementation of AWE recommendations was that the recommendation was considered a high priority by the user. This factor had a median value of 4.0 on a scale from one to five. This factor was higher than any other rated item, including that the issue was fully funded, was considered a high priority by the program office, or had a strong political backing. A summary of the factor medians and associated 95% confidence intervals for the thirty-four included initiatives are graphically illustrated in Figure 10.

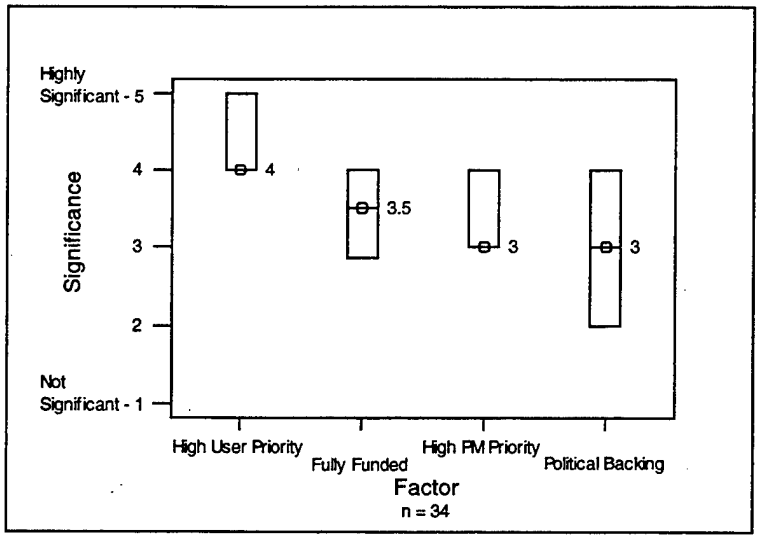

Figure 10. Median Values of Factors Supporting Implementation

C. ANALYSIS

1. The Effects of Perceived Value of Data and Recommendations on Implementation

The perceived value of AWE data and recommendations was compared to the levels of recommendation implementation. Survey responses were grouped according to reported perceived value of data. Figure 11 illustrates the median level of recommendation implementation by the reported value of data and the associated 95% confidence intervals. Those reporting very low value in the received AWE data indicated a median implementation level of 2.0 on a scale of one to five with 95% confidence that the level of implementation was between 1.0 and 3.5. Those reporting very high value in the received AWE data indicated a median implementation level of 2.75 with 95% confidence that the level of implementation was between 1.0 and 3.9. Those initiatives reporting high values of data value reported slightly higher rates of recommendation implementation. However, the wide range of responses and resulting large confidence intervals suggests that the extent that recommendations were implemented varied only slightly across the entire reported spectrum of perceived value of data.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .757 showing no significant difference among the median ratings of the value of AWE data. Therefore, the data indicates that the perceived value of AWE data and recommendations was not in correlation with the level of recommendation implementation.

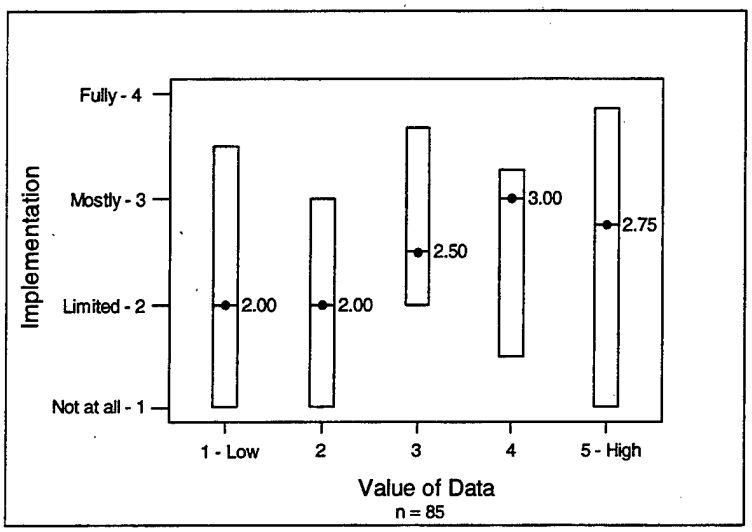

Figure 11. Median Levels of Recommendation Implementation by Value of Data

To determine if the perceived value of data had a causative effect on the level of recommendation implementation, a comparison was made of the reported value of data and implementation levels. Implementation levels were grouped into two samples: (1) fully and mostly, and (2) limited and not at all. Figure 12 illustrates the median level of value of data by the reported implementation level and the associated 95% confidence intervals. Those programs with recommendations that were fully or mostly implemented reported a median value of data equal to 3.0. Those programs with recommendations that had limited implementation, or no implementation at all, reported a median value of data equal to 2.0. A trend is evident that suggests programs with high levels of recommendation implementation reported higher levels of value of data.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .322 signifying that the two levels of implementation are not significantly different in terms of the value of the data received from the AWE. Although a trend is evident that suggests programs with high levels of recommendation implementation reported higher levels of value of data, the small sample size and large

variance leads to a statistically insignificant conclusion. An analysis of the respondent comments helps to explain the suggested trend and variance in responses.

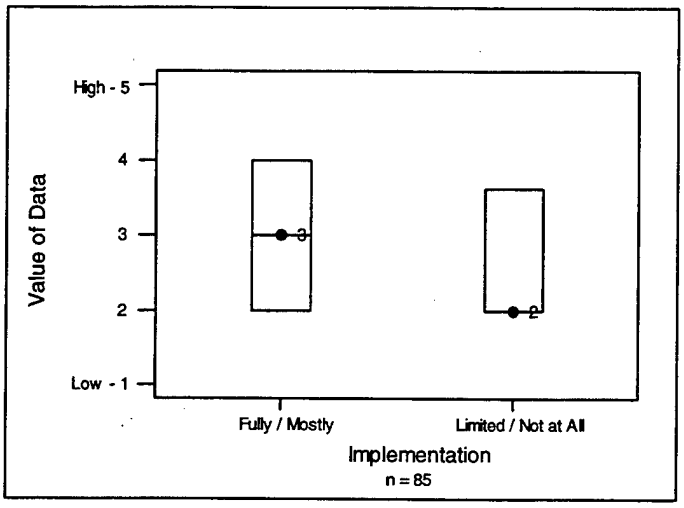

Figure 12. Median Levels of Value of Data by Recommendation Implementation

A program manager for a conceptually new communication program stated that the feedback from the AWE was very valuable in the decision making process because it was based on actual user feedback and very specific user requirements. However, the recommendations provided by the AWE Live Assessment Report were not all technically feasible. The program's technology was also considered commercial-of-the-shelf (COTS) and did not lend itself to recommendation implementation. The user representative from a program currently in full production stated that the data gained was highly valuable in developing tactics, techniques, and procedures. However, the recommendations requiring contractor developmental effort could not be implemented because of a lack of available research, development, and procurement funding as well as the inability to be included in production models due to the late stage of maturity for the initiative. The program manager of the same initiative stated that the value of the data was only moderately valuable in identifying "connectivity issues" (the interoperability of digital systems) associated with TF XXI and that most of the recommendations fell outside of the responsibility of the program management office.

Data indicated that the OPTEC recommendations were either fully or mostly implemented by one program in the concept exploration phase of development. However, the program manager of this initiative stated that the value of the AWE data

was low because those in leadership positions were not willing to acknowledge the demonstrated capabilities of the system. Another program manager stated that the recommendations had low value in making decisions because of the statistically insignificant data provided by an unrepeatable experiment.

It can be concluded from the above data and statements that the perceived value of the data may not have been a significant factor in the implementation of the AWE recommendations. The trend pattern of medians suggests a positive correlation. However, the small sample size in each group leads to a lack of statistical significance. Qualitative comments elaborated the rating results that factors other than perceived value of data effected the recommendation implementation. Specifically, participants considered data valuable in making decisions as acquisition managers when the recommendations met one of three requirements. First, the data was valuable when it provided actual user feedback on specific user requirements. Second, data was considered valuable when it contributed to the development of tactics, techniques, and procedures. Finally, the data was considered valuable when it was provided at a time when it could be instrumental in refining requirements and design.

2. The Effects of Perceived Benefit from Participating in the AWE on Implementation

The perceived benefit from participating in the AWE was compared to the recommendation implementation levels. An acquisition manager's perception of the extent that a program benefited from participating in the AWE was reflected in the level that AWE recommendations were implemented. Survey responses were grouped according to reported perceived benefit gained from the AWE. Figure 13 illustrates the median level of recommendation implementation by the extent that a program benefited from the AWE and the associated 95% confidence intervals. The programs that reported a very low level of benefit from participating in the AWE indicated a median implementation level of 1.0 (not at all) on a scale of one to five with a 95% confidence that the implementation was between 1.0 and 2.0. Those reporting a very high level of benefit indicated a median implementation of 2.8 (mostly implemented) with a confidence interval from 1.5 to 3.0.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .036 showing that the median levels of

implementation were significantly different when comparing levels of reported perceived benefit. Therefore, the data indicates that the perceived benefit of the AWE was in correlation with the level of recommendation implementation. The data indicates that those programs receiving moderate to high benefit from the AWE were more likely to implement the OPTEC recommendations then those reporting low or very low.

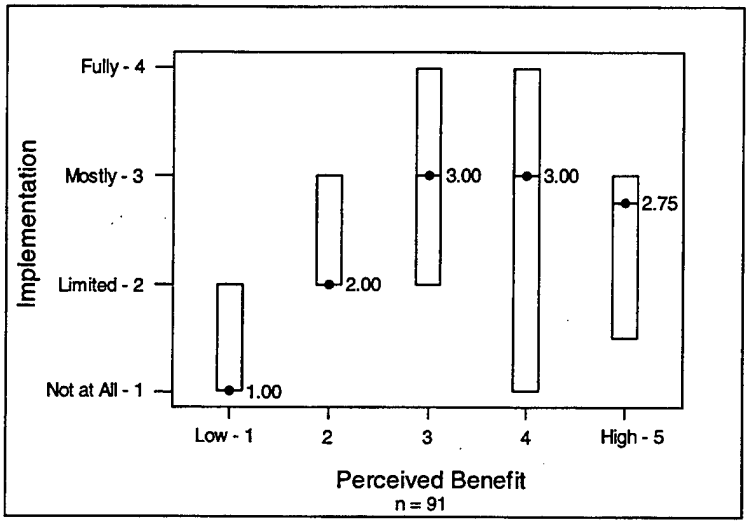

Figure 13. Median Levels of Recommendation Implementation by Perceived Benefit

To determine if the level of recommendation implementation had a causative effect on the perceived benefit from AWE participation, a comparison was made of the reported perceived benefit and implementation levels. Implementation levels were grouped into two samples: (1) fully and mostly, and (2) limited and not at all. Figure 14 illustrates the median level of perceived benefit by the reported implementation level and the associated 95% confidence intervals. Those programs with recommendations that were fully or mostly implemented reported a median perceived benefit equal to 4.0. Those programs with recommendations that had limited implementation, or no implementation at all, reported a median perceived benefit of 3.0. A trend is evident that suggests programs with high levels of recommendation implementation reported higher levels perceived benefit.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .117 signifying the difference in the two implementations levels are not significantly different in terms of the perceived benefit of the AWE. However, this difference comes close to the critical value of $p < .10$ often used

for small sample tests. The small sample size and variance leads to a statistically inconclusive finding. However, the data shows that their is some effect. An analysis of the respondent comments helps to explain the suggested trend and variance in responses.

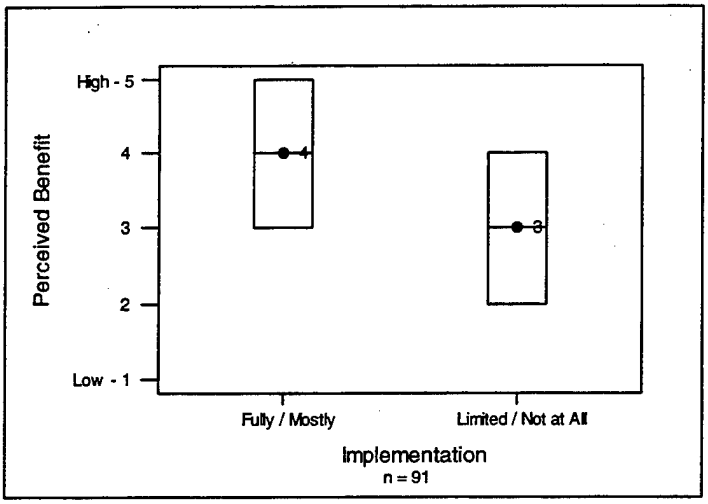

Figure 14. Median Levels of Perceived Benefit by Recommendation Implementation

A program manager directing a pre-milestone II initiative stated that the AWE provided tremendous insight for Program Definition and Risk Reduction (PDRR). All of the associated AWE recommendations for this initiative were fully implemented. It is interesting to note that the mean implementation level in those programs receiving the most benefit from the AWE (high = 5) was lower than those reporting moderate of moderately-high levels of benefit (3-4). The mean recommendation implementation level of these programs receiving high benefit was reduced by two specific initiatives. Both initiatives reported a high level of benefit received with no implementation of recommendations (not at all = 1). The first program stated that none of the recommendations fit any of the user's requirements. The user representative for the program stated that the high level of benefit was attributed to the attention and exposure that the initiative's performance generated at the AWE. The second program was a logistics and support system that, according to the program manager, was not adequately stressed in the AWE environment. None of the recommendations were implemented because it was felt that the data and recommendations were not valid or accurate. The program manager stated that the focus of the AWE was on combat systems and not on the

associated support systems. The main benefit this program manager reported was critical feedback from the user on required functionality.

The high level of implementation for those programs reporting moderate benefit (3) from the AWE was effected mostly by one initiative that reported full implementation of all AWE recommendations. The program reported, however, that all but one of the shortcomings was identified prior to the AWE and that the AWE was not instrumental in identifying these problems. Therefore, the program manager reported high levels of recommendation implementation but a moderate benefit from the AWE.

It can be shown from the collected data and comments that the level of recommendation implementation and the perceived level of benefit from the AWE were generally related. It cannot be concluded, however, that the implementation of AWE recommendations was solely responsible for a respondents perception of benefit, as illustrated by the provided comments and slightly lower recommendation implementation levels for those reporting a high amount of perceived benefit. A wide range of confounding factors effected an initiatives ability to benefit from the AWE. These contributing factors to a program's ability to benefit from participation in the AWE are discussed in Chapter V.

3. Effects of Tailoring a Program's Activities in the AWE on Implementation, Value of Data, and Perceived Benefit

The reported ability to tailor or influence a program's activities in the AWE was compared to collected data on recommendation implementation. Tailoring was defined as the ability to influence the program's activities to relate to the issues and decisions facing the program. Additionally, comparisons were made between the ability to tailor and perceived value of data as well as the ability to tailor and the reported level of benefiting from AWE participation. For the following comparisons, survey responses were grouped according to reported ability to tailor or influence program activities in the AWE.

a. Tailoring and Implementation

Figure 15 illustrates the median level of recommendation implementation by the extent that a program was able to tailor and the associated 95% confidence intervals. The median implementation level reported for those programs with a low ability to tailor or

influence was 2.0 (limited implementation) on a scale of one to five with a 95% confidence that the value was between 1.0 and 3.0. The median implementation level reported for those programs with a high ability to tailor their activities was 3.5 (mostly to fully implemented) with an associated confidence level between 2.6 and 3.9. Implementation levels increased as levels of tailoring increased for every factor but one. . The low median implementation level for the tailoring factor of four can be attributed to a significantly low sample consisting of only one initiative. This initiative was a production item that lacked developmental funds to implement the derived recommendations.

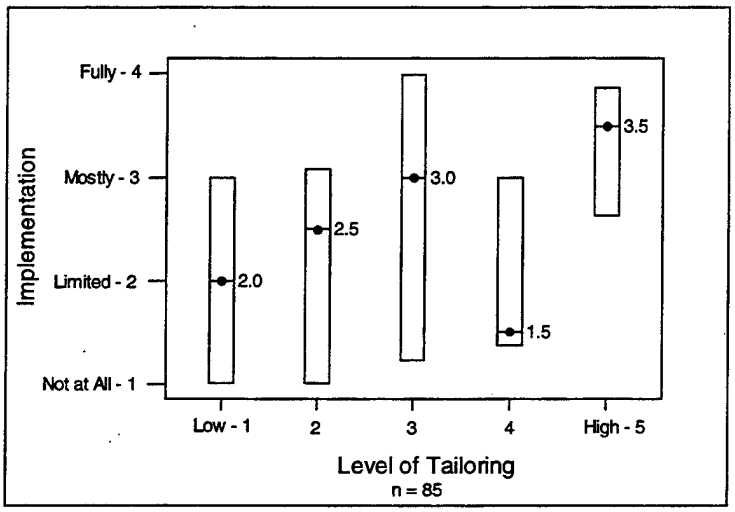

Figure 15. Median Levels of Recommendation Implementation by Level of Tailoring

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .062. Given a significance criterion of $p < .10$, this demonstrates that the levels of tailoring differ significantly in terms of the degree of implementation of recommendations. Therefore, the data indicate that the level of recommendation implementation level was in correlation with the reported ability to tailor. The collected data suggest that as a program manager's ability to tailor activities in the AWE to relate to the program's issues and decisions increases, so does the implementation level of derived recommendations

To determine if the level of tailoring had a causative effect on the level of recommendation implementation, a comparison was made of the reported ability to tailor and recommendation implementation levels. Implementation levels were grouped into

two samples: (1) fully and mostly, and (2) limited and not at all. Figure 16 illustrates the median level of tailoring by the reported implementation level and the associated 95% confidence intervals. Those programs with recommendations that were fully or mostly implemented reported a median perceived benefit equal to 2.0. Those programs with recommendations that had limited implementation, or no implementation at all, reported a median perceived benefit of 1.0. A trend is evident that suggests programs with high levels of recommendation implementation reported higher levels ability to tailor.

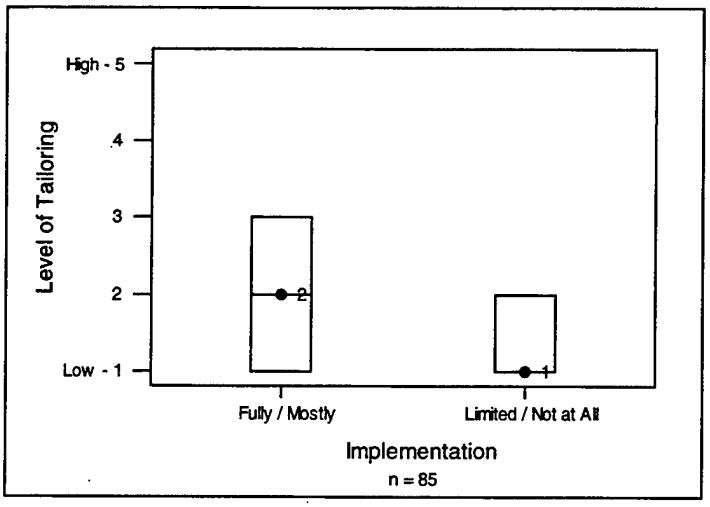

Figure 16. Median Levels of Tailoring by Recommendation Implementation

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .091. Given a significance criterion of $p < .10$, this analysis shows the higher implementation group reported significantly more tailoring than the low implementation group.

b. Tailoring and Value of Data

Figure 17 illustrates the median level of perceived data value by the extent that a program was able to tailor and the associated 95% confidence intervals. The median value of data and recommendations reported for those programs with a low ability to tailor or influence was 3.0 on a scale of one to five. The median value of data reported for those programs with a high ability to tailor their activities was 5.0. The very low sample size prevented the calculation of confidence intervals for some levels of tailoring.

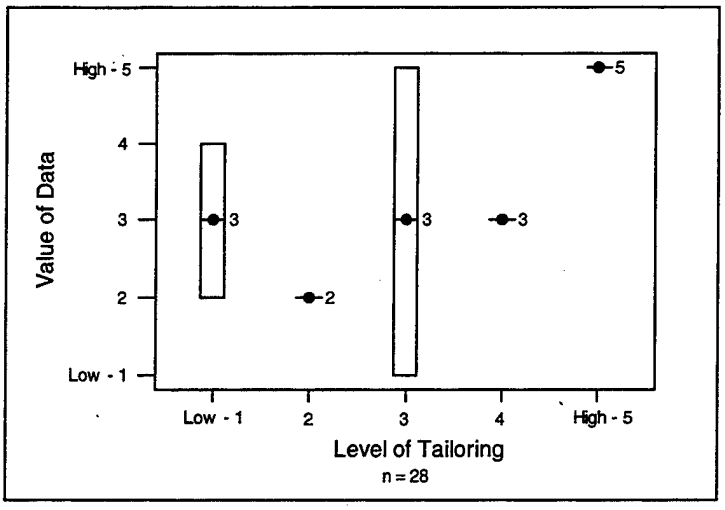

Figure 17. Median Levels of Perceived Value by Level of Tailoring

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .042 demonstrates that the levels of tailoring differ significantly in terms of the rated value of data resulting from the AWE. A trend is evident in the data that suggests as a program manager's ability to tailor activities in the AWE increases, so increases the perceived value of the data and recommendations in making acquisition management decisions. However, the wide range of responses and associated confidence intervals requires further analysis of provided comments to reach a conclusion on the correlation of tailoring ability with value of data. This concept is explored further in Chapter V.

c. Tailoring and Perceived Benefit

Figure 18 illustrates the median level of perceived benefit by the extent that a program was able to tailor activities in the AWE and the associated 95% confidence intervals. The median perceived benefit reported for those programs with a low ability to tailor or influence was 3.0 on a scale of one to five. The median value reported for perceived benefit of those programs with a high ability to tailor their activities was 5.0. The very low sample size prevented the calculation of confidence intervals for some levels of perceived benefit.

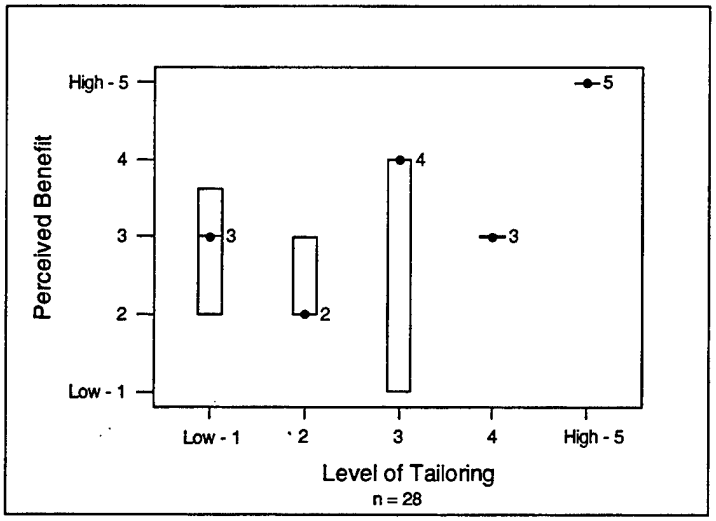

Figure 18. Median Levels Perceived Benefit by Level of Tailoring Ability

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .054 demonstrates that the tailoring levels differed significantly in their reported benefits of the AWE. The data indicate that a high ability to tailor or influence activities in the AWE had a correlation with the perceived benefit gained. Those initiatives reporting a low ability to tailor, generally had low levels of perceived benefit.

d. Conclusions on Ability to Tailor

It can be concluded that the extent that a manager was able to tailor or influence a program's specific activities in the AWE to relate to the program's acquisition issues and decisions directly contributed to the level of recommendation implementation, perceived value of data, and the extent that the program benefited from participating. However, the wide range of responses and associated confidence intervals requires further analysis of provided comments to reach a conclusion on the effects of increased tailoring ability. These trends are explored in more detail in Chapter V.

4. The Effects of Program Maturity on Implementation, Value of Data, and Perceived Benefit

The program's level of maturity while at the AWE was compared to the data collected on recommendation implementation. Additionally, comparisons were made between maturity and perceived value of the data and recommendations, and also between maturity and the perceived benefit from AWE participation.

Programs were categorized into maturity groupings based on the standard Department of Defense acquisition management process as detailed in DoD Regulation 5000.2-R. Phase 0 is Concept Exploration (CE) and typically consists of competitive, parallel short-term concept studies. Programs that were Advanced Technology Demonstrations (ATDs) are also included in this group. Phase I is Program Definition and Risk Reduction (PDRR). In PDRR, programs become defined as one or more concepts, design approaches, and/or parallel technologies. Phase II is Engineering Manufacturing and Development (EMD). In EMD, the most promising design approaches are translated into stable, producible, supportable, and cost-effective designs. Also manufacturing and production processes are developed and system capabilities are demonstrated through testing. Programs late in EMD begin Low Rate Initial Production (LRIP). The initiatives that have begun LRIP have been group under Limited Product (LP). Phase III is production, fielding, deployment, and operational support and have been grouped as production items (PROD). [DoD 5000.2-R].

a. Maturity and Implementation

Figure 19 illustrates the median levels of recommendation implementation by program maturity and the associated 95% confidence intervals for the medians. This comparison was conducted using multiple recommendations for each of the thirty-seven included programs, resulting in a sample size of one hundred. The highest level of recommendation implementation was seen on those programs in Engineering and Manufacturing Development (EMD) with a median implementation level of 4.0 (fully implemented) on a scale of one to five with a 95% confidence interval from 3.0 to 4.0. The lowest levels of implementation were on either end of the spectrum, with Concept Exploration (CE) and Advanced Technology Demonstration (ATD) initiatives reporting a median of 2.5 and full rate production items having a mean of 2.0.

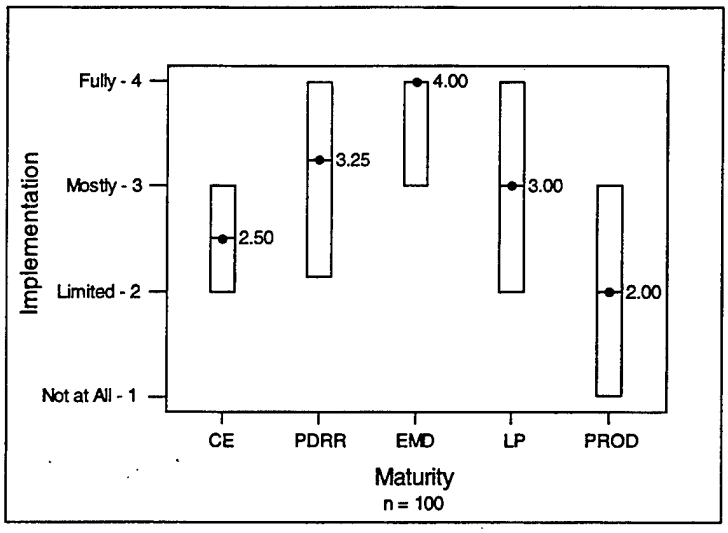

Figure 19. Median Levels of Implementation by Maturity

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .021. This finding shows that the maturity levels differed significantly in terms of the degree of implementation of recommendations. The data indicates a trend in which programs with high levels of recommendation implementation were most likely midpoint in programmatic development.

b. Maturity and Value of Data

Figure 20 illustrates the median level of perceived value of data and recommendations by initiative maturity and 95% confidence levels for each median value for each of the thirty-seven included programs. The highest median score for value of data was reported by those programs in the PDRR phase of development, with a median of 5.0 on a scale of one to five with a 95% confidence that the value was between 1.0 to 5.0. Programs in EMD had the second highest median at 4.0. Programs in Limited Production (LP) and Production placed the lowest value on the data received, rating at 2.0 and 3.0 respectively. Programs in CE also scored low, with a median of 3.5.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .458 indicating no significant difference in the maturity levels of programs and their respective ratings of data value. Therefore, the data indicates that value of data and recommendations was not in significant correlation

with level of maturity. However, the data indicates a possible trend between programmatic maturity and the perceived value of the data and recommendations gained from the AWE in making decisions as acquisition managers. Those programs in the mid-developmental phases of acquisition were more likely to report high perceived value of data and recommendations than those programs early or late in development. Further analysis of provided comments is required to determine the correlation between these two factors. This correlation is explored further in Chapter V.

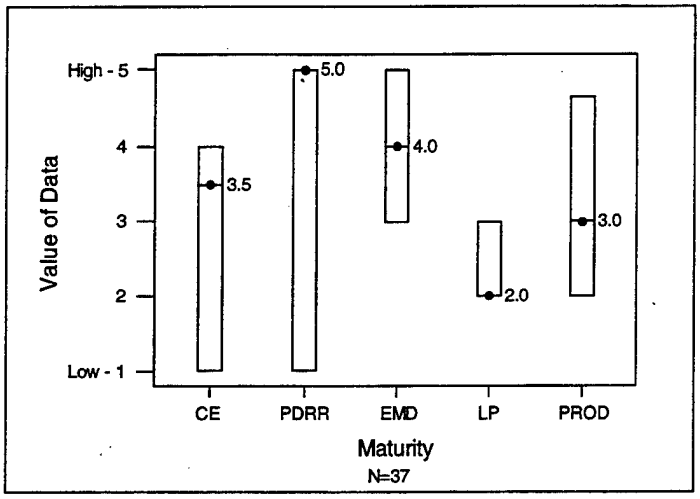

Figure 20. Median Perceived Value of Data by Maturity

c. *Maturity and Perceived Benefit*

Figure 21 details median levels of reported benefit by program phase of development with 95% confidence intervals on the medians. The highest reported benefit was seen by those programs in PDRR and EMD with a reported median value of 4.0 on a scale of one to five with a 95% confidence that the value was between 2.0 and 5.0 for PDRR and between 3.0 and 5.0 for EMD. Initiatives in production reported similar perceived benefits. Initiatives in CE and limited production had median values of 3.0.

A Kruskal-Wallis H test was conducted to determine the equality of the sample medians. The test resulted in a P of .235 signifying no difference in the median reported perceived benefit by levels of maturity. Therefore, the data indicates that perceived benefit was not in correlation with level of maturity. However, there is a trend, not supported by statistical findings, that those programs in or near the mid-developmental phases of acquisition were more likely to report higher levels of benefit

then those programs in other phases. Of additional importance, those programs late in production reported high levels of benefit. A full analysis of the perceived benefits of AWE participation, as reported by acquisition managers is included in Chapter V and fully explains these trends

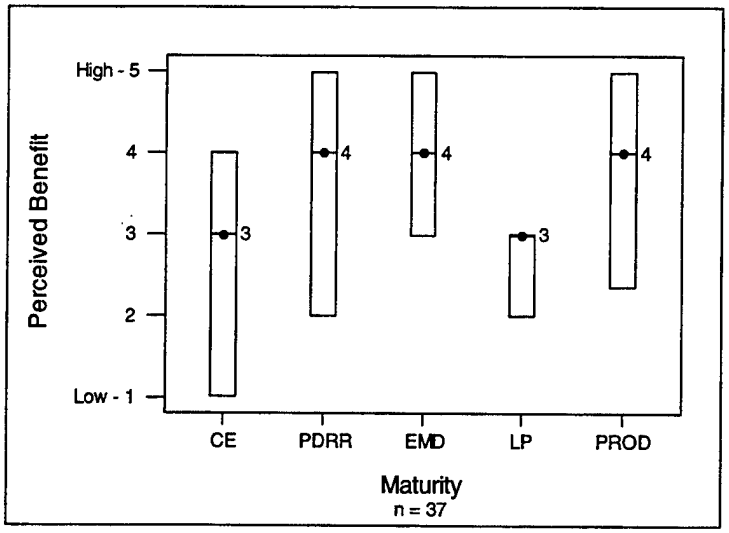

Figure 21. Median Perceived Benefit by Maturity

d. Conclusions on the Effects of Maturity

It can be concluded that a program's level of maturity related to the level of recommendation implementation. A trend is evident that more maturity did not directly transcribe into a higher ability to benefit, but rather points existed on the maturity spectrum where a program was best positioned to benefit from the experiment. Additionally, a similar pattern of relationship seams to exist between a program's level of maturity and the perceived value of data. The preceding data indicates that a program reported the highest level of implementation, perceived value of data, and benefit if it was in the mid-development phases at the time of the AWE. Programs early in development, or into production, generally reported lower values for these items. However, initiatives in production also reported high levels of benefit, even though they did not fully implement the AWE recommendations. This suggests that factors other than recommendation implementation may have effected a program's ability to benefit. Maturity's effect on a program's ability to benefit from participating in the AWE, as well as other factors, are explored in Chapter V.

D. CHAPTER SUMMARY

This chapter presents the summaries of the subjective ratings gathered from the thesis survey and the findings on the use of information derived from the AWE in supporting acquisition decisions. Gathered subjective comments are provided to help interpret the data. Overall, programs reported that fifty-two percent of the OPTEC recommendations from the AWE Live Assessment Report were either fully or mostly implemented. Thirty percent of recommendations were not implemented at all. A combined fifty-four percent of initiatives reported a low ability to tailor their activities in the AWE to relate to issues and decisions they faced as acquisition managers. Respondents indicated only a moderate benefit from participating in the AWE and that the data and recommendations received were only somewhat valuable. The most cited reason for recommendations not being implemented was a lack of funding. The recommendation was most likely to be implemented if it was a high priority of the user.

The quality and amount of collected data enables one to reach several conclusions about a program's participation in the AWE. First, the perceived value of the data and recommendations did not have a statistically significant role in determining if recommendations were implemented. However, those programs that had reported the most benefit from the AWE generally had higher levels of recommendation implementation. Secondly, the data suggest that the ability to tailor activities in the AWE contributed to the resulting implementation levels. The data indicates a significant relationship between degree of tailoring and the level of implementation, the value of the data, and the reported benefits of the AWE. A trend was evident that a program's phase of development also was a factor in receiving benefit from the AWE in that programs in or near the mid-developmental phases reported higher levels of recommendation implementation and value of data than did programs that were early or late in their developmental lifecycle. This trend is illustrated by the dramatic inverted "U" shape seen in Figures 18, 20, and 21. This trend is explored further in Chapter V.

The acquisition manager's definition of the term "benefit" as it applies to AWE initiatives is instrumental in conducting further analysis of the outcomes of the AWE. The next chapter provides further analysis of the factors contributing to a program's ability to benefit from the AWE based on this data as well as collected subjective comments.

V. ANALYSIS OF CONTRIBUTING FACTORS TO BENEFITING FROM ADVANCED WARFIGHTING EXPERIMENTS

A. INTRODUCTION

This chapter presents analysis and findings on the contributing factors to acquisition managers benefiting from Advanced Warfighting Experiments. The analysis is based on survey ratings data presented in Chapter IV, subjective comments provided by the open-ended questions of the survey, and opinions collected during personal interviews. The themes discussed in this chapter represent the opinions of a significant number of respondents and interviewees. Section B discusses how the level of benefit derived from the TF XXI AWE for acquisition managers was limited due to the nature and environment of the experiment. Section C defines "benefit" as perceived by the majority of acquisition managers and discusses the various benefits received by TF XXI AWE participants. Section D discusses the implementation of the Decision to Experiment Ladder (DEL) during the AWE and how it effected a program's ability to benefit. The DEL is analyzed in terms of objective documentation, utilization of the AWE, and a manager's ability to tailor his initiative's participation in the AWE. Section E provides findings on the effects of program maturity on the ability to benefit. Section F presents risk considerations and a tentative risk and benefit analysis plan for acquisition managers considering future AWE participation. A chapter summary is included as Section G.

B. LIMITATIONS DUE TO THE NATURE OF THE EXPERIMENT

According to the experiment's directive, the Task Force XXI Advanced Warfighting Experiment was not designed to provide significant benefits to the acquisition manager. The AWE process was designed primarily to determine if digitization of the force resulted in increases in lethality, survivability, and tempo [ECC, 1996]. The nature of the AWE experiment limited the potential derived benefits for the program manager. The acknowledged limitations in the design of the AWE experiment caused by low repeatability, incomplete data collection, the interaction of effects of varying initiatives, and small sample size, precluded any summative findings. Formative uses of the AWE by the acquisition team were also limited because, according to one

acquisition manager, "large scale exercises do not lend themselves to gathering data that is useful." According to many program managers, the experiment's results were influenced by politics. Finally, the applied results of the AWE made many managers question the utility of the exercise.

1. Design of the Experiment

The design of the AWE, its large scale, and the attempt to combine training with assessment, did not allow a controlled, repeatable experiment. Data collection was limited to insure that it was unobtrusive to the training unit. The large number of interacting initiatives participating in the AWE led to confounded results. Finally, the relatively small sample of focused iterations and unrepeatability of the experiment prevented the collection of statistically meaningful data. A program manager stated that the AWE data and recommendations had low value because they were statistically insignificant and thus, invalid. The limitations in the experiment's design were a result of the large scale of the exercise.

2. Scale of Experiment

The large scale of the AWE prohibited the detailed evaluation of a system's technical performance. When asked to provide comments that would assist planners in designing experiments that would better benefit participating acquisition managers, a respondent stated that "large exercises such as TF XXI do not permit the evaluation of a system's increase or decrease in combat effectiveness." Another official stated that "analysis from an AWE perspective does not usually attempt to discriminate what in particular within a program contributed to an overall experimental outcome." The previous respondent went on to state that "the amount of equipment required for adequate data collection and storage is cost [prohibitive]...In the best cases, 50% of the actions performed by the crews is captured. This causes inaccurate conclusions in most cases." Another respondent stated:

> These large scale exercises, that have multiple new systems installed on individual vehicles, negate any positive outcome. The soldiers are required to learn many new systems and TTPs [tactics, techniques, and procedures] at one time and this leads to mass confusion. In many cases the systems under evaluation were simply turned off or never turned on. These large scale exercises are a political asset and provide no concrete data for decision makers to make a decision on the system.

3. Political Influence

The influence of politics was a topic discussed by many acquisition managers participating in the survey. While "strong political backing" was the lowest rated reason that recommendations were implemented, participants believed that the preconceived biases of senior army officials effected the final perceptions of a program's performance at the AWE. One participant stated, "watch the politics. On day one of the AWE, the event was declared a major success. Contrary opinions were downgraded. This mindset started with the then TRADOC Commander. Ethics and testing are a key consideration." Another respondent stated that "incoming biases prevented any real analysis of the system." The Army's Applique program, now called Force XXI Battle Command Brigade and Below (FBCB2) was often cited as a program that performed marginally in the AWE but received the majority of post-AWE funding because "Army leadership backed them" and the system was "pushed from the top".

4. Utility of Experiment

Some AWE initiatives received high marks at the experiment but were subsequently terminated, leaving the acquisition managers of those programs with negative impressions about the utility of the experiment. A program manager for an initiative with a large role in the AWE commented that their system had great performance but Army leadership did little to exploit the system. A user representative for a now terminated program stated:

> The use of [the initiative] in the AWE makes me question the criteria for a program's acceptance into the AWE. If the [initiative] was never going to be accepted it should not have been included...Bottom line to us is that even though this [initiative] proved very successful, its acceptance was doomed from the start. In the end a great deal of time, money, and energy was wasted in this effort.

For a small scale initiative participating in the experiment, the AWE was described as a "lose/lose" situation. The program manager stated that "there were only a handful of high visibility programs. While the AWE was a great way of proving out a system, the smaller initiatives couldn't get any visibility." In a personal interview, a product manager summarized that the AWE was a "diversion." It was "not focused on the end goal of getting the product in the hands of the soldiers. The AWE took away from program resources to play in a sandbox."

5. Conclusions on Limitations

Generally, AWEs have not been designed to provide significant benefits to the acquisition managers. Managers charged with the development, production, and fielding of programs participating as AWE initiatives must take active measures to increase the likelihood of achieving benefits for the program.

C. BENEFITS TO THE ACQUISITION MANAGER

The previous section reinforces the fact that the AWE was not designed to purposefully provide data to acquisition managers. Nevertheless, survey participants identified a number of potential benefits from participation. The extent that a program benefited from participation in the AWE varied widely. Chapter IV showed that the perceived benefit from the AWE was only moderate, with differing opinions from various initiatives. Subjective comments show a wide interpretation of the term "benefit" as it applies to the acquisition manager. One respondent stated that "the feedback obtained from the AWE was very valuable to the decision making process. It is...easier to structure a program based on actual user feedback and very specific user requirements obtained during the AWE." From another perspective, a respondent stated that "there was no benefit to the program from the AWE. It cost a lot of money to provide system support...we feel that the data...will not provide any additional concrete information that can be used."

A significant number of survey participants agreed that managers must determine if potential return from participating in an AWE outweigh the costs. A cost analysis of AWE would include expenses for prototyping, manning, fielding, schedule, transportation, and other risk categories. One program manager stated:

> A study should be conducted to define the problems to be resolved and/or the goals of the AWE. It should include a section on the perceived benefits to each participant. Each PM whose participation is required should be given the opportunity to provide an impact statement to his program if he participates. He should propose alternatives to minimize the impact to his current efforts that have funds obligated.

The benefits from the AWE to the acquisition manager can be summarized into the following categories: (1) marketing and exposure of program, (2) early user feedback, (3) refinement of user requirements, (4) development of tactics, techniques, and procedures, (5) follow-on support for funding and production decisions, (6) information on integration, interfaces, and interoperability, and (7) exposure of developers to the user's environment.

1. Marketing and Exposure of Program

Participating acquisition managers were in agreement that no PM would participate in the AWE solely for the marketing effects. However, in terms of potential AWE benefits, the desire for positive exposure of their program was discussed as a benefit by respondents more than any other aspect.

The importance of being perceived as a "member of the team" was emphasized by several respondents. One program manager was adamant that he did not want to participate in the AWE but was forced into participation by the user representative. He stated that the user viewed the initiative's participation as "a marketing opportunity." Another program claimed that they participated in the AWE "to increase visibility of [the initiative's] performance capabilities rather than to address developmental issues." A program that reported a very high level of benefit from the AWE stated that benefit was "extremely high from a marketing perspective. The [initiative] demonstrated to the world its ability to dominate the battlefield."

Marketing was most often described as an ancillary benefit. In a personal interview, a senior engineer stated that the AWE process is a good way to expose the program but was not just marketing. Participation provided exposure of the program among soldiers and Army leadership. Another participant said in an interview, that the positive response to his program benefited him. He added, however, given the nature of the experiment, the results and data could not be valid.

2. Early User Feedback

Most acquisition programs do not experience any hands-on exposure to actual users until Initial Operational Test and Evaluation (IOTE). A program manager stated that any time you can get your product into the hands of the actual user early, it serves to benefit the program. IOTE was also characterized by a significant number of respondents as "too structured" to provide any significant feedback from the user. Feedback during IOTE is also "too late to impact system design."

It is still unclear if benefits associated with the transference of AWE data to reduce the operational test and evaluation process will be realized. In February 1997, an article discussing this subject stated:

> Whether or not the results from TF XXI will contribute to the formal test and evaluation...[process]...is a question under debate right now...The acquisition community has averred that the experiment data will not receive formal consideration, but at the same time we're hearing comments that the testing community needs to be cognizant of the participation in TF XXI and take advantage of the test results coming out of that. [Lum, 1997, p26]

3. Refinement of User Requirements

For the majority of respondents, participation in the AWE provided significant data to be used for the refinement of user requirements. Feedback provided from representative users experimenting with the new systems in a combat simulated environment was determined to be of high value to many acquisition managers.

For one program, the AWE caused a complete reanalysis of requirements and led to the development of new key performance parameters. One manager stated that "the AWE provides a good forum to ascertain whether or not certain requirements are feasible or even desirable from a user perspective." A user representative summarized:

> The AWE demonstrated a great deal of utility in the requirements development process. The Army's experimental process determined what concepts and technologies worked and how they can be made to work better. The process also identified concepts that did not work well.

A program manager directing a pre-milestone II initiative stated that the AWE provided tremendous insight for program definition and risk reduction. All of the associated AWE recommendations for this initiative were fully implemented. A user

representative of a program highly concerned with refinement of requirements stated that "the lessons learned from actual field user are invaluable."

Refinement of requirements was even beneficial to some programs already in production. One particular initiative utilizing extensive commercial-of-the shelf and non-developmental technology had received a Milestone III decision and moved on to production without any operational testing. Participation in the AWE resulted in "major changes in system architecture". According to the program manager, the experiences gained would be "utilized in the design of follow-on systems."

Regardless of an initiative's level of maturity, most acquisition managers were able to collect valued data that would assist in the refinement of system requirements, and contribute to the development of a more effective system.

4. Development of Tactics, Techniques, and Procedures (TTPs)

The development of tactics, techniques, and procedures (TTP) was identified by a significant number of respondents as a benefit received from the AWE. TTP development is not normally a function of the acquisition manager, but rather a function of the branch specific office responsible for organizational doctrine. However, the development of TTP is a vital step in the process of gaining user support for a technology. The program manager for one AWE system described his initiative as a whole new concept for the Army. The AWE helped to refine tactics, techniques, and procedures in an area that previously had no doctrine. Another manager stated that the AWE confirmed "a concept in an operational environment without a commitment to expensive, pre-production hardware."

5. Follow-on Support for Funding and Production Decisions

The nature of today's defense acquisition environment includes a constant struggle for program funding. A former acquisition manager stated that he spent twenty-five percent of his time as a PM dealing with funding issues on his program. Many respondents stated that one of their goals in AWE participation was to gain data to support funding requests and to "get a foot in the door for production funding".

The Army's Warfighting Rapid Acquisition Program (WRAP) was tied to the TF XXI AWE. The WRAP process was designed to accelerate the fielding of advanced systems and technologies from AWEs, Advanced Technology Demonstrations (ATDs)

and Advanced Concept Technology Demonstrations (ACTDs). WRAP links TRADOC's battle labs to the formal acquisition process so that compelling successes quickly transition from experimentation to enhanced warfighting capability. The TRADOC Commander nominates candidates for WRAP after a review based on urgency of need and compelling success. Approved candidates are then ranked by priority and given two-year funding for operational prototypes. [Monnett and Rheinlander, 1996]

Several AWE initiatives desired publicity to secure WRAP funding and used AWE results as a demonstration of compelling success. A program that was ultimately selected for WRAP commented that "the data and recommendations gained from the AWE were critical to the system's success as a WRAP candidate. Without the WRAP funding, the program was an unfunded requirement with little probability of being funded."

The attainment of production funding was of particular concern for several initiatives with no programmed dollars beyond the AWE. The Department of the Army specifically delayed production decisions on some programs until the AWE was completed. During a personal interview, a PM stated that Army leadership "expected great things of the AWE." The manager of a now terminated program commented "if the program could have shown merit at the AWE as a last chance effort, then it would have been a good investment. We had nothing to lose."

The data show that initiatives facing future funding decisions stand to receive significant benefit from AWEs if compelling success can be demonstrated in an AWE.

6. Information on Integration, Interfaces, and Interoperability

Integrating, interfacing, and interoperability of new technologies within the current Army force structure is a constant challenge among acquisition programs. AWE participants collected data to meet future integration, interface, and interoperability requirements. This data provided significant benefit to acquisition managers.

Integration in acquisition is defined as the incorporation of a system as an equal into an organization. A system interface is a common boundary between two associated systems across which information may flow. Interoperability is defined as the ability of a system to provide services to and accept services from other systems to enable them to operate effectively together. [CALL, 1999].

One program manager explained how AWE participation benefited the program in terms of integration, interfaces, and interoperability:

> Historically each PM had his own requirements to implement and did not feel justified in experimenting with interoperability. Each PM would develop an interface to other systems using the minimum resources to get the job done. The interface was implemented from a paper design based on the data that needed to be shared. In the AWE each [initiative] got the opportunity to view the operational picture as presented by each of the other [initiatives].

According to program managers, operational testing does not provide the required data to facilitate integration, interfacing, and interoperability. The AWE, however, provides much needed information on how a program "interfaces with the force." Reportedly, the AWE was a "great way of proving out hardware" and a "great way to test integration." A program manager stated that it is "always worthwhile to exercise interoperability with other systems to identify nuances and characteristics of other systems that must be 'designed to'."

7. Exposure of Developers to the User's Environment

By participating in the AWE, acquisition managers and program engineers received exposure to the user's environment in a realistic combat simulation. Most of the participating managers lacked any real experience in military field operations. This exposure was cited as a significant benefit from AWE participation.

During the AWE, program managers were allowed to observe the experiment firsthand. A participating program manager stated that the AWE was beneficial because it "allowed for realtime feedback to answer questions and understand deployment issues." A senior official with oversight of multiple initiatives in the AWE stated during an interview that the AWE had "additional intangible benefits" to the program manager, beyond the benefits derived from official collected data. The AWE provided acquisition managers "early exposure to the customer." According to the official, most of his engineers and program managers have never been on active duty. The AWE provided an opportunity for these personnel to experience the user's environment firsthand. The AWE also allowed the engineers and program managers to gather data on peripheral programs and to learn the state of technology across the force. Another program manager stated

that "the biggest benefit was from debriefing the soldiers that used the equipment. They provided more information, all be it subjective, than any questionnaire did."

The data clearly show that acquisition managers who lack significant experience in military field operations are positioned to receive significant benefit from the AWE by gaining an understanding of the environment and scenarios in which their respective systems will operate.

D. THE DECISION TO EXPERIMENT LADDER (DEL)

The decision-to-experiments ladder (DEL) discussed in Chapter II, directly links experiments to decisions and is designed to increase the utility of experiments. The DEL includes: issues, decisions to be made, argument to support the decisions, hypotheses to be adjudicated, experiments to resolve hypotheses, and analysis and measures to implement decisions. [Lucas, Banks, Vye, 1998]

The level that the DEL was implemented in the AWE appeared to directly effect an initiative's ability to benefit from the experiment. The analysis of survey responses provides evidence that those program managers who could provide a detailed explanation of the specific developmental issues being addressed on their program at the time of its participation in the AWE, the decisions to be made from gathered data, and were able to specifically tailor their program's activities and measures in the AWE to support these issues and decisions, generally reported a much higher level of perceived benefit from the experiment.

The extent to which acquisition managers implemented the DEL in the TF XXI AWE can be measured by analyzing the extent a manager was able to tailor or influence a program's specific activities in the AWE to reflect the program's current acquisition issues and decisions. Additionally, one can analyze the level at which AWE data was derived and used to support future acquisition decisions.

1. The Ability to Tailor

Chapter IV illustrated that the extent a manager was able to tailor or influence a program's specific activities in the AWE to reflect the program's current acquisition issues and decisions had a direct impact on the extent to which the program benefited from participating. Those initiatives reporting a high level of ability to tailor or influence

generally reported much higher levels of perceived benefit from participation in the AWE.

The level that acquisition managers were able to participate in the planning process for the TF XXI AWE, as run by the TRADOC Joint Venture office, varied among programs. It is unclear if the level of participation in the planning process for specific programs was dictated by the various empowered organizations including TRADOC, TRADOC Analysis Center White Sands (TRAC-WSMR), the Operational Evaluation Command (OEC), and the Test and Experimentation Command (TEXCOM) or if the level of participation was a conscious decision made by the program managers and user representatives for the participating initiatives.

Many of the surveyed initiatives reported that they had no influence on their system's role in the experiment or on the analysis plan for their system. One program manager stated that "there was a hands off policy instituted" and that "there was no avenue at all for any program influence [on the AWE plan]." Other managers reported that they had no real influence on the conduct of the AWE because they "had no issues to be addressed." Another manager reported that "the requirements from the [user representative] did not line up with the main thrust of the AWE," therefore no tailoring of the AWE was attempted. Funding shortages also contributed to the limited tailoring reported by mangers. No additional funds were provided to any program specifically to support participation in the AWE. This required managers to "minimize the AWE's impact on current efforts that already had funds obligated."

The inability of one program manager to influence his program's activities in the AWE resulted in the initiative not using "real communication systems." The initiative was not "employed over realistic distances." As a result, "times and completion rates were unrealistically skewed." The initiative's level of benefit from the AWE was subsequently reported as low. A user representative for a different program stated that he had "little influence on how his system was used in the AWE" and this "hampered the [initiative's] ability to fully participate." Another user explained that he was unable to influence his program's role in the AWE and that his initiative was "artificially restricted." The result was a failure to follow establish tactics, techniques, and procedures leading to a low reported value for the gathered data.

Some programs, however, reported a high ability to tailor or influence their initiative's participation in the AWE. One user representative stated that they were "able to tailor all of the required activities" because they were "part of the AWE IPTs

[Integrated Product Teams]." They reported that they played an active role in developing the analysis plan for OPTEC to conduct their assessment. They also assisted in the data collection and assessment process. Another user representative stated that his office was an active participant "in the various working groups by the primary contractor, PM, and the TSM [TRADOC System Manager] to ensure that all exercise objectives were met or exceeded."

Generally, those initiatives reporting a high level of ability to tailor or influence reported much higher levels of perceived benefit from participation in the AWE. One program manager summarized that "we pretty much had our way." They reported their perceived benefit from the AWE as very high. The initiative that participated in the AWE IPTs and contributed to the analysis plan discussed earlier, was reportedly praised by the then TRADOC commander when he commented that the system was a "clear winner" in the AWE.

Both program managers and user representatives agree that to achieve maximum benefit from AWEs, acquisition managers must be able to participate in the planning process. One manager stated that acquisition officials should participate in the planning process to "define clear goals and objectives, as well as the process to be used to achieve the goals and objectives." Another PM stated that "a study should be conducted to define the problems to be resolved" and that it should "include a section on the perceived benefits to each participant."

The TRADOC Joint Venture office has recognized the value of having program managers participate by extending their role in the planning process for the Joint Contingency Force (JCF) AWE to be held in late 1999. A program manager participating in this upcoming AWE stated that he developed Measures of Effectiveness (MOEs) for the AWE in concert with independent analysis agencies. For the JCF AWE, OPTEC representatives will meet with program managers to determine issues that are linked to AWE objectives [TRADOC JCF-AWE, 1998]. Still, no additional funding is provided to the program manager for AWE participation or for implementation of any derived recommendations. Participation in AWEs requires expensive prototyping, manning, fielding, training, and transportation costs that must be drawn from existing research and development accounts. Program managers cannot increase their roles in the AWE process and ability to tailor activities without dedicated support from the Army's budgetary process. Therefore, they may likely continue to report low levels of benefit from live experiments.

2. Documentation And Use Of AWE Data

The level at which AWE results were documented within the acquisition management office had a direct effect on the ability of a program to benefit from participation. As discussed in Chapter II of this thesis, the value of any evaluation must be judged by its eventual utility in implementing change.

A significant number of the TF XXI AWE initiatives had no historic data or documentation of their AWE experience. Several programs were not able to confirm that their system participated in the TF XXI AWE. Six of the original seventy-two offices initially identified to participate in the AWE admitted that they had no records or knowledgeable managers that could comment on the experiment. Personnel turnover and attrition can account for some of this absence of knowledge. When asked to list specific issues that needed to be investigated in the AWE, a user representative stated "unfortunately, we are not aware of what specific developmental issues were being addressed on the program. The personnel involved in them at the time have PCS'd [moved due to a permanent change of station] and that data is not available." A substantial majority of the programs, however, had significant records and detailed after-action reports from the AWE.

A respondent discussed the AWE documentation process and the eventual utility of the data. He reported that "too often a unit pushes to get a system in an AWE and never comes into the decision making process nor does guidance get passed down to the people who have to execute the actions to make it happen." Another program office admitted their shortcomings by stating "we needed to figure out a better way to document [lessons learned from the AWE]." Another manager recommended that participants "document as well as possible the lessons learned so that a third party can understand."

In some cases, implementation of the DEL in the TF XXI AWE was limited due to poor documentation before and after the experiment. In many cases, issues and decisions to be made were not identified prior to the AWE. One program manager stated that his system "did not have any specific developmental issues that needed to be addressed in the AWE." Another program manager stated that "no specific data was proposed to be gathered or evaluated, nor were any specific issues identified for analysis." This lack of issue identification prevented acquisition managers from developing arguments and hypotheses to be adjudicated. Many programs did not perform analysis or develop measures to implement decisions. One program manager stated repeatedly that

"the recommendations fell outside the responsibility of the PMO [Program Management Office]." Another program manager stated "to date, we have not seen the [AWE] report, and have only heard rumors as to the outcome." The manager continued that "there was no benefit to the program from the AWE."

A manager from an initiative reporting a high level of perceived benefit recommended that AWE participants "define clear goals and objectives, as well as the process to be used to achieve the goals and objectives." Another program reporting very high benefit, contributed the benefit to "thorough planning and understanding of what the expected outcomes were supposed to be." A program with a low level of reported benefit explained that their problems related to a failure to identify how collected data would "be used to focus future activity."

One program manager effectively summarized the requirement for documentation and planning by stating "it is important for a program manager to develop test objectives and measurement processes that identify product improvements, areas for future research, and follow-on programming, while allowing AWE results to drive go/no-go decisions for the Army."

3. Conclusions on the Decision to Experiment Ladder

The data clearly indicates that the benefit derived from participation in AWEs can be increased by managers developing detailed experiment objectives and expected outcomes, systems for data documentation and analysis, and strategies for implementation of AWE data and recommendations. Additionally, a program's specific AWE activities should be tailored to reflect these objectives, systems, and strategies.

E. PROGRAM MATURITY

As illustrated in Chapter IV, a relationship exists between an initiative's programmatic maturity and the benefit gained from participating in the AWE. More maturity does not directly transcribe into a higher ability to benefit, but rather a point exists where a program is best positioned to benefit from experimentation. All of the collected objective data supports the finding that an initiative in the mid-developmental phases of acquisition will be best positioned to benefit from AWE participation.

Acquisition managers agree that timing is critical to success in an AWE. Programs in Concept Exploration (CE) are too immature to effectively participate.

Programs in production cannot take advantage most findings or recommendations from the AWE. Even OPTEC agrees that "AWE planners should carefully consider whether it is worthwhile to devote scarce data collection and assessment resources to assess post-Milestone III systems" [ECC, 1997].

A key factor of maturity, as defined by survey participants, was system reliability. Immature initiatives were generally not environmentally hardened or ruggedized for field trials. Poor operator handling of these non-ruggedized systems resulted in excessive maintenance problems that were reported as system failures and contributed to a negative post-AWE analysis. A program manager commented that the AWE was "not a good environment for marginal systems." According to this manager, if the system is not sufficiently mature, "the opportunity for failure is much greater than the opportunity for success."

Participating initiatives must also be sufficiently mature, programmatically, so that prototypes and demonstration versions are readily available for participation. In several cases, surrogate systems were included in the AWE to simulate proposed capabilities. Often these surrogates did not effectively represent proposed production systems. A program manager stated that immature systems were responsible for "reducing the effectiveness or otherwise limiting the lessons learned by other platforms." Respondent comments show that the varying levels of maturity and functionality of initiatives affected the overall performance of the experimental force." It was stated that "soldiers are practical and will not waste time using technology that is cumbersome or does not work As a result, substandard systems were ignored."

Some mature programs that had moved into production prior to the AWE were able to benefit from refinement of Tactics, Techniques, and Procedures (TTP) at a higher level then immature programs. Production items generally provided the reliability required to adequately stress the system using realistic methods. Program managers agreed that systems providing "new capabilities" or "leap-ahead technologies" were best situated to benefit from the development of TTPs.

Program managers often lacked the funding required to implement changes recommended by the AWE analysis. One program manager stated that "programs must be sufficiently mature to preclude the need for drastic changes as a result of the AWE." As stated earlier, one initiative was forced to make "major changes in system architecture" as a result of the AWE. Funding for this restructuring was made available at the expense of other programs within the program management office.

Survey comments show that programs at any level of maturity can benefit from AWE participation. Programs that are early in development, such as CE and PDRR, can demonstrate the benefits of new concept technologies to the force, and gain subsequent program support. Mature programs that are in production, can gain visibility and positive marketing aspects required for continued funding. However, initiatives in mid-developmental phases of acquisition, that are sufficiently mature to tolerate the harsh environment of a live experiment but do not have a finalized architecture, seem to benefit most from an AWE.

F. RISK AND BENEFIT ANALYSIS

Survey comments indicate a substantial risk to programs participating in an AWE. Program risks include factors beyond the costs of participation, to include a poor return on investment, potential negative exposure, and extensive changes in requirements. Acquisition managers contemplating participation in future AWEs could benefit from conducting a detailed analysis of the risks associated with AWEs, comparing these risks to potential benefits, and considering their tolerance for risk as a factor in making a decision to participate.

Program managers reported a wide range of tolerance for risk. One program manager stated "we had nothing to lose." The program had no funding for future production and the program manager believed that the AWE served as a "last chance" effort. Reportedly, if the initiative could have shown merit at the AWE then participation in the experiment would have been a good investment. Another manager stated "we had nothing to gain." The design of the system was finalized and a production decision had been made and funded.

Data collected from TF XXI AWE participants can be used to measure the risks and benefits involved with AWE participation. This thesis presents a model to measure risk as compared to potential benefit. Although this model has not been validated through actual implementation, it is supported by the findings of this thesis. Program managers should complete this risk and benefit analysis, and if necessary, modify the risk analysis plan based on the unique situation of their program and their personal tolerance for risk. Potential risks involved with AWE participation are presented, followed by a description of risk and benefit factors. A method to compare risk factors and potential

benefits and analyze the risk situation for AWE initiatives is illustrated. Finally, methods to mitigate some of this risk are presented.

1. Potential Risks

Potential risks are areas where acquisition programs may be negatively effected. This thesis has reveled three significant risks involved with participation: poor return on investment, potential negative exposure, and extensive change in requirements.

a. Poor Return on Investment

TF XXI AWE acquisition managers stressed that AWE participation is resource intensive. One manager stated that "PMs must determine if potential return outweighs the cost in prototyping, manning, fielding, transportation, etc." He stated that the Army should provide funding to program offices for participation. However, no funding has been provided for past AWEs and as stated in the plan for the upcoming Joint Contingency Force (JCF) AWE, submitting agencies must "bear the complete costs associated with the initiative" [TRADOC JCF-AWE, 1998, p3]. Given the low levels of benefit reported by some programs, there is an inherent risk that the benefits received by any one initiative will not justify the cost.

b. Potential Negative Exposure

Program exposure to both user and senior Army leadership and the associated marketing effects of AWE participation must be considered with both their positive and negative potential consequences. Some initiatives with outstanding AWE performance received high acclaim and significant support for future funding decisions. However, this thesis has many examples of programs that received negative feedback from the AWE. The results of the AWE provided negative marketing for some programs that hampered their ability to move into production. One initiative had two of four systems fail at the AWE. This was reported as a reliability problem when damage was likely due to poor operator handling. Another system received a poor evaluation primarily due to host vehicle failures. The risk of program exposure, positive or negative, must be considered prior to AWE participation.

c. *Excessive Changes in Requirements*

One of the stated goals of the TF XXI AWE was to provided information to support investment decisions and refinement of requirements [ECC, 1996]. Some TF XXI initiatives received so much information that the refined requirements negated the current system design. These programs were then either terminated, or underwent complete restructuring. One such program was in production at the time of the AWE and subsequently was forced to design a complete new architecture and develop new metrics to measure performance. Although these changes may represent an ultimate benefit from AWE participation, some acquisition programs may not be positioned to adequately adapt to such drastic changes in requirements.

2. Risk Factor Ratings

Risk factors are those issues that can be measured by an acquisition manager in an attempt to determine overall risk from participation. As shown in Table 2, these risk factors directly contribute to the three identified risks of poor return on investment, negative exposure, and excessive changes in requirements. This thesis has revealed seven contributing risk factors to AWE participation including: (1) system maturity, (2) ruggedization and maintainability, (3) how the system fits within the focus of AWE, (4) funding availability, (5) equipment availability, (6) incoming biases, and (7) the status of production decisions.

Table 2. Factors Contributing to Potential Risks

Potential Risks	Contributing Risk Factors
Poor Return on Investment	Maturity, Focus of the AWE, Funding Availability, Equipment Availability,
Potential Negative Exposure	Maturity, Ruggedization, Funding Availability, Equipment Availability, Incoming Biases
Excessive Changes in Requirements	Maturity, Funding Availability, Status of Production Decisions

a. *Maturity*

Maturity is measured in terms of the system's programmatic stage of development, from Concept Exploration to Production. Maturity effects the ability of a

program to perform adequately as well as the ability of the initiative to implement recommendations derived from the AWE. Programs in Concept Exploration are high risk because of their unpredictability and vaguely defined roles and requirements. Programs in Production or Limited Production are considered medium risk because they may be too far in development to capitalize on recommendations. Programs in PDRR or EMD are considered low risk.

b. Ruggedization and Maintainability

Ruggedization and maintainability are measured as high or low. A system that is highly rugged is able to withstand the stresses associated with operational use in harsh environments. A system that scores low in this factor has sensitive components with maintenance procedures that are difficult to conduct in a field environment. Low ruggedization may be associated with early prototype systems.

c. Focus of the AWE

A manager must analyze the published goals and objectives of the AWE as stipulated by the planning officials and characterize how his program fits within the experiment focus. Also, a manager must measure how the AWE will address the issues facing his initiative. How an initiative fits into the focus of the AWE is measured as complimentary or ancillary. As demonstrated in the TF XXI AWE, those programs that are not a high priority of the analyzing agency may not receive adequate focus and feedback. This inadequate focus and feedback can lead to a poor return on investment.

d. Funding Availability

Participation in an AWE is resource intensive. A program must have sufficient funds for prototypes, manning, training, transportation, and maintenance. Required funding will vary based on the complexity of the system. Additional funds will not normally be available specifically for AWE participation. Low availability of funding can contribute to an inability to properly prepare for the AWE and an inability to implement any derived findings. This can result in negative exposure and low return on investment. Funding is measured as sufficient or insufficient. Sufficiently funded programs will have budgeted dollars specifically for AWE participation and are

considered low risk. Insufficiently funded programs will have tight budgetary constraints and are considered high risk.

e. Equipment Availability

Development of prototypes or surrogates for AWE participation requires additional costs, time, and developmental testing beyond that normally experienced in system development. Surrogates and prototypes may also be less robust and contribute to poor performance at AWEs, potential negative exposure, and low return on investment. Mature systems with readily available production items are best positioned for AWE participation. Equipment availability is measured on a continuum from production items to surrogate representatives. Initiatives with readily available production models are considered low risk. Initiatives that require the development of prototypes or surrogates are considered high risk.

f. Incoming Biases

Program managers from the TF XXI AWE stated that incoming biases by users, evaluators, and Army leadership can prevent any real analysis of a system's performance at the AWE. Biases are measured as either favorable or unfavorable. Unfavorable biases can contribute to reported poor performance and negative exposure. Those programs with unfavorable biases are considered high risk. Those programs with favorable biases are considered low risk.

g. Status of Production Decisions

Production decision status is measured as either pre-production with Milestone III decision, imminent production decision, or post production. Programs that have secured approval and funding for production prior to participation in an AWE but have not yet begun production, face the added risk of poor performance and loss of support. These pre-production decision initiatives are categorized as high risk. Those initiatives with imminent production decisions are considered medium risk, in that AWE performance can significantly influence the survivability of the system. Programs in post-production or with no pending production decision are categorized as low risk.

3. Benefit Factor Ratings

Benefit factors are those issues that can be measured by an acquisition manager in an attempt to determine the potential to benefit from AWE participation. These factors can be measured in terms of potential to benefit based on the unique needs and situation of the initiative in question. This thesis has revealed seven benefit factors to AWE participation including: (1) marketing and exposure of program, (2) early user feedback, (3) refinement of user requirements, (4) development of tactics, techniques, and procedures (TTP), (5) follow-on support for funding and production decisions, (6) information on integration, interfaces, and interoperability, (7) exposure of developers to the user's environment.

a. Marketing and Exposure of Program

The effects of marketing and exposure of a program are a result of system performance at the AWE and cannot be accurately predicted. The potential for benefit from advantageous exposure is measure based on needs of the program. A program that requires positive exposure for survival, would rate this area as high potential benefit. Those programs that do not require this marketing effect, or already have strong support among senior leadership, would rate this area as low potential.

b. Early User Feedback

The potential to benefit from early user feedback is measured based on needs of the program. Those programs that have had little to no user feedback would rate this area as high. Those programs that already possess sufficient feedback, or those that are not in a position to implement any recommendations from the feedback, would rate this area as low potential.

c. Refinement of User Requirements

The potential to benefit from refinement of requirements is measured based on the initiative's stage of development. Those programs early in Concept Exploration would score this area as high, because they are best positioned to implement the refinements without a significant investment. EMD programs would score medium. Programs late in development or into production would score this area as having low

potential benefit because the refinements cannot be adequately implemented in production models.

d. Development of Tactics, Techniques, and Procedures (TTP)

The potential to benefit from TTP development is measured based on needs of the program. Initiatives that are new concept technologies with no current TTP would rate this area as high. While existing TTPs can be modified and refined based on AWE data, programs that are not new concepts to the Army and have established TTPs do not require this data to move into production. These initiatives would rate this area as low potential benefit.

e. Follow-on Support for Funding and Production Decisions

The need for funding and support for production decisions determines the potential benefit in this area. Those programs with production decisions pending would rate this potential benefit as high, as favorable AWE performance can result in favorable decisions by Army leadership. Those programs with future production decisions would rate this area as medium, as the derived AWE data can be used to support these decisions. Programs that are currently in production have no extensive need for funding support and would rate this as a low potential benefit.

f. Information on Integration, Interfaces, and Interoperability

Potential benefit in this area is measured based on need. Those systems with a high requirement to integrate or interface with other programs would rate this area as high. An initiative that does not interface or interoperate with other systems would score this as a low potential benefit.

g. Exposure of Developers to the User's Environment

The exposure of developers to the user's environment is rated as a high potential benefit for those programs where managers and engineers have little field experience. Those programs with managers and engineers who have sufficient exposure to the user's environment would rate this potential benefit as low.

4. Measurement and Analysis of Risk and Benefit

a. Risk Measurement

The presented risk factors can be subjectively measured and totaled using the risk analysis matrix shown as Table 3. In Table 3, an acquisition manager should subjectively measure each of the seven risk factors as either high, medium, or low, and circle the appropriate rating. The total number of ratings for each of the three measurements should be totaled and entered as the factor total. Each of the three factor totals should then be multiplied by a risk multiplier with the high risk factor total multiplied by three, the medium risk factor total multiplied by two, and the low risk factor total multiplied by one. The results of this multiplication should then be entered as the risk total for each of the three measurement levels. All three risk totals should be added together to compute the total risk score.

The results of a hypothetical AWE initiative is presented in Table 4 as a risk factor example. This hypothetical initiative is a new digital communications system. This initiative is currently in the PDRR phase of development, so maturity is assessed as low risk. The system has not been extensively ruggedized but has low maintenance requirements, therefore, ruggedization / maintainability is assessed as moderate risk. The focus of the AWE is digital communication systems so the initiative is considered complementary and risk is assessed as low. Funding is available for research and development on this item, though specific funds have not been programmed for the AWE. Therefore, the funding availability risk factor is assessed as moderate. A prototype of the system is being developed specifically for the AWE, so the equipment availability risk factor is rated as high. The Army leadership believes that this communication system is of paramount importance to the future of army digitization and has a high level of favorable biases. Therefore, the bias risk factor is assessed as low. The program believes it will move into EMD shortly and be facing a production decision within the next two years, and thus has assessed the production decision risk factor as medium. The risk factor totals equate to one high risk factor, three medium risk factors, and three low risk factors. The risk multipliers are applied for a total risk score of 12.

Table 3. Risk Factor Computation

Factor	High Risk	Medium Risk	Low Risk
Maturity	Concept Exploration	Production/LP	PDRR/EMD
Ruggedization / Maintainability	Not Rugged / High Maintenance	Moderate	Rugged / Low Maintenance
Focus of AWE	Ancillary	Moderate	Complementary
Funding Availability	Tight Budget Constraints	Available Funding	Programmed AWE Funding
Equipment Availability	Prototype / Surrogate Required	Moderate	Production Items Readily Available
Biases	Unfavorable Biases	No Biases	Favorable Biases
Production Decisions	Pre-Production with MS III Decision	Production Decision Imminent	Post-Production or no Pending Decision
Factor Totals			
Risk Multiplier	**3**	**2**	**1**
Risk Totals			
Risk Score (Total of H/M/L)			

Table 4. Risk Factor Example

Factor	High Risk	Medium Risk	Low Risk
Maturity	Concept Exploration	Production/LP	PDRR/EMD
Ruggedization / Maintainability	Not Rugged / High Maintenance	Moderate	Rugged / Low Maintenance
Focus of AWE	Ancillary	Moderate	Complementary
Funding Availability	Tight Budget Constraints	Available Funding	Programmed AWE Funding
Equipment Availability	Prototype / Surrogate Required	Moderate	Production Items Readily Available
Biases	Unfavorable Biases	No Biases	Favorable Biases
Production Decisions	Pre-Production with MS III Decision	Production Decision Imminent	Post-Production or no Pending Decision
Factor Totals	1	3	3
Risk Multiplier	**3**	**2**	**1**
Risk Totals	3	6	3
Risk Score (Total of H/M/L)	12		

b. Benefit Measurement

Potential to derive benefit from the AWE can be measured based on the factors presented earlier in this chapter and totaled using Table 5. In Table 5, an acquisition manager should subjectively measure each of the seven potential benefit factors as either high, medium, or low, and circle the appropriate rating. The total number of ratings for each of the three measurements should be totaled and entered as the factor total. Each of the three factor totals should then be multiplied by a benefit multiplier with the high benefit factor total multiplied by three, the medium benefit factor total multiplied by two, and the low benefit factor total multiplied by one. The results of this multiplication should then be entered as the benefit total for each of the three measurement levels. All three benefit totals should be added together to compute the total benefit score.

Table 5. Benefit Factor Computation

Factor	High Benefit	Medium Benefit	Low Benefit
Marketing / Exposure	Required for Program Survival	Moderate Need	Not Required / Strong Support Exists
Early User Feedback	Feedback Required	Moderate Need	Not Able to Implement Feedback
Refinement of Requirements	Early in Concept Development	Engineering Phase of Development	Late in Development / Production
TTP Development	No Current TTPs / New Concept Technology	Moderate Need	TTPs Established / No New Concepts
Support for Funding / Production Decisions	Production Decision Pending	Future Production Decisions	Currently in Production
Info on Integration / Interfaces / Interoperability	Required	Moderate Need	System Does Not Interface / Interoperate
Exposure to User's Environment	Managers / Engineers have Little Exposure	Moderate Need	Field Experienced Managers and Engineers
Factor Totals			
Benefit Multiplier	**3**	**2**	**1**
Benefit Totals			
Benefit Score (Total of H/M/L)			

The results of a benefit factor analysis of a hypothetical AWE initiative is presented as Table 6. This example uses the same hypothetical initiative presented above, in risk factor computation. The program manager has assessed his potential to benefit in each of the seven benefit factors. The program manager has determined that his program has a moderate need for marketing and exposure. This program does not have a wide familiarity among Army leadership, yet this exposure is not required for program survival in its current phase. Therefore, he has assessed the potential for a marketing and exposure benefit as medium. The program manager has determined that his initiative requires early user feedback from its user community and has assessed the potential to benefit from in this area as high. The initiative is currently in PDRR and has a medium potential to benefit from requirement refinement while at the AWE. While some TTPs exist for digital communications system, the program manager has determined that they have a moderate need to refine these TTPs and has assessed the potential to benefit in this area as medium. The program manager believes the initiative will move into EMD shortly and be facing a production decision within the next two years, and thus has assessed the potential to benefit from funding support and future production decisions as medium. Being a digital communications system, the program requires detailed information on integration, interfaces, and interoperability, and thus has assessed this potential benefit as high. The program managers and engineers currently have little exposure to the user's field environment, so this factor has also been assessed as having a high potential benefit. The results of the benefit assessment included three areas of potentially high benefit, four areas of medium benefit, and one area with low potential benefit to the program. With the benefit multipliers applied, the total benefit score computed to seventeen.

c. Comparison and Analysis

Resulting risk and potential benefit measurements can be compared using the risk analysis chart illustrated below as Figure 22. When computed risk and benefit scores are compared, four risk analysis quadrants are developed. Quadrant I describes an initiative with a high potential to benefit from AWE participation with very low risk to the program. Program managers assessing their system in Quadrant I are in the best position to benefit from AWEs. Quadrant III describes a program with very low potential benefit and high associated risk. From an acquisition manager's perspective, these

programs would be best served by not participating in AWEs. Quadrant II and Quadrant IV describe programs with situations that are not as clear as the previous two cases. A program in Quadrant II has a high potential for benefit but not without significant risk. In this quadrant, an acquisition manager must determine his tolerance for risk in making an AWE participation decision. A program in Quadrant IV has low risk from participation but also does not stand to receive significant benefit. Program managers in this situation should base their participation decision on a monetary basis or consider other potential benefits not discussed in this thesis.

Table 6. Benefit Factor Example

Factor	High Benefit	Medium Benefit	Low Benefit
Marketing / Exposure	Required for Program Survival	Moderate Need	Not Required / Strong Support Exists
Early User Feedback	Feedback Required	Moderate Need	Not Able to Implement Feedback
Refinement of Requirements	Early in Concept Development	Engineering Phase of Development	Late in Development / Production
TTP Development	No Current TTPs / New Concept Technology	Moderate Need	TTPs Established / No New Concepts
Support for Funding / Production Decisions	Production Decision Pending	Future Production Decisions	Currently in Production
Info on Integration / Interfaces / Interoperability	Required	Moderate Need	System Does Not Interface / Interoperate
Exposure to User's Environment	Managers / Engineers have Little Exposure	Moderate Need	Field Experienced Managers and Engineers
Factor Totals	3	4	0
Benefit Multiplier	**3**	**2**	**1**
Benefit Totals	9	8	0
Benefit Score (Total of H/M/L)	17		

The results of a risk and benefit comparison and analysis for a hypothetical AWE initiative are shown in Figure 23. The hypothetical initiative is the same communication system used above for the risk and benefit factor measurement. The system's total risk score was twelve and the total benefit score was seventeen. As shown in Figure 23, the resulting comparison lies in Quadrant II of the risk / benefit comparison chart. This signifies that the initiative has high potential benefit from AWE, but with moderately high risk. Based on this analysis, the initiative's acquisition manager must determine his tolerance for risk in making an AWE participation decision. Through the application of risk mitigation, as discussed below, the risk score can be reduced so that the initiative lies within Quadrant I, where potential benefits are high, but participation risk is low.

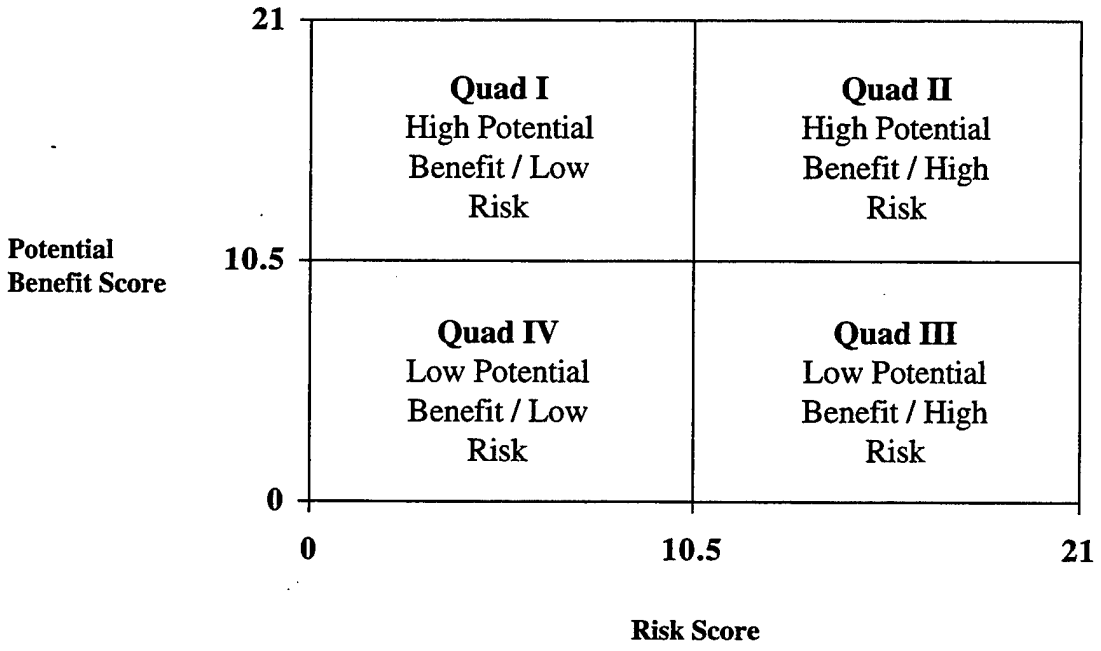

Figure 22. Risk / Benefit Comparison and Analysis

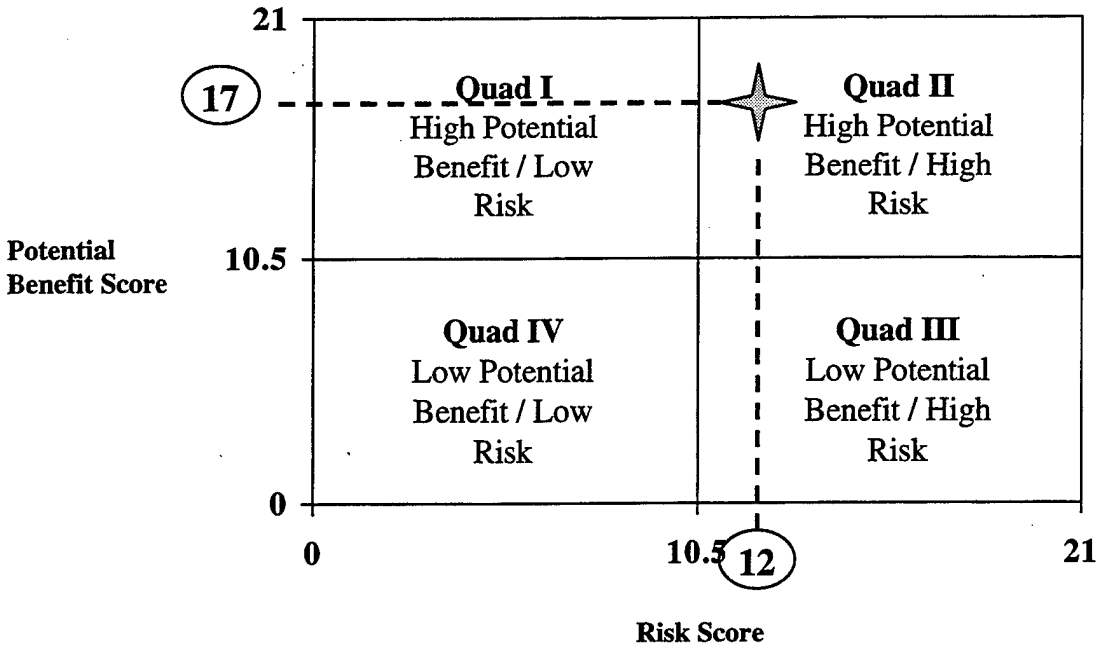

Figure 23. Risk / Benefit Comparison and Analysis Example

5. Risk Mitigation

The risks discussed previously in this chapter are based on reported results of the TF XXI AWE. Programs participating in future AWEs can mitigate these risks based on the TF XXI experience. Methods to mitigate risk include program budgeting, marketing to the user, user training, and participation in the planning process.

a. Program Budgeting

The experiment plan for the JCF-AWE states that one the main criteria used for consideration for inclusion is "the ability of the submitting agency to bear the complete costs associated with the initiative, to include its integration into the JCF-AWE architecture" [TRADOC JCF-AWE, 1998, p3]. A manager participating in the TF XXI AWE stated that he needed to conduct "monetary trade-offs between supporting his current mission and supporting the AWE." Certainly, program managers do not need to be the sole source for AWE funding. Stakeholders in the system, to include program managers, combat developers, TRADOC system managers, and battle labs can all combine resources to fund AWE participation. AWE participation risks centered on

funding issues can be mitigated by proactively budgeting for AWE participation early in the system's lifecycle using available research and development dollars. This proactive budgeting will help ensure that sufficient funds are available for AWE participation without the need to conduct schedule or performance trade-offs. Certainly, as the likely benefit of AWE participation can be enhanced, program managers will be more motivated to build participation in their program planning.

b. Marketing to User

In several cases, initiative managers stated that their system received a poor assessment at the AWE because actual users failed to appreciate the capabilities of the system. One such initiative reported that it did not get much use at the AWE because the soldiers were concerned with some potential negative characteristics of its design. He stated that the soldiers using the equipment did not fully understand these characteristics and their effects. Marketing the advantages of the system to the soldier to enhance the perception of the initiative would have increased opportunities to collect data during the AWE. Risks associated with preconceived biases by users, evaluators, and Army leadership can be mitigated with an early investment in system marketing.

c. User Training

One of the most often commented factor contributing to a program's success at the AWE was the quality of user skills. One respondent stated that there were "too many new systems being introduced in the AWE and it confused the soldiers." Reportedly, soldiers were "overwhelmed at the complexity of the additional systems installed on their vehicles." Another acquisition manager stated that "in many cases the systems under evaluation were simply turned off or never turned on." All new systems preparing for fielding are required to develop initial fielding training plans. Normally this consists of civilian contractors training senior military instructors, who in turn train the actual user. Systems that are early in their development lifecycle may not have training programs designed or tested. Risks associated with maturity, ruggedization, maintainability, and biases can be mitigated through high quality, hands-on training of actual users in field conditions, prior to AWE participation.

d. Participation in Planning Process

As stated earlier in this thesis, the extent that a manager was able to tailor or influence a program's specific activities in the AWE to relate to the program's acquisition issues and decisions contributed to the extent that the program was able to benefit. The only way to tailor or influence a program's activities in the AWE is by investing heavily in the AWE planning process. Managers should attempt to influence their system's role in the AWE, the scenarios that it is placed in, the analysis and data collection plan, and the tactics, techniques, and procedures to be implemented by the user. AWE officials will often call upon user representatives to provide Subject Matter Experts (SMEs) to aid in the data collection effort. Risks associated with the focus of the AWE, equipment availability, equipment maintainability, and preconceived biases can be mitigated by active participation in the AWE planning process.

G. CHAPTER SUMMARY

This chapter presented analysis and findings on the contributing factors to acquisition managers benefiting from Advanced Warfighting Experiments. The Task Force XXI AWE was limited in its ability to provide benefit to participating acquisition managers due the nature of the experiment. Limitations in repeatability, data collection, interactions, and sample size associated with the experiment resulted in data and recommendations with reduced reliability. According to many program managers, the experiment's results were also influenced by politics. Finally, the applied results of the AWE made many managers question the utility of the exercise. Acquisition managers participating in future AWEs must take active measures to increase the likelihood of achieving benefits for their programs.

The potential benefits to acquisition programs participating in AWEs include:

- marketing and exposure of program
- early user feedback
- refinement of user requirements
- development of Tactics, Techniques, and Prodedures (TTP)
- follow-on support for funding and production decisions
- information on integration, interfaces, and interoperability
- exposure of developers to the user's environment

Multiple factors contribute to a program manager's ability to benefit from AWE participation. Program managers should develop objectives and measurement processes for the AWE that will identify product improvements and areas for future investment. The results of AWE participation should be adequately documented to allow the use of AWE derived information and findings throughout the developmental lifecycle of the participating program. To achieve maximum benefits from the AWE, the Decision to Experiment Ladder should be implemented. Acquisition managers should actively participate in the AWE planning process and tailor their program's activities in the AWE to relate to the issues and decisions facing the program. Data collection and analysis plans should also be tailored to insure that the information derived from AWE participation is of value to the program. Finally, program maturity has a impact on an initiative's ability to benefit. While programs at all levels of maturity can benefit from AWE participation, initiatives in mid-developmental phases of acquisition that are sufficiently mature and ruggedized to tolerate the harsh environment of AWEs are best positioned to benefit. Also, these programs have architectures that are not yet finalized and can make the most use of information derived from participation.

Program managers should conduct a detailed cost and benefit analysis to decide if AWE participation will be advantageous to their program. Costs in terms of protoyping, manning, fielding, transportation, and schedule should be included. Potential benefits should be weighed against potential risks involved with AWE participation. These potential risks include poor return on investment, potential negative exposure for the program, and excessive changes in requirements definition. This chapter presented a model to conduct risk analysis for AWE participation based on derived risk factors. This risk analysis method should be tailored to the program's specific situation and the program manager's tolerance for risk. The risks associated with AWE participation can be mitigated by early budgeting of funds for the AWE, marketing to the user, placing significant emphasis on user training, and by directly participating in the AWE planning process.

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. AWE Objectives and Structure

The stated TF XXI AWE objectives included: (1) experimenting with advanced technologies and concepts that leverage capabilities of information age technologies and (2) providing information to support investment decisions on the most promising initiatives [ECC, 1996]. The AWE was also meant to help the U.S. Army Training and Doctrine Command (TRADOC) refine requirements and develop solutions for Force XXI. The AWE Experiment Directive published five specific objectives for the AWE:

a. Assess Force XXI Battle Command Brigade and Below (FBCB2) Applique and Tactical Internet capabilities to refine FBCB2 requirements.

b. Assess digitized brigade combat service support concept.

c. Experiment with advanced technologies and concepts that leverage capabilities of information age technologies.

d. Refine digitized tactics, techniques, and procedures (TTP) for brigade operations.

e. Provide information to support investment decisions on the most promising initiatives. [ECC, 1996]

The Task Force XXI Advanced Warfighting Experiment was not designed to provide significant benefits to the acquisition team of program manager and user representative. The nature of the AWE experiment limited the potential derived benefits for the program manager. The acknowledged AWE limitations in repeatability, data collection, interaction effects, and sample size, precluded any summative findings. However, participating initiatives can benefit from formative findings derived from the AWE data and take measures to increase the potential to benefit from the experiment.

2. Use of Recommendations to Support Investment Decisions

The specific recommendations derived from the Task Force XXI Advanced Warfighting Experiment (AWE) were used to support investment decisions and to refine

requirements of participating initiatives in some cases. Overall, programs reported that fifty-two percent of the OPTEC recommendations from the AWE Live Assessment Report were either fully or mostly implemented. Thirty percent of recommendations were not implemented at all. Respondents indicated only a moderate benefit from participating in the AWE and that the data and recommendations received were only somewhat valuable. The most cited reason for recommendations not being implemented was a lack of funding. The recommendations were most likely to be implemented if it was a high priority of the user.

The perceived value of the derived AWE data was not a significant factor in the implementation of the AWE recommendations. The data indicates that changes to a program were more often implemented based on user requirements and funding availability, rather then on OPTEC's recommendation. Participants considered data valuable in making decisions as acquisition managers when the met one of three requirements. First, the data was valuable when it provided actual user feedback on specific user requirements. Second, data was considered valuable when it contributed to the development of tactics, techniques, and procedures. Finally, the data was considered valuable when it was provided at a time when it could be instrumental in refining requirements and design.

3. Contributing Factors to a Program's Ability to Benefit

It can be shown from the collected data that the level of recommendation implementation and the perceived level of benefit from the AWE were generally related. It cannot be concluded, however, that the implementation of AWE recommendations was solely responsible for a respondents perception of benefit. A wide range of confounding factors effected an initiative's ability to benefit from the AWE.

a. Definition of Benefit

In determining the contributing factors to a program's ability to benefit from AWE participation, a program manager must first define the term benefit, as it relates to his program. Program managers reported the following potential benefits from their TF XXI AWE participation:

- marketing and exposure of program
- early user feedback

- refinement of user requirements
- development of Tactics, Techniques, and Prodedures (TTP)
- follow-on support for funding and production decisions
- information on integration, interfaces, and interoperability
- exposure of developers to the user's environment

b. Objective Determination, Measurement, and Documentation

The level at which AWE results were documented within the acquisition management office had a direct effect on the ability of the program to benefit from participation. A subjective analysis of survey responses provided evidence that those program managers who could provide a detailed explanation of the specific developmental issues being addressed on their program at the time of its participation in the AWE and the decisions to be made from gathered data, generally reported a much higher level of perceived benefit from the experiment. Those programs that specifically developed test objectives and measurement processes linked to specific acquisition decisions to be made, were better positioned to benefit from AWE participation.

c. Tailoring of AWE Participation

The extent a manager was able to tailor or influence a program's specific activities in the AWE to relate to the program's acquisition issues and decisions directly contributed to the extent that the program benefited from participating. Those initiatives reporting a high level of ability to tailor or influence generally reported much higher levels of perceived benefit from participation in the AWE.

d. Program Maturity

Program maturity has a impact on an initiative's ability to benefit. While programs at all levels of maturity can benefit from AWE participation, initiatives in PDRR or EMD that are sufficiently mature and ruggedized to tolerate the harsh environment of AWEs are best positioned to benefit. Also, these programs have architectures that are not yet finalized and can make the most use of information derived from participation.

e. *Risk Assessment*

Survey comments indicate a substantial risk to programs participating in an AWE. Program risks include factors beyond the costs of participation, to include a poor return on investment, potential negative exposure, and extensive changes in requirements. The factors contributing to risk include:

- Maturity
- Ruggedization and maintainability
- The focus of the AWE
- Funding availability
- Equipment availability
- Biases
- Status of production decisions

4. Characteristics of Programs Best Positioned to Benefit from AWE Participation

Based on the data presented in Chapters IV and V, a program's potential to gain valued investment and requirements information from participation in Advanced Warfighting Experiments can be evaluated based on the following factors:

- State of the technology and how the initiative relates to the goals of the AWE
- The ability to tailor activities to relate to the needs of the program
- Development of clear objectives, expected outcomes, and strategies for implementation
- System maturity
- Ruggedization and maintainability
- Equipment availability
- Funding availability
- Data requirements
- Risk situation

a. *State of the Technology and Goals of the AWE*

Programs positioned to receive the most benefit from AWE participation will fit within the published goals, objectives, and focus of the AWE as stipulated by the

planning officials. Also, the AWE must address the issues facing the initiative. As demonstrated in the TF XXI AWE, those programs that are not a high priority of the analyzing agency may not receive adequate feedback. Additionally, initiatives that are new concept technologies with no current tactics, techniques, and procedures are best positioned to benefit from the integration of multiple systems in an experimental environment. Finally, programs with positive preconceived biases and general acceptance by leadership, users, and evaluators are best positioned to benefit. Program managers from the TF XXI AWE also stated that incoming biases can prevent any real analysis of a system's performance at the AWE.

b. The Ability to Tailor

The extent a manager was able to tailor or influence a program's specific activities in the AWE to reflect the program's current acquisition issues and decisions had a direct impact on the extent to which the program benefited from participating. Those initiatives reporting a high level of ability to tailor or influence generally reported much higher levels of perceived benefit from participation in the AWE. Both program managers and user representatives agree that to achieve maximum benefit from AWEs, acquisition managers must be able to participate in the planning process.

c. Development of clear objectives, outcomes, and strategies

The data suggests that those program managers who develop detailed experiment objectives and expected outcomes, systems for data documentation and analysis, and strategies for implementation of AWE data and recommendations will receive more valued data and will experience more benefit from AWE participation.

d. Maturity

Maturity effects the ability of a program to perform adequately as well as the ability of the initiative to implement recommendations derived from the AWE. Programs in the mid-developmental phases of acquisition are best positioned to benefit from AWE participation. Programs in early in development are high risk because of their unpredictability and vaguely defined roles and requirements. Programs late in development or in production are medium risk because they may be to far in development to capitalize on recommendations.

Additionally, programs with no pending production or funding decisions are best positioned to benefit from AWE participation. Programs that have secured approval and funding for production prior to participation in an AWE but have not yet begun production, face the added risk of poor performance and loss of support. Those initiatives with imminent production decisions are medium risk, in that AWE performance can significantly influence the survivability of the system.

e. Ruggedization and Maintainability

Systems participating in AWEs should be ruggedized and easily maintainable. A system that is highly rugged is able to withstand the stresses associated with operational use in harsh environments. A system that scores low in ruggedization has sensitive components with maintenance procedures that are difficult to conduct in a field environment. Low ruggedization may be associated with early prototype systems.

f. Equipment Availability

Mature initiatives with readily available production items are best positioned for AWE participation. Development of prototypes or surrogates requires additional costs, time, and developmental testing.

g. Funding Availability

AWE initiatives must have sufficient funding to benefit from AWE participation. Participation in an AWE is resource intensive. A program must have sufficient funds for prototypes, manning, training, transportation, and maintenance. Required funding will vary based on the complexity of the system. Additional funds will not normally be available specifically for AWE participation. Sufficiently funded programs will have budgeted dollars specifically for the AWE. Insufficiently funded programs will have tight budgetary constraints

h. Data Requirements

Programs with extensive need for data on integration, interfaces, interoperability, and user requirements are best positioned to benefit. Those programs early in Concept Exploration would score have the added benefit of receiving early user

feedback to refine system requirements. Those programs with sufficient feedback from other sources, or are not in a position to implement any recommendations from the feedback cannot take significant advantage of AWE results. Also, those programs with manager's and engineers having little exposure to the user's environment, are positioned to gain valued experience.

i. Risk Situation

AWE participation is not without risk. Programs with a high tolerance for risk are best positioned to participate in AWES. Acquisition programs may be negatively effected by AWE participation. Participating programs will experience significant costs associated with the AWE that may not provide a return on investment. AWE initiatives might receive negative exposure, effecting future funding and development decisions. Finally, AWEs can reveal drastic changes in requirements that a program might not be positioned to tolerate.

B. RECOMMENDATIONS

1. Acquisition Managers

a. Cost Benefit Analysis

Acquisition managers should conduct a detailed cost and benefit analysis to decide if AWE participation will be advantageous to their program. Costs in terms of protoyping, manning, fielding, transportation, and schedule should be included.

b. Formulation of Objectives and Measurements

To maximize the potential to benefit from AWE participation, acquisition managers should develop objectives and measurement processes for the AWE that will identify product improvements and areas for future investment. The results of AWE participation should be adequately documented to allow the use of AWE derived information and findings throughout the developmental lifecycle of the participating program.

c. *Participation in the Planning Process*

To achieve maximum benefits from the AWE, acquisition managers should actively participate in the AWE planning process and tailor their program's activities in the AWE to relate to the issues and decisions facing the program. Data collection and analysis plans should also be tailored to insure that the information derived from AWE participation is of value to the program.

d. *Risk and Benefit Comparison and Analysis*

Acquisition managers contemplating participation in future AWEs should conduct a detailed analysis of the risks associated with AWEs and consider their tolerance for risk as a factor in making a decision to participate. Potential risks should be compared to potential benefits from participation and interpreted to determine the best course of action for the program. Active measures should be identified to mitigate the specific risks associated with AWE participation. Methods to mitigate risk include (1) early budgeting of funds for the AWE, (2) marketing to the user, (3) placing significant emphasis on user training, and (4) direct participation in the AWE planning process.

2. AWE Planners

a. *Acquisition Manager Involvement*

For the JCF AWE, OPTEC representatives will meet with program managers to determine issues that are linked to AWE objectives [TRADOC JCF-AWE, 1998]. Planners for future AWEs should allow acquisition managers to actively participate in the development of AWE goals and objectives, scenarios, and data collection and analysis plans so that the information derived from AWE participation is of value to the program.

b. *AWE Funding*

The Army should consider providing funding for AWE initiatives so that acquisition managers can increase the benefits derived from participation. No additional funding will normally be provided to the program manager for future AWE participation or for implementation of any derived recommendations. Participation in AWEs requires

expensive prototyping, manning, fielding, training, and transportation costs that must be drawn from existing research and development accounts. Program managers cannot increase their roles in the AWE process and ability to tailor activities without dedicated support from the Army's budgetary process.

C. SUGGESTED FURTHER STUDY

1. Cost Benefit Analysis

Conduct a detailed cost benefit or cost effectiveness analysis of AWE participation. Include costs associated with prototyping, training, fielding, manning, transporting, and supporting participation in the experiment as compared to the benefits received. This study will assist the program manager in making participation decisions based on quantifiable data.

2. A Study of Increased Acquisition Manager Participation in the Planning Process

Conduct a study of most recently completed as well as future AWEs where planners actively promote the participation of acquisition managers. Determine if increased benefit is derived from this participation with or without an additional commitment of funding specifically for AWE participation.

3. Risk Analysis Study

Conduct a detailed study of all risks associated from AWE participation and validate a formal risk analysis and mitigation evaluation system through use on actual systems participating in AWEs. This validated risk analysis and mitigation plan will assist acquisition managers in deriving the higher levels of benefit from AWE participation while being exposed to less risk of a poor return on investment, negative exposure, or extensive changes in requirements.

4. Study of Contributing Factors to Benefiting from Current AWEs.

Conduct a detailed study, similar to this thesis, on more current AWEs to include the Division XXI AWE and the Joint Contingency Force (JCF) AWE to determine if the findings and recommendations from this thesis are applicable to other AWEs.

APPENDIX A. SPECIFIC INITIATIVE RECOMMENDATIONS FROM THE TF XXI AWE LIVE EXPERIMENT ASSESSMENT REPORT

Tactical Unmanned Aerial Vehicle (TUAV)

- A target location/designation capability should be included in the objective TUAV that allows targeting operations from a standoff position.
- Antennas on the TUAV should be positioned so that communications with ground terminals can be maintained during all aspects of flight.
- Users indicated that it was important for the TUAV to be able to support imagery exploitation at the target identification level. It must be able to distinguish between weapon model types (I.e., M-1 versus T-72).
- Every TOC should have the ability to receive a direct feed from a UAV operating in its area.
- Video display needs to include telemetry data so users know when the UAV is in its area (telemetry data was not relayed to battalion TOCs via RVT or
- Users indicated that they needed more tools for digitizing imagery (e.g., an imagery editing station that would permit them to grab a still frame and annotate it prior to dissemination).
- Users reported during interviews that the UAV downlink needs to be digital and encrypted. They were concerned that the enemy could intercept the down-link and benefit from its output.

Force XXI Battle Command Brigade and Below (FBCB2) (Applique)

- Continue experimentation with Applique/FBCB2 using other interface devices. Soldiers were not satisfied with the keyboard/mouse configurations, especially during movement. Recommend experimentation with more function key, touch screen, or light pen systems as an interim to voice activated, hands-free system.
- Determine the most critical/useful functions and eliminate non-critical
- Improve vehicle hardware integration.
- During future experimentation/testing with the Applique, perform technical testing to ensure that specifications for environmental and EMI/REC/NBC hardening are met. A particular area of concern is the possible EMI effects within designated and planned combat platforms.

- Ensure that prototypes of the acquisition version of the DSSU are subject to as many experiments/user juries as possible, in order to further refine and define operating systems and intended capabilities.

- Relook the DSSU distribution plan, based upon the refinement of intended capabilities. Certain functions may not be necessary at lower levels of command and control.

- Continue to develop and mature the Applique CSS functions. While the Applique did not perform well during the experiments, it has great potential in the CSS

Long-Range Advanced Scout Surveillance System (LRAS3) and the Hunter

- Develop the LRAS3 or HS3 for use by the Brigade Reconnaissance Troop and scout organizations.

- Incorporate system survivability improvements into development plan.

- Several comments noted that at times the HS3 system was hard to emplace and the stowed mast can make the vehicle unbalanced.

- There were concerns that the HS3 system gave off too much of a signature, could be easily spotted by enemy soldiers and did not have a crew served weapon with the vehicle to help make the crew and vehicle more survivable. It was suggested that the system be put in a vehicle, such as an M113, that would allow the system to be stowed under armor protection, give the crew a better work area and provide better cross country travel capability.

- The capability to dismount the LRAS3 system, place the system on an observation post, and hide the vehicle would improve system and BRT

Javelin Antitank Weapon System

- Improve day sight to enable the gunner to identify out to the range of the weapon.

- Improve the battery life of the CLU from current specification of 4 hours to 12-24 hours.

- Adjust the communication system distribution plan to allow for proper communications of AT section personnel.

Lightweight Video Reconnaissance System (LVRS)

- Increase communication range of the LVRS to 25-30 KMs.

- When the LVRS initiative is more mature (improved reliability and communications capability), that it be included in a future experiment.

- Modify the LVRS so that scouts can operate remotely and emplace the camera, in order to move to a covered and concealed location to monitor the screen.

Target Location and Observation System (TLOS)

- Investigate the concern expressed by some users indicating the laser emitted by the TLOS would compromise their position.
- Consider use of the initiative in future exercises when the initiative has matured (improved reliability).

Mortar Fire Control System (MFCS)

- Recommend that an experiment or test be set up so that data on the fire mission processing time, at each of the fire mission processing nodes, can be collected so an evaluation of MFCS affects on timeliness of mortar fires can be completed.
- Improve communications between the MFCS and the AFATDS at the BN FSE.

Stingray Combat Protection System

- Continue system development with emphasis on increasing system reliability.
- Investigate if the maximum effective range requirements are adequate to best support the force.

Light Tactical Operations Center (LTOC)

- Continue experimentation and development of the LTOC as digital systems and initiatives are improved.
- Place emphasis on digital systems' hardware and software integration development to improve the automatic sharing and integration of information among the systems in the LTOC and improve staff mission planning and
- In addition to preformatted messages, develop common, user friendly, e-mail message type capability for all digital information passing systems.
- Develop tactics, techniques, and procedures to cover the operation of the LTOC.

OH-58D Kiowa Warrior

- Increase the maneuver unit commander and staff training on the use and utility of the near real time picture of the battlefield provided by the OH-58D.
- Provide the capability to receive the near real time picture at all maneuver battalion TOC, not just the AVTOC.

- Fix the problems with the image file format and the baud rate of the modem used to transfer the images.
- Consider a video down link similar to the UAV.
- Fix problems with SINCGARS SIP radio, line of sight reception and reliability in system.

Army Airborne Command and Control System (A2C2S)

- Increase maneuver unit commander and staff training on the use and utility of the real-time picture of the battlefield provided by the A2C2S.
- Relook the crash survivability of the A2C2S physical layout.
- Provide additional ground and air radios with increased range and data handling capability to correct the identified limitations of the SINCGARS SIP and power output of the FH MUX.
- Fix the file transfer problems prior to production of the A2C2S.
- The A2C2S should have fewer MCS workstations and should have ASAS and AFATDS, instead. The A2C2S should have at least five radio nets.
- Some human factors engineering improvements are needed, such as lighting, available workspace, and intercom switch placement.

Aviation Tactical Operations Center (AVTOC)

- Improve mobility of the AVTOC. It took approximately 3-4 hours to tear down and six hours to set up using all of the TOC personnel.
- Provide training for commanders and staff personnel on ATCCS in terms of capabilities, functionality, and management of assets.
- Allow for integration of additional liaison officers and their equipment which were not part of the AVTOC system, e.g., field artillery and USAF LNO's.
- Improve communications and connectivity between the ATCCS, MCS, Applique, and AMPS.
- Provide additional MCS, ASAS, and AFATDS systems to allow for future planning while conducting current operations.
- Provide a wireless LAN for workstations to reduce setup/tear-down times and clutter within the TOC.

AH-64D Longbow Apache (LBA)

- Increase maneuver unit commander and staff training on the use and utility of the

near real-time picture of the battlefield provided by the LBA.

- Provide the capability to receive near real-time picture at all maneuver battalion TOC, not just the AVTOC, Maneuver Bde TOC, and A2C2S.
- Solve the interface problem between the IDM and EPLRS.
- Solve the problem of being able to select the priority of JSTARS or LBA FCR data feeds into the CGS(P).
- Make the AVTOC target type data field match the LBA target type data field to enable the AVTOC to recognize the target type from the LBA shot at files.
- Fix the problem with the A2C2S IDM sending LBA FCR data to its file server to enable the A2C2S to display the LBA FCR data on a map overlay to all its work stations and the large screen display.
- Provide a means of disseminating the LBA targets data files to multiple users, such as posting of enemy SA on Applique after ASAS review.

Aviation Mission Planning System (AMPS)

- Make AMPS fully interoperable with MCS for connectivity or combine the capabilities of both systems into one unit.
- Replace dot matrix printer with a faster more capable printer with laser print
- Increase AMPS screen size to allow collective use and mission briefings.
- Make software more user friendly with Microsoft Office type work processing capability.
- Make the import of situational data simpler. AMPS did allow the import of situational data however, that data had to be manually loaded at the AMPS workstation before it could be passed to another AMPS. Generally, it was too difficult, not enough time was available to perform the required tasks.

Advanced Field Artillery Tactical Data System (AFATDS)

- Add target strength to the software logic protocol consideration queue for the calculus of determining a target value.
- Modify the software functionality for counter-fire to appropriately reflect Army doctrine on counter-fire missions.
- Modify the AFATDS/LCU software to provide the FSCOORD with current fire mission data.
- Improve some user interface capabilities. Modifying the Attack Methods Table

information must be easier for the user to do during the course of the battle.

- Improve some user interface capabilities. The battalion FDO should have the capability to modify a mass fire order at his OPFAC when needed, and be able to send that modified fire order to multiple subordinates simultaneously. This would allow him to retain digital interface with subordinated OPFACs while tailoring the tactical fire solution to current battlefield realities.

- Develop a better communications system than SINCGARS-SIP currently provides for AFATDS OPFACs.

Experimental-Fire Support Team (X-FIST)

- Improve the maintenance concept of the X-FIST targeting station. The targeting station maintenance personnel should deploy for combat with the maneuver unit.

- Review the LCU hard drive and RAM issue to determine if more RAM is necessary or if a hardware modification might allow the user to operate the system successfully during operations on the move. When on the move the LCU hard drive tended to crash requiring the system to be shut down while on the

Paladin/Field Artillery Ammunition Support Vehicle (FAASV)

- The Paladin/FAASV was identified as a "high-performing" system and fielding should be continued.

Fire Direction Center Vehicle (FDC-V)

- The FDC-V should continue as a viable candidate to replace the 1068 as the FDC/POC operations vehicle.

Lightweight Laser Designator & Rangefinder-Surrogate (LLDR-Surrogate)

- Field the initiative as a replacement for G/VLLD in scout and Striker forces.

- Provide a "slave" capability for the LLDR from a vehicle that will provide longer use capability for the observers.

Linebacker and Avenger

- The Avenger and Linebacker were assessed as "high-performing" initiatives during the conduct of the experiment. Develop tactics, techniques, and procedures that fully support the new Linebacker/Avenger system improvements.

Forward Area Air Defense Command, Control and Intelligence (FAAD C2I)

- FAAD C2I was identified as a "high-performing" initiative during the conduct of

the TF XXI AWE. Develop TTPs that fully support the new FAAD C2I/Sentinel system improvements.

- While operating in the "HOVER" mode to detect low-flying RW aircraft, the increased radar sensitivity resulted in clutter on the unit display. In addition to helicopters, ground clutter and vehicles appeared on the EO and SHTU display.

Wide Area Munitions (WAM) Hornet

- The self-arming battery should be increased to six hours versus the current two-hour life once the WAM Hornet is installed.

- The remote arming range needs to be increased from 1000m to 3000m.

- The training device for the XM97 needs to be redesigned to incorporate remote arming and the remote arming capability needs to incorporate visual sign allowing observation that the WAM Hornet is armed or recycled.

- The commander needs to have a flexible employment strategy that allows him to employ the WAM Hornet to mass the effects of the Hornets and to ensure that the proper integration of fires is accomplished. The X pattern and Gauntlet are still good employment strategies, but hornet employment shouldn't be limited to just X and Gauntlet.

Automated Nuclear, Biological, and Chemical Information System (ANBACIS)

- IT&E IPT should include an operational test as part of the normal acquisition strategy for the ANBACIS.

- Establish seamless connectivity between Applique and MCS/P.

Radio Frequency Tags/Identification Devices (RF Tags), PLS-E Enhancements

- Develop a mobile interrogator. An interrogator mounted on a trailer with a cellular phone could be easily transported from site to site.

- Continue to pursue RF technology to include improvement of components and interservice interoperability.

- Attention must be given to development of control procedures for use of AIT technology in the field.

- Integrate the equipment required to install and support network operations into the appropriate supply, transportation and ammunition automated information systems. Supporting these systems with RF technology must be "fly-away" packages capable of quick installation and easier maintenance.

Personnel Service Support Control System (PSSCS)

- Fully integrate the Force XXI Manning System (FMS) within CSSCS so that accurate and near-real time strength reporting can occur. Presently, FMS is a prototype of the desired personnel functionality that is needed in CSSCS.

- Include an additional table or data black that shows the task force that the soldier is attached to in addition to his/her UIC that is already listed.

- Continue the development of FMS to make it more user friendly. Commonly used custom queries should be added to the reports section within FMS.

- Provide an automated interface between Applique and FMS. The manual data that had to be inputted and managed detracted from the potential responsiveness of the system.

Medical Communications for Combat Casualty Care (MC4)

- Test Telementoring, Teleconsultation, and the MDA in a test event with less OPTEMPO than the TF XXI AWE where their capabilities can be fully assessed/evaluated.

- Perform appropriate studies which address concerns on the survivability/vulnerability of AMEV as a forward area evacuation platform I.e., replacement for the M113.

- Reevaluate doctrine for Telementoring and Teleconsultation to determine how far forward they can be effective on the battlefield.

- Improve the users ability to load litters into the AMEV and securing them into the top litter rack.

Command & Control Vehicle (C2V) and Battle Command Vehicle (BCV)

- Continue procurement process on C2V.

- No further development should be considered on the BCV until unacceptable communications problems are resolved.

- Perform a detailed technical analysis on the effect on communications of the large number of antennas and signal emitters in the Bn/Bde TOC areas.

- Test the C2V, BCV, and digital TOC in a long-distance Command Post Exercise (CPX) environment with extensive operations on the move in order to fully demonstrate their utility in operations on the move.

- Investigate and resolve the C2V antenna system. The system poses a hazard to soldiers, under certain circumstances.

- Numerous suggestions were made that, to reduce motion sickness in the C2V, crew stations needed to face toward the front of the vehicle at all times.

Situational Awareness Data Link (SADL) and Battlefield Combat

- Fully investigate and resolve the reasons for the incomplete passing of digital 9-line reports.
- Develop a reliable, rugged display unit for use on an active battlefield.
- Continue development of the SADL-EFAC system.

Battlefield Combat Identification System (BCIS)

- Fully integrate all identification systems with the weapon firing system, similar to the M1 version of BCIS, so that the gunner can make an engagement decision without breaking the sight picture.
- Provide a functional system for dismounted soldiers to prevent them from becoming targets or engaging friendly vehicles.
- Perform a smaller experiment with fully equipped units to render more information on the system.
- Investigate whether the width of the BCIS interrogation beam prevents positive ID on a battlefield with friendly and enemy vehicles intermingled.

Asynchronous Transfer Mode (ATM)

- Examine the use of high-speed multiplexer cards to support VTC data feed as an alternative to the current ATM.
- Implement ATM with higher data rates, more bandwidth, dynamic bandwidth allocation, and high-speed multiplexing to reduce load on the MSE system.
- Simplify the difficult methods to install, operate, and maintain the ATM switches.

Surrogate Digital Radio (SDR)

- The SDR was identified as a "high-performing" initiative during the conduct of the TF XXI AWE. Continue development of TTPs which will ensure that it is utilized properly in the future.
- Increase bandwidth and throughput in the fielded version of SDR.

Global Broadcast Service/Battlefield Awareness Data Dissemination

- Develop methods for users to properly manage the increased information provided by the GBS/BADD.

- Continue further development of the GBS/BADD and associated TTPs.
- Review the user survey results and incorporate desired features into the GBS/BADD such as UAV imagery, LBA messages, weather data, and commercial

Air Defense Applique

- Improve the real time battlefield situational awareness, digitized command functions and connectivity with the FAAD C2I network.
- Relocate the Applique workstations in vehicles to ensure ease of operation.
- Air Defense Liaison officers should have Applique. They currently track the battle using a map and information they obtain from monitoring the voice nets.
- Ammunition re-supply vehicles should be equipped with Applique to assist in timely re-supply operations.
- Include an automatically scrolling map that is oriented to the vehicle direction of travel with the vehicle icon centered on the display.
- Improve the Applique menu selection option procedures by making them more user friendly.
- Applique digital network is most effective when the unit is stationary. This is due to the difficulty of using the mouse and keyboard on the move. Develop an improved input device for the Applique.
- Improve the resolution of the Applique map and data update cycle for adequate vehicle navigation.

CSS Applique

- Improve reliability of communication links and simplify complex input screens.
- Increase situation awareness by allowing Applique to access multiple radio nets.
- Improve ability to request support using Applique by providing an acknowledgment of request from the receiving unit.
- Increase situational awareness by improving Applique screen resolution.
- Simplify the cryptic and unusable addressing system.
- Continue to develop and mature the Applique CSS functions.

Fire Support Applique

- Continue development of the applique while improving connectivity problems.
- Integrate Applique with AFATDS.

M/CM/S Applique

- The Applique capabilities should be matured to provide the Engineers with a robust method to produce graphics and overlays for identifying friendly and enemy obstacles.

- The tactical internet architecture for the engineer force structure should be modified to meet mission requirements. The architecture will need changing so it provides the capability to communicate within the supported maneuver force as well as within the engineer battalion.

- The practice of disseminating known obstacle information and receiving template obstacle locations on MCS/P and Applique overlays should be enhanced.

- The graphics for minefields need to be military graphics, not just a box on the screen and symbols need to be drag and drop.

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APPENDIX B. SURVEY COVER LETTER

134 Brownell Circle
Monterey, CA 93940
831-372-8150
kwstraye@nps.navy.mil

Dear _____,

I am an Army student in the Acquisition Management program at the Naval Postgraduate School (NPS), Monterey, California. Thank you for agreeing to help my research on the use of Advanced Warfighting Experiments (AWE). By completing the enclosed survey, you are providing valuable insight into the results of the 1997 Army Task Force XXI AWE.

My research will evaluate the effectiveness of the 1997 AWE objective of providing information to support investment decisions and refinement of requirements for information age technologies. The enclosed survey collects data from involved program offices and user representatives to determine the perceived utility of the AWE data. Opinions detailing why specific AWE recommendations were or were not implemented will assist in determining the contributing factors to a program's ability to benefit from participation in the experiment.

My research will make recommendations on how to best use Advanced Warfighting Experiments to support acquisition decisions. This study will assist acquisition managers in gaining maximum benefit from participation in future experiments. Also, the research will assist planners in tailoring future experiments to better benefit participating programs.

The survey includes four sections:

- Section one collects information about the specific level of implementation of recommendations made for your program by the Army Operational Test and Evaluation Command's Live Experiment Assessment Report.
- Section two contains questions about your program's experience in the AWE.
- Section three asks you to rate given reasons why AWE recommendations may or may not have been fully implemented in your program.
- Section four is available for you to provide any other information that you think may be valuable to my study.

For your convenience, I have provided this survey as an attached word document. You may email the completed survey to me or mail a printed copy to the address above. For your convenience, I will send a copy of the survey by mail to you in several weeks with a stamped, self-addressed envelope. I estimate that the survey should take between thirty and forty-five minutes to review and make comments. I would be happy to send you an electronic copy of my final effort for your own use.

If you need any additional details, please contact me at the above address, email, or phone. All information gathered will be used on a non-attribution basis and the names of individuals providing opinions will be kept in strict confidence. Names of programs will be kept confidential upon request. Please feel free to distribute this survey to others that may have experience relating to my research. I appreciate your help on this project.

Sincerely,

Kenneth W. Strayer
Captain, United States Army

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