INTEGRATING USERS INTO SYSTEM DEVELOPMENT: USER EXERCISES IN CCTT

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ABSTRACT

CCTT is a networked training simulation system being developed for the U.S. Army STRICOM through a series of seven incremental builds. These builds will progressively add system components and increase the complexity of components delivered in previous builds. Each build will integrate the previously built system with newly delivered hardware and software components into a system which is partially functional. Total system functionality incrementally increases until at the conclusion of build seven the system is complete and can enter qualification testing. To increase assurance that system testing will be successful and that CCTT is ultimately training effective, a user assessment of each incremental build is conducted. These assessments are conducted in the context of operational user exercise scenarios with Army users. Each scenario is designed to train those collective tasks which can be performed using the technical capabilities provided by the system functionality in the CCTT system built thus far in the program. The user exercises provide both a checkpoint on progress toward meeting the technical requirements of the CCTT program and a way to assess the system's training effectiveness. Training effectiveness is assessed based upon collective tasks which are going to be evaluated for training transfer during the system's initial operational test and evaluation (IOT&E). The approach supports a continuous test and evaluation philosophy while gauging the training effectiveness of a system throughout its development. The methodology used in CCTT is key to integrating a user focus into a concurrently engineered training system being incrementally developed.

ABOUT THE AUTHORS

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OVERVIEW OF CCTT

The Close Combat Tactical Trainer (CCTT) is a Distributed Interactive Simulation (DIS) Standards compliant system for training Army Company/Teams and Platoons in the collective tasks required by their unit type Mission Training Plans (MTP) [1]. The system requirements and conceptual design for CCTT were derived from the ARPA SIMNET technology demonstration [2, 3]. CCTT will be fielded at fixed sites starting in 1997 to the Armor and Infantry Schools and to posts which garrison Armor or Mechanized Infantry Divisions in the United States, Germany, and Korea.

Mobile versions of CCTT are being designed to train Armor and Mechanized Infantry platoons. Current plans are for these platoon sets to support distributed training in National Guard combat units. CCTT is comprised of a network of simulators. Simulator modules represent the primary weapons systems and support vehicles found in the close combat portion of the battlefield. These include, the M1A1 and M1A2 Abrams Tank, the M2A2 and M3A2 Bradley Fighting Vehicle, the HMMWV, the Fire Support Team Vehicle (FIST-V), and the M113A3 Armored Personnel Carrier.

The Army needs CCTT to fill critical training deficiencies resulting from more restrictive access to training areas, funding limitations, and increases in the sophistication of weapons technology [4]. Units will train in CCTT under unit control. It will have the capability to simulate Battalion Staff tactical functions by emulating real world equipment such as the SINCGARS radio interacting with combat crews in their simulators.

Computer workstations provide a way to interact with computer generated forces which perform battlefield functions in the virtually simulated world (e.g., combat engineer units conducting counter-mobility operations). Opposing forces (OPFOR) and friendly units on the battlefield located near the training unit will be emulated by Semi-Automated Forces (SAF) [5].

INTEGRATED SYSTEM DEVELOPMENT

CCTT is presently under development by an Integrated Development Team (IDT) comprised of engineers from six companies and the government [6].

The IDT has organized its development effort into seven incremental system builds. These builds are designed to integrate, throughout the course of the development phase, the CCTT functionality which has been developed to that point by concurrent engineering teams responsible for each of the system components. This spiral system development methodology is conceptually illustrated in Figure 1.

The incremental builds both add functionality (i.e., components) to the maturing system and increase the capabilities of each component. For example, the first CCTT build integrated an M1A1 simulator module, an After Action Review Component able to record and replay the training exercise, a DIS network, and the system Master Control Console. The second build increased the capabilities of that M1A1 module, incorporated the capability to process remote entities, and integrated a rudimentary Semi Automated Forces (SAF) component.

The idea behind the incremental system builds is to integrate a complex system step-wise throughout development, allowing engineers to identify early any inconsistencies or problems that impact proper integration. The availability of a partially functional CCTT system offers a unique opportunity to assess its progress toward achieving the objective of providing effective training for the soldiers who are the ultimate system users.

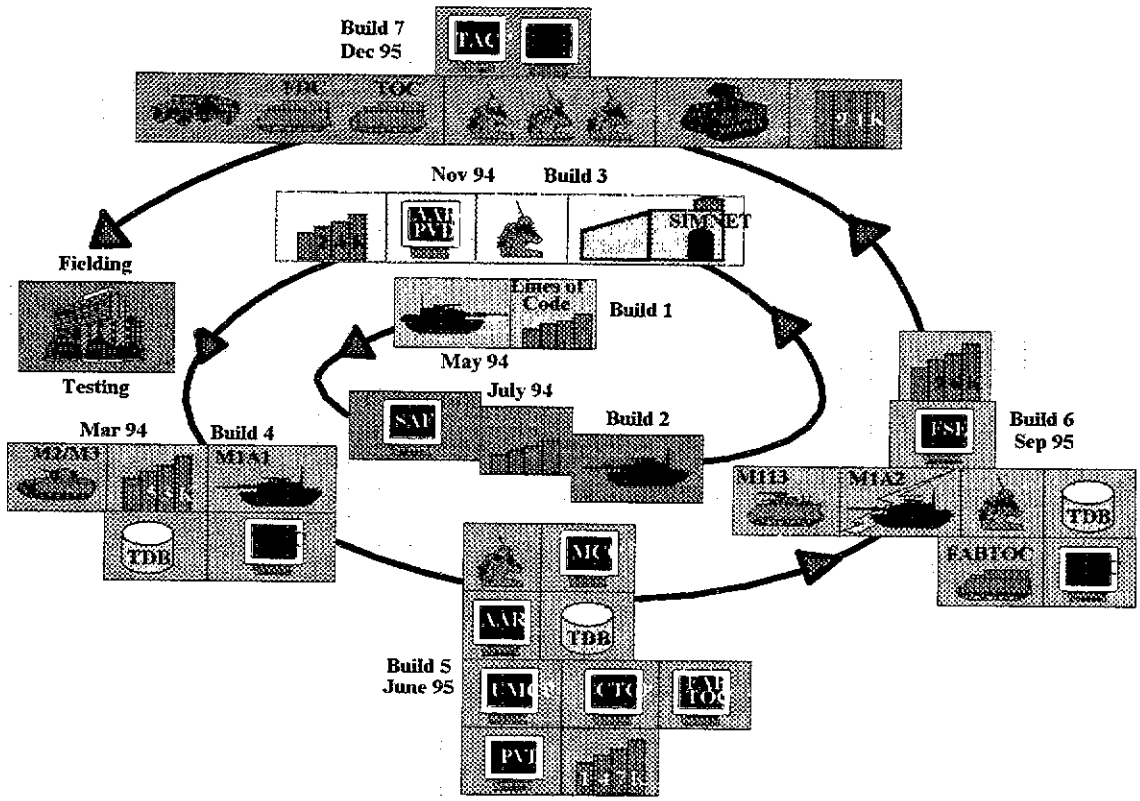

FIGURE 1

RATIONALE FOR EVALUATIONS

By examining the functionality available in each build and cross walking it with collective tasks to be trained in CCTT, we develop a user exercise that can be performed at the conclusion of each integrated CCTT build. This gives us an opportunity to conduct early system level evaluations against system operational requirements as well as checking technical specifications. Our approach is not necessarily unique. For example, the Air Force Training Systems SPO developed an approach to system testing called Simulator Test 2000 [7] that makes extensive use of subject matter experts as members of a Critical Process Team. Their focus is evaluating training products and services while CCTT is the first full scale development of an Army collective training system.

CCTT is the largest and most complex training system the Army has ever procured, and in terms of the number of its components, it may have that distinction for all of the military services. Basing CCTT user exercises on crew and collective tasks integrates an operationally oriented evaluation of the system into the development process sooner than it would be using just traditional formal operational testing approaches used for final system checkout.

There are numerous benefits to this approach:

- Engineers get to see soldiers using their system; they get direct feedback early enough so that it can effect design and development for subsequent builds.
- The user community sees the contractor's progress toward meeting their requirements, and
- Users are brought into the development process early, rather than being handed a

system at operational test and then asked to decide if it meets their needs.

The approach is not without its drawbacks, significant attitudinal changes are required:

- The user community has to be level set to understand that the system is immature and that the early builds do not completely resemble the finished product. Users must be convinced that they are part of the team developing the system and that their input is needed to assess what has been done to date.
- Industry engineers need to be assured that they will not have to "start over" after every evaluation because a new set of requirements has been generated.
- The military procurement community has to accept a major paradigmatic change. They must be comfortable with allowing their customer (the system user) to see how industry is progressing; they have to control user expectations.
- A process for managing user feedback, specifically providing it in a useful format to engineering, must be developed.

Strong industry and procurement community leadership is required to make theuser exercise concept effective and accepted.

USER EXERCISE APPROACH

To develop the user exercise approach for CCTT we conducted a front end analysis of collective tasks that could be supported using the technical capabilities of each build. For each build we develop tactical scenarios based on those tasks, design a data collection methodology, conduct the exercise, and finally analyze the raw data gathered from user feedback to determine a set of technical issues.

To accomplish all of these steps a working group was formed consisting of development engineering staff, human factors engineers, system integration staff, training and doctrine experts, subject matter experts, test engineering, and software engineering. This working group is co-chaired by the industry Training Effectiveness Advocate and the Assistant Army Program Manager. This group authors, reviews and approves the training scenarios for each build, the plan for conducting the user exercises, and the final report of results.

To determine which tasks would be included in a user exercise, the team starts with the technical capabilities provided in a CCTT build, that is, the system build to be evaluated. This set of capabilities is cross walked with a previously completed analysis of the tasks that can be trained in CCTT. The latter are documented in a database called CATTASK built by a government support contractor. Electronic access to CATTASK facilitates rapid information retrieval during the analysis.

A subjective assessment is made of which tasks can probably be supported. This task set gets refined as scenarios based on them are developed and tested. The scenarios are not scripted chains of events, but rather a set of tactical conditions to which the training unit must respond that are set in a situation training exercises (STX). The actual STXs used are modifications, as necessary, of those defined by the Army in their Mission Training Plans for Armor and Mechanized Infantry units.

The scenarios are tested during system integration and adapted where needed. In some cases, we find that not all predicted collective tasks can be trained in the next build. We then refine our analysis to show which ones would in fact be evaluated within a given scenario. As integration progresses and in preparing for the user exercise the scenarios are "dry run" by personnel assigned to the IDT. These personnel include the subject matter experts who are part of the Army Optimization Team [6], active duty soldiers assigned full time to support the program on site.

The actual user exercise (USEX) is conducted by a 15 person team drawn from the Working Group. Integration and Test personnel operate the system assisted by development engineers from each CE team. The purpose of including development engineers is so that they can view first hand how their system component performs and observe user interaction with it. This has proven useful in helping the CE teams understand technical issues arising from user comments. Responsibility for directing the evaluation is shared by the CCTT Training Effectiveness Advocate and the Assistant Program Manager from the Army responsible for test and evaluation. Control of specific scenarios is managed by a government subcontractor who authored the scenarios.

Two types of users participate. Army uniformed personnel operate the simulators and also observe the exercise in a trainer or observer/controller role. In the latter role, they guide the after action review process. Contractor personnel fill the same roles that Contract Logistic Support (CLS) personnel will perform at an actual CCTT site. The roles are system operator, SAF commander, and AAR workstation operator. Data is collected by human factors engineers who observe the users in the training scenario, administer questionnaires to elicit specific feedback, and conduct individual and group interviews following each phase of the evaluation.

Following the exercise, the human factors engineers, in coordination with the Training Effectiveness Advocate, extract from the feedback a set of user comments which are loaded into a database. A second analysis is then conducted to determine which of the user comments address technical issues relevant to CCTT.

The set of technical issues is then assessed by a review board comprised of CE team leads and chaired by the Chief Engineer. They jointly identify which issues are true deficiencies in the system implementation and need to be tracked to insure that they are remedied, which ones are clearly outside the scope of the program and belong to management for consideration as the basis for an engineering change proposal, and which ones are a planned future build functionality. Issues in the first category are reported to the CE team. They manage and integrate the appropriate hardware or software modification to address the problem and they document in a formal tracking system the results of their efforts.

RELATIONSHIP TO SYSTEM TESTING

The user evaluation approach taken in CCTT is designed to complement and support formal technical and acceptance test procedures. The user exercises themselves do not attempt to cover all test conditions because they focus on an operational scenario based on Army doctrine and training methods. However, since the exercises are designed based on the build capabilities they do evaluate a significant portion of the technical requirements met in a given build.

As the seven builds and associated user exercises progress over time, the tactical scenarios used are not redesigned, but rather they evolve through enhancements. This both saves scenario development time and assures that what is planned for can be accomplished because a similar scenario was used in the previous USEX. The scenarios which evolve will be recommended for use in technical testing such as PPQT and as the basis for operational testing acceptance.

Government test agencies have representatives assigned full time to the IDT in Orlando. These individuals work with the User Exercise Working Group on a regular basis. Test agencies also send personal to observe the user exercises and evaluate their agency's planned procedures for test data collection. Although, there is not yet approval for this concept, we believe that during the user exercises for the later builds, a cooperative testing and user evaluation effort will occur which shares scenarios and exercise results. Potential savings to the overall program costs could be significant. Working cooperatively in this manner extends the integrated development approach [6] one step beyond simply engineering organizations working together. Our concept encourages engineering organizations and evaluation agencies to cooperate by sharing processes, products and data.

EXPERIENCES TO DATE

As of August 1994 we have conducted the user exercises associated with the first two CCTT spiral system builds. Build 3 User Exercise is planned for November of 1994. Government support has been superb. The exercises have proven to be an appropriate way to acquire early feedback from users and a way to show progress toward completing the system the user community has requested.

Results of the User Exercise are reported in several forms. For USEX1 136 user comments were collected from which 75 technical issues were identified. For USEX2 86 comments, 27 of which were duplicates from USEX1. Table 1 summarizes the results of these first two user exercises and subsequent analysis. It is our contention that the 76 total Problem Trouble Reports (PTRs) identified as a result of the user exercises would have eventually been identified But this would probably not be until qualification

testing when the cost to fix them would be considerably increased.

USEX	# User Cmts	# Tech Issues	PTRs
1	113	79	47
2	86	49	29

TABLE 1

All comments are captured in a database where their linkage to technical issues and final disposition is shown. This database has been incorporated into the CALS system used on CCTT so that all government and contractor personnel have access to results. A formal report is also prepared on each exercise, it includes a training effectiveness assessment. That assessment indicates, for each training tasks underlying the exercise scenario whether the task can be fully trained, partially trained, or not trained using the current build configuration.

We have found it necessary to refine the manner in which findings (user comments) are processed and reported. The initial concept of simply reporting these comments out to the engineering organization, specifically the CE teams, was not effective. The three analysis steps described in III above was the result of evolving this process so that it generated information in the form of specific technical issues that is understandable and could be acted upon by engineers.

It is important to manage expectations and that procurement agency concerns be continuously addressed. For the early builds, we are using Subject Matter Experts from the Army centers as our soldier subjects. In some cases, these are NCOs who have previously reviewed CCTT specifications and designs so they are intimately familiar with both what is being developed and the incremental build process. For Build 3 to 7 User Exercise we plan to use soldiers from field commands who are unfamiliar with the system as subjects. This will add a requirement for another type of expectation management. We have worked diligently to identify system anomalies that are the result of using early development (in some cases just prototypes) components which will be improved or replaced later in the program. User subjects receive a detailed briefing on these anomalies prior to beginning the training scenarios.

CONCLUSION

We plan to continue using the approach described above for all CCTT builds. Our first two user exercises have been well received and supported by the contractors involved, the government procurement agency (STRICOM), and the Army user community (TRADOC). The approach will be refined and institutionalized for future use on complex training systems.

Incorporating user evaluations into a development effort of any system is critical to the successful implementation of the human-computer interaction components of that system. This is a fundamental aspect of user centered system design and for software developed with a usability engineering focus. A training simulation system is primarily a human-computer interaction, all other components – modeling algorithms, terrain data bases, etc. – exist to support that purpose. For this reason, it becomes even more critical to conduct early and continuous user assessments of training simulations. For CCTT we have developed a methodology using tactically-based scenarios that successfully accomplishes that purpose.

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