Rethinking the Collective Task Analysis Process to Support Future Combat System (FCS) Embedded Training

David Olsen
Dynamics Research Corporation
dolsen@drc.com

Bob White
Science Application International Corporation
Emett.robert.white@saic.com

Mike Flynn
Northrup Grumman Information Technology
Michael.Flynn@ngitky.org

Ed Kersey
Dynamics Research Corporation
ekersey@drc.com

Jim Mowery
Computer Sciences Corporation
jmowery@csc.com

Chris Graves
Human Resources Research Organization
Chris.Graves.HumRRO@ngiky.org

ABSTRACT

In the near future, the Future Combat System (FCS) Embedded Training (ET) system will provide Soldiers with stand-alone and distributed collective training that is enabled through embedded training technologies within FCS systems. FCS embedded training will support live, virtual and constructive (LVC) training approaches. Training Support Packages (TSP) for the FCS equipped Unit of Action (UA) will provide all the materials needed for conducting collective training. To support FCS embedded training, the TSP must be a mechanism that will provide commanders with the flexibility to tailor training based upon specific needs of their units. A substantial collective task analysis effort is currently underway to support design of the TSPs that will be implemented in an embedded training environment. This requires a substantial "rethinking" of the traditional collective task analysis process identified in the Army's Systems Approach to Training (SAT). This paper addresses challenges related to conducting a collective task analysis when the end product is embedded training. Particular emphasis is placed on the approach being used to identify task conditions and how this approach will support a commander's ability to tailor training in an embedded training environment. Finally, discussion is provided on how data products from the task analysis are being leveraged to support FCS embedded training system and software engineering teams.

ABOUT THE AUTHORS

David Olsen is a Senior Systems Analyst for Dynamics Research Corporation. He has 19 years experience designing and developing military training systems. His work has included examination of training, human factors, manpower, and cost issues impacting training system design and implementation. He has been involved in the design of numerous training systems encompassing various configurations of embedded training, multimedia, and virtual and constructive simulation. Recent work has focused on user interface design and usability assessment for WARSIM, JSIMS, and CCTT. His current assignment is to guide process issues for the FCS collective task analysis.

COL (Ret) Bob White is the lead for collective task analysis for the Future Combat Systems (FCS) Lead Systems Integrator (LSI). While in service, he commanded cavalry units up through squadron level and served in staff positions from squadron through the Office of Secretary of Defense. He has a master's degree in Operations Research. He has extensive experience with instrumented field training, use of simulations for training and analysis of weapons systems performance, and development of simulations for strategic defense. COL White was involved with SIMNET from its beginning in 1984 while serving as Chief, Studies Directorate, Ft Knox, Ky. He culminated his career as the TRADOC System Manager for Combined Arms Tactical Trainer (TSM CATT).

Mr. Michael R. Flynn is the Technology Applications Program Manager for Northrop Grumman Information Technology at Fort Knox, KY. He has an MPS in Counseling and holds the rank of Lieutenant Colonel in the U.S. Army Reserves. Mr. Flynn has over 25 years experience in Army training, training development, and simulations. His recent work has focused on Unit of Action tactical concept exploration, prototyping of performance support tools for Future Combat System of Systems (FCS), distributed leader team training, and development of prototype electronic Warfighter training support packages. Currently, Mr. Flynn is the Northrop Grumman Information Technology Program Manager for the Army's FCS TSP development effort.

COL (Ret) Ed Kersey is the Dynamics Research Corporation Program Manager for Package 27 (Collective TSPs) Task Analysis Process, and is the lead for Task Analysis for the UA Brigade and the UA Forward Support Battalion. During his 28 years of active duty in the U.S. Army he commanded Airborne Infantry, Mechanized Infantry, and Cavalry units from platoon through the battalion level, and served in staff positions from battalion through the Department of the Army. He is a graduate of the National War College, at Ft McNair, and served 6 years as an Inspector General at the State and Department of the Army level. He has extensive experience is military training and simulation. Mr. Kersey served as the software lead for the Battle Space Workstation for the JSIMS Common Component Workstation. He also provided Knowledge Acquisition (KA) and Knowledge Engineering (KE) support to the WARSIM program from 1997 through 2002.

COL (Ret) Jim Mowery is the CSC project manager for Army Aviation and Non-Line Of Site (NLOS) battalion and below collective task analysis for the Future Combat Systems (FCS) Training Support Package development. While in service, he commanded maneuver units from platoon through brigade in peace and war and served in staff positions from battalion through field army. He has an MBA and is a doctoral candidate in the field of Education. He has extensive experience in training development spanning the live, virtual, and constructive environments. COL Mowery was involved with simulations and simulators as early as 1974 and served on the United States Army Aviation Center staff as the Deputy Assistant Commandant and as the Director of Evaluation and Standardization. He joined the Army in 1964 and retired in the year 2000.

Christopher R. Graves is a Senior Scientist with Human Resources Research Organization (HumRRO) and holds an M.A. (1996) in Experimental Psychology. He has 11 years experience in the development of simulation-based military training, focusing on training design, program evaluation, task analysis, research design, and test development. Mr. Graves' most recent work included the development of a method for providing performance coaching for small leader-teams operating in distributed environments. Currently, Mr. Graves is serving as a senior training developer for the Army's Future Combat System of Systems training support package development effort.

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RETHINKING THE COLLECTIVE TASK ANALYSIS PROCESS

"The heart of the Army's training remains the training conducted by junior officers and noncommissioned officers (NCOs). To empower them, we must shake a legacy of planning-centric rather than execution-centric training. We need battle drills rather than "rock drills, free play rather than scripted exercises, and Soldiers and units conditioned to seek out actionable intelligence rather than waiting passively to receive it."

Serving a Nation at War: A Campaign Quality Army with Joint and Expeditionary Capabilities

Les Brownlee and Peter J. Schoomaker

FCS Embedded Training

Embedded training (ET) will be a key component of the Army's Future Combat System (FCS) and will encompass the capabilities to support live, virtual and constructive approaches to training. The importance of training for FCS has been raised to a level where it has been designated as a Key Performance Parameter (KPP) for the FCS program. The ET capability being developed will provide a range of training approaches previously unavailable to commanders and will be resident on the Soldier's platform. For individual training, instruction will be provided via Interactive Multimedia Instruction (IMI). A catalog of lessons will be available either onboard, or downloadable from a remote repository. An Interactive Electronic Technical Manual (IETM) capability will be available to support operations and maintenance of FCS platforms. Perhaps the most ambitious embedded training requirement will be the distributed training of collective tasks using the operational systems of the Unit of Action (UA). A distributed training event may include any combination of live, virtual and constructive training approaches and involve echelons of squad through brigade. Through the platform's Warrior Machine Interface (WMI) training options will be made available to the commander to plan the training, modify the exercise as necessary to meet training needs, prepare the embedded training system components, conduct the exercise, and evaluate performance.

This paper focuses on two key issues related to the requirement for FCS embedded training to support the training of collective tasks.

Issue #1: Tailoring the process for conducting the task analysis to ensure the right data was collected to support subsequent collective training products, i.e., Training Support Packages (TSP).

Issue #2: Leveraging an exceptional opportunity during task analysis to collect task data to support system and software engineering teams responsible for embedded training.

Both of these issues require a "rethinking" of the traditional collective task analysis process.

Beginning with the End in Mind

The traditional collective task analysis process prescribes a systematic investigation that identifies what tasks are performed. In the case of the FCS equipped Unit of Action (UA), task data reflecting how the UA will fight is slowly emerging. A new force structure coupled with significantly enhanced capabilities that will be available to the UA has resulted in many new tasks and substantial changes to how tasks will be performed by the UA. A great deal of FCS task data has been extracted from TRADOC Pamphlet 525-3-90, United States Army Objective Force Operational and Organization (O&O) Plan Maneuver Unit of Action. In addition to the O&O, task data is being developed through participation in various battle lab experiments, and through war gaming/rock drill activities. This work is being performed at Ft. Knox, Ft. Lee, Ft. Rucker, and Ft. Sill.

The goal of task analysis is to support objective decisions on what tasks should be trained and how they should be trained. For FCS, this equates to identifying what tasks must be performed by UA units and staffs to accomplish their warfighting mission. Further, task analysis must support the design and development of training products. Within the general collective task analysis process, there are many options that must be considered. These include which data items to collect, the level of detail required, and how to archive the analysis data for efficient retrieval when the design of training products begin. Identifying what you want to do with the analysis data is crucial for tailoring the process, including which data items will be needed down the road to support development of training products.

With embedded training the "end" is not so clear. Within the military simulation and training community embedded training is still a rather nebulous term. Ask ten military training experts or instructional developers to define it and give an example and you will probably get ten answers. Throw in that FCS embedded training must support live, virtual and constructive training approaches and the waters get exceptionally muddy. For the FCS collective task analysis, there was not a template available for conducting the analysis because the end, i.e., what embedded training will look like and the details of implementation have not been fully defined.

Building a Shared Vision of FCS Embedded Training

To build a shared vision of what FCS embedded training might look like for the analysts conducting the FCS collective task analysis, the project team was fortunate to leverage some progressive thinking from two sources. First, a draft operational concept for FCS embedded training has been developed (White, 2004). This concept identifies the flow of activities across four phases; plan, prepare, execute and assess. Written from a functional point of view, this CONOPS provides a specific, though notional, functional flow to describe how the user, sitting at the FCS WMI, would use the embedded training capabilities.

The second source is work from the Army Research Institute (ARI) on Electronic Training Support Package or E-TSP. Presentation of the concept is via an informative, as well as an entertaining multimedia presentation distributed on a CD. As conceptualized, the unit commander for the FCS equipped UA will be able to choose from a library of training exercises, modify the exercise based upon the unit's experience, and availability (or lack thereof) of units to participate in the exercise. The unit's progress will be monitored and options will be given to the commander to receive "coaching" during the exercise from an outside source such as an Observer Controller (OC), or stop and repeat the training exercise or an event within the exercise. With the potential to implement any combination of live, virtual and constructive training approaches, and control the tempo of the exercise, the unit commander will be able to build a prescriptive training regimen that leverages the capabilities of all three approaches to training.

The ET CONOPS and E-TSP concepts allowed the project team to begin building a shared vision for embedded training for FCS and enabled a tailored task analysis process to be developed.

Development of Task Conditions – A High Pay-off Task Analysis Activity

Given the significant differences between doctrine/ Tactics-Techniques-Procedures (TTP) for current force versus the UA, the team wrestled with the issue of how best to <u>influence</u> the conduct of LVC training and concluded that the condition statement for each task was the key. Not only will task condition information be necessary for developing the exercise scenarios that will be part of the FCS embedded training, but as will be discussed later in this paper the objective identification of condition information provides exceptionally valuable information to engineering teams responsible for building the virtual and constructive simulation capabilities that will support training the FCS equipped UA.

Redefining How Task Conditions are Developed

In accordance with the Army's process for collective task analysis defined in TRADOC Regulation 350-70, a condition statement for a task details information related to the job environment under which the task is performed. The condition statement sets the stage for task performance, identifies the boundaries for task performance and identifies the pertinent influences on task performance. Typically, a condition statement contains a cue, which is a word, situation or other signal for action. The cue is followed by descriptive data that provides the when, why, where and resources required to perform the task. Condition statements reflect a live regimen of training. A commander's ability to change conditions is limited by what conditions can be reasonably established in a training environment.

Up to now, Army training developers have had to be content with writing a single generic condition statement for a task. This was done so as not to restrict the commander to a specified set of conditions for training, particularly if these conditions could not be reasonably established during training because of logistics and other considerations. With the advent of FCS embedded training capabilities that can leverage virtual and constructive approaches to train the FCS equipped UA tasks, a significant opportunity will exist for the commander to tailor training by having the availability of multiple conditions that can be selected.

Condition Categories, Elements and Sets

Three terms are essential for understanding how conditions for collective tasks for the FCS equipped Unit of Action are being developed. These terms are condition categories, condition elements and condition sets. A **condition category** provides a convenient way to organize condition elements. Currently, eleven condition categories have been identified as presented in Figure 1.

Troop availability/strength	Communications
Terrain	Civil
Obstacles	Equipment
Weather	Supplies
Targets	Time
Enemy-threat capabilities	

Figure 1. FCS UA Condition Categories

A **condition element** is a singular piece of a condition, such as *visibility*. Condition elements are being identified that are specific to each task. Several guidelines are applied in identifying condition elements. First, the condition element must have a direct influence on how difficult or complex the task will be to perform. Essentially, the analyst is asking the following question.

***If (condition element) were changed/adjusted in some manner, would the difficulty or complexity of performing the task change as a result?* Y N?**

A second criterion is that the condition element must be able to be quantified at some point. For example, consider "weather" as a condition element. While "weather" might meet the first criteria of impacting difficulty or complexity of a particular task, it is not quantifiable until it is decomposed further. Good weather, bad weather, heavy weather; these terms are qualitative only. For the purpose of a generic condition statement, these may suffice. However, for the purpose of defining a scenario environment that can be adjusted/modified for a "crawl, walk, run" training regimen these terms are not adequate. To arrive at quantifiable condition elements that can be modified to affect task difficulty, the condition must be decomposed further. Precipitation (rain, snow, ice), which is a component of weather is quantifiable and can be modified in a simulation environment. By decomposing the condition to the point where it is quantifiable, a mechanism is in place to increase or decrease the impact of the condition element on performing the task. A specific mathematical relationship is not expressed, but the analyst must be able to say that some relationship does exist that has the potential to be quantified. A preliminary list of condition elements has been identified for each condition category. Since it is anticipated that additional condition elements will be added, criteria have been established if an analyst desires to add to the list.

A **condition set** is an identifier for a particular grouping of condition categories and elements. A condition set may apply to a number of related tasks and thus, will allow the training analyst to re-use previously developed condition sets.

The use of condition categories, elements and sets is providing a means to use standardized terminology. This consistency of terminology is enabling a searchable database that will be useful for training developers. For example, using databases that are tied to the ET system, training developers will be able to call up all tasks that involve a specific type of unit, or type of terrain. This will enable training developers for the virtual and constructive training approaches to reuse existing scenarios that were developed for training other tasks, but contain the desired conditions.

Figure 2 is an example of what a condition might look like for a task for conducting a combined arms breach of an obstacle. For this task, nine categories were selected by the analyst. It was determined that the condition category and the elements contained within each of the categories would impact the difficulty or complexity of performing the task.

Building the Task Condition

In selecting the specific condition elements, the analyst applied a systematic process. First using experience with the current task, and discussions and rock drills on how the FCS equipped Unit of Action will perform the task, the analyst conceptualized the environment and situation in which the task would be performed. The METT TC paradigm (Mission, Enemy, Terrain and weather, Troops and support, Time, Civil considerations) was used to assist the analyst in his thinking. As part of the analyst thought process, consideration was given to some of the critical overarching skills and knowledge for performing the task. The challenge for the analyst was to determine which condition elements would trigger opportunities to train these key overarching skills and knowledge for the task. One of the advantages of this approach is that selecting the condition elements to use forces the analyst to uncover and highlight the strengths and uniqueness of the FCS equipped Unit of Action.

In our example seven condition elements were designated with asterisks. These elements were determined to have the most impact on difficulty or complexity for this particular task. This information will be beneficial to commanders who will be given the flexibility via embedded training capabilities to dial-up or dial-down the difficulty of performing the task.

Since the collective task analysis being conducted currently must support War Fighter TSP design, this information on conditions will provide TSP designers and developers with key information that will be integral to the exercise scenarios that will be developed as part of the TSP. The format of this task condition, while appearing dramatically different from the traditional narrative condition statement, contains the same information as the textual description, and meets a key purpose of a task condition. The purpose is to provide the commander and task performers with an understanding of the range of conditions under which the unit will be expected to perform the task.

Cue: Requirement to breach an obstacle

Troop Availability/Strength	Terrain	Obstacles	Weather	Enemy Capabilities & Strength
* Engineer	* Cover	Location	Visibility	Direct Fire
NLOS	* Concealment	Orientation	Illumination	* Indirect Fire
AVN	Trafficability	Gaps and bypasses		ADA
Bn MCG		* Mine type		Aviation
Bn IN Co		Inhibitors (wire, etc)		* CBRN
Authorized vs on-hand %		Minefield composition (surface – buried)		ECM/ECCM

Comms	Civil	Supplies	Time	
* Network availability	Non-combatants #	Class V availability	Time avail. to complete phase/task	
Network strength	Proximity Of non-combatants			

Condition Set ID: CAB_Obstacle1

Figure 2. Example of Collective Task Condition for the Task "Conduct a Combined Arms Breach of an Obstacle"

LEVERAGING COLLECTIVE TASK ANALYSIS PRODUCTS FOR EMBEDDING TRAINING ENGINEERING EFFORTS

Linkage to the Objective OneSAF System (OOS)

A beneficial by-product of the approach that is being used by the collective task analysis project team is the potential to provide useful system level information to the Objective OneSAF System (OOS) project team engineers. OOS has been designated as the simulation component for FCS embedded training. Since OneSAF will play a key role in both virtual and constructive training approaches for FCS, the analysis products being developed to support training UA tasks can be cross-walked with evolving OneSAF terrain, environmental capabilities, unit models, and OneSAF AAR capabilities.

A New Approach for Linking Training and Engineering Efforts

This leveraging of task analysis products for engineering efforts represents a new and needed approach, particularly to enhance the probability of success for FCS embedded training. Why the concern? The requirement for new Army weapon systems to integrate embedded training has been around since 1989. In practice, there are very few embedded training systems residing in Army weapon systems. Embedded training presents a significant challenge for both the engineering and training domains. For the engineering community, identifying and building the complex functionality that will be needed to support this training delivery approach has proved elusive. Training using embedded capabilities cannot be an engineering after-thought. While "drive by" and "fly-by" wire systems provide an exceptional opportunity for embedded training, there is no margin for error during early engineering design activities. If the needed functionality is not articulated through the internal systems/components, seamless embedded training capabilities will not be present. The result is often less desirable part task trainers or clumsy "strap-on" components that offer few opportunities to train collective tasks.

For the training community, there are a number of major challenges in the design and development of embedded training events. First, what functionality will be available to achieve the desired training outcomes? For this issue, the devil is very much in the details. Not only does the training developer need to consider the equipment functionality that can be leveraged, but the developer must also consider the instructional support features that are available. For example, how will the exercise scenarios be created or conditions modified? How will they be initialized? What triggers or "magic" (e.g., magic move, magic resupply, magic reconstitution) capabilities will be available to the training staff to ensure opportunities exist to exercise the specific training objectives? What AAR data will be available to assess performance? How will the team receive feedback? How will training consistency be established and maintained? This list is very long.

System and software engineering teams rarely utilize the task analysis outputs that are the foundation for training design. There are several reasons for this. First, the Instructional Systems Development (ISD)/Systems Approach to Training (SAT) and engineering processes usually operate on separate, but parallel paths. That is, while the engineers are doing their thing, the trainers are doing theirs. Rarely do the two teams exchange information until the system has been nearly fully developed. Second, trainers usually are part of the Integrated Logistics System's (ILS) team and wait for engineering outputs to produce meaningful technical data that can be dissected to derive training task data. As such, producing training data typically is subsequent to the development of engineering data. Third, most task data is not tailored in such a way to be meaningful to system or software engineering efforts. This is unfortunate since the data that must be collected to support training design could be extremely meaningful to the engineering community if fleshed out and presented in ways that are more familiar to system and software engineers.

Aligning the training and engineering communities more closely will be essential in order to prevent another embedded training "lost opportunity". Since Training has been designated as a Key Performance Parameter (KPP) for FCS and embedded in the approach selected, failure is not an option. The evolving discipline of Human Systems Integration (HSI) stresses the importance of linking training and engineering technical activities. An important and typically overlooked step is the tailoring of task data so that it merges the separate but parallel paths that engineering and training activities often take.

Tailoring the FCS Task Analysis Products

While task data is needed to support a number of training development activities, the potential for reuse of this data for systems and software engineering activities is enormous. However, the training task data must be tailored, and in some cases embellished to meet the engineering needs for the design of FCS embedded training.

The following are the areas where the FCS collective task data is being most effectively leveraged to support system engineering embedded training activities.

1. Collective tasks descriptions and performance steps

Engineers are rarely Army subject matter experts and need descriptions of the tasks. This provides an essential context for the FCS embedded training functionality that will be developed. As detailed task performance steps are developed, these are being provided to engineering teams as addition clarification of the task.

2. The underlying concept, i.e., CONOPs of how the task will be trained

Engineers are familiar with the term "use case". This is a brief narrative description of what will happen during the training event. Functionality can be derived from the use case or the use case can serve as a "check and balance" for ET functionality that has been identified already. It is critical that a shared mental model be developed between training and engineering teams of how the task will be trained. The E-TSP discussed previously is being used for this as well as other FCS embedded training operational concepts that have been developed.

3. Task conditions

This is more than a narrative condition statement that is part of a training objective. To support the engineering technical activities, the conditions are being embellished to identify the scenario components (e.g., unit models, synthetic natural environment (SNE) environments), implications of how SNE will influence task performance and the forces/players/SAF/CGF that that need to be part of the exercise to properly train the task. The condition categories, elements and sets presented previously are the mechanisms being used to identify the essential SNE, scenario generation and model capabilities needed for FCS embedded training.

4. Task standards and performance measures

To support ET engineering activities, the task data must identify or suggest the functionality needed to schedule the collection of data, the production of reports and other tools needed to assess the performance of the training audience. Essentially, this equates to development of a "use case" of how evaluation of the task will occur and the instructional support features that are needed within the ET system. From a number of use cases and concept of operations that have been developed, a separate set of tasks is being developed. These tasks detail what the instructor staff must do or what the team initiating the embedded training scenario will need to do to receive feedback on their performance. Performance measures are being embellished to identify AAR data collection and reporting needs and how this will be accomplished with ET.

REFERENCES

TRADOC Pamphlet 525-3-90, *United States Army Objective Force Operational and Organization (O&O) Plan,* Maneuver Unit of Action, Ft. Knox, 30 June 2004 (Change 2).

White, E R., *A Concept of Operations for the Future Combat System (FCS) Embedded Training* (Draft), Science Application International Corporation, Orlando, June, 2004.

U.S. Army Research Institute for the Behavioral and Social Sciences, Armored Forces Research Unit, Fort Knox, KY., *Prototype Electronic Training Support Package for the Future Force.* Feb 2004. Contact Info: Dr. Billy L. Burnside DSN 464-3450, Tel 502-624-3450, billy.burnside@knox.army.mil