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Agent Based Automated Scenario Generation Environment Phase 1 Technical Summary CDRL A001 Contract Number: N61339-97-K-0006 STRICOM

An Automated Scenario Generation Environment

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January 14, 1998

Submitted by: Institute for Simulation and Training University of Central Florida 3280 Progress Drive Orlando, FL 32826



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Contract Number: N61339-97-K-0006 DARPA January 14, 1998

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University of Central Florida Office of Research and Graduate Studies

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1. Introduction

This report describes IST's investigation into the feasibility of automating the process of planning and Scenario Generation for large scale (joint level) simulation exercises and development of an architecture for that purpose. The effort was conducted during the base period of contract N61339-97-K-0006 for DARPA's Advanced Simulation Technology Thrust (ASTT) Program

1.1 Scenario Generation

A scenario, in its simplest form, provides an outline of a hypothesized chain of events which characterize the "plot' of a situational setting and associated activities over a period of time. Developing a scenario requires the synthesis of multiple points of view, components, objectives and constraints to form a common, consistent and coherent description of the flow of events.

Research reported herein investigates methods and technologies for automating the development of a scenario specification and related documentation used to plan and prepare for large scale (joint level), computer assisted military training exercises. This research effort formulates an approach to develop formal methods for scenario generation which can be automated to achieve significant reductions in the time and people resources now required to develop large training exercise scenarios.

1.2 Research Goals

The overall goal is to provide a scenario generation environment which highly automates scenario development to a level which requires minimal external human decisions in resolving conflicts and negotiating agreements related to the final scenario description.

Scenario descriptions provide the baseline used for preparing and conducting simulation based training exercises. One of the critical problems with scenario generation is that it represents a crossroads for conceptualizing and bringing to definitive specification a combination of operational mission descriptions, training objectives, performance measures, and simulation assets which define a synthetic battlespace used to conduct a training exercise tailored to a specific training audience. Current methods are cumbersome, informal, often times ad hoc and rely strongly on the conventional wisdom of a diverse mix of simulation training exercise practitioners. Moreover, the process of formulating scenarios currently involves large numbers of people participating with multiple views and in some cases biases which produces inefficiency and limits effectiveness. Additionally, the lack of well defined data sources, structures and interchange methods results in the extension of the time required to formulate scenario descriptions.

The operational goal established by the ASTT program [1] states:

"...the domain of large scale simulation system auto/semi-automation Scenario Generation is largely unexplored, which potentially present a number of technology challenges for programs such as JSIMS, and its family of programs.. The challenge that exists today is to develop the necessary technologies to automate this process. Auto/semiautomation will reduce the time and expense required to effectively address rapid response training and mission rehearsal, while facilitating the likelihood that the training objectives, synthetic environment, and training evaluation factors are inextricably linked. With this goal in mind, the JSIMS program has established the requirement to reduce the total Scenario Generation time to a maximum of 96 hours and to reduce the number of operators necessary to support the Scenario Generation process by two-thirds over that necessary to construct similar exercises within the ALSP JTC."

More specifically, the ASTT Automated Scenario Generation goal centers on identifying and developing the critical technologies to automate the initial design phase of the scenario planning and generation process that synthesizes mission and training plenary data into the training and scenario documentation. As indicated in Figure 1 (taken from [1]) the initial design phase concentrates on rapidly producing a scenario specification which provides a self sufficient baseline and common reference for developing a specific instance of a simulation based exercise.



Figure 1. The Advanced Scenario Generation Process

This outlook builds on the hypothesis that it is meaningfully possible to separate the design and definition of the scenario specification from the remaining exercise planning and preparation activities. Moreover, this outlook has the premise that an appropriate data model can be

developed which is suitable for use in preparing the initial scenario specification and the continuing development of a full set of exercise description documentation. Once automated, the time required to complete this initial phase of the scenario planning and generation process should not exceed 4 hours.

 $\tau = -\frac{d_{12}}{d_2} \left[\frac{1}{2} \left[\frac{1}{2} \left[\frac{1}{2} \right] \right]^2 \right]$

1.3 Approach

The conceptual framework [2] for developing an Automated Scenario Generation Environment (ASGE) recognizes that scenario development must incorporate and integrate views from three domains: 1) the view of the commander, 2) the view of the training manager, and 3) the view of the simulation system operator. To achieve rapid and effective scenario generation, the automated environment must allow the interests of the three primary views to develop concurrently, both within their individual domains and collaboratively among domains, to form a single scenario description. Additionally, the development must progress from initial conceptual views to a final composite view contained in a non ambiguous set of scenario description documents suitable for implementing and executing a simulation based training exercise. The resulting documents provide a formal baseline description of the scenario which can serve as the top level reference for VV&A of the training exercise and associated simulation based battle space.

As shown in Figure 2 (taken from [2]), the automated scenario generation environment is composed of four logically defined "agents." Three are configured to represent the three primary viewpoints involved with scenario generation. The fourth scenario manager agent controls the transactions among the other three agents and consolidates the agreements made by the different agents into the final scenario description documentation.



Figure 2. Primary Domain Agent Relationships

Each of the agents provides interfaces which support one or more people working interactively conducting collaborative negotiations and making group decisions during the scenario formulation process.

The approach taken for developing the ASGE draws upon experience gained from implementing computer generated forces (CGF) systems. Methods and experience used in developing CGF are well suited for automating the multiple, diverse, and concurrent activities which occur during scenario development. Activities and interactions occurring within and among the logically defined domains are accomplished by component entities. Use of entities provides a convenient means for describing process relationships and individual and collective tasks which are performed during scenario generation. Entities may be instantiated either by human beings or software. In the general sense, both the process relationships and tasks can be treated as behaviors. When the knowledge and interactions for accomplishing a behavior can be written in software, the corresponding entities constitute component or sub agents used in creating the ASGE. For cases where the knowledge and interactions for accomplishing behaviors is difficult or impractical to convert to software, the role of the corresponding entities is filled by humans.

Use of conventional knowledge engineering approaches applied to current scenario generation practices and processes was considered not feasible for a number of reasons. Unlike well established domains such as medicine and law, there are few, if any, authoritative sources which describe the "know how" and "how to" used in developing scenarios. Much of the experience and expertise resides in a small population of subject matter experts and is stylized to reflect the conditions and environments in which they work. More significantly, the processes used today have not incorporated the advanced and emerging capabilities to formulate "just in time" simulations made possible by the HLA. To rely too strongly on current practice would result in developing agents and automated environments which are out of date before they have been implemented. Thus, it becomes important to formulate an approach which affords the opportunity to "re-engineer" the process as an integral part of developing and implementing automated entities as component agents.

Using this approach affords the opportunity for building an evolutionary, continuous learning path to achieving fully automated agents. The initial automated environment would be organized around the logically defined "agent" domains. Initial implementation phases of the automated environment would consist of participants who develop scenarios and plan simulation exercises using computer work stations networked together to facilitate information sharing and interchange. The people and work stations would be organized or grouped to match the logical domains described above. This presents the opportunity for incorporating the use of the numerous tools now being developed as a first level of automation. During this phase, emphasis is placed on creating an automated environment for the interchange and composition of information among the primary interest domains. Attention is focused on what is done, who has responsibility for doing it, and the information elements produced which contribute to the scenario specification and related exercise planning documentation. A process model and data/information model are used to define and organize the primary domain groupings.

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Initial versions of the automated environment implement the logically defined agents for the primary domains as ensembles of humans working in combination with software tools. This allows for describing the process in terms of inter-related activities among entities which represent the resources performing the activities without having to know the details of how the activities are performed. Over time the level of automation will grow. Attention will shift to describing selected entities to perform the activities leading to models and algorithms describing the internal behaviors. As experience grows, entities which begin as humans working in combination with first level automation software tools are replaced by fully automated sub agents to form a hybrid environment in which some activities are fully automated by agents and some are done by humans using automated tools.

The goal is to automate the primary domain agents to a level which requires no more than one person for each agent. This approach can be scaled to provide multiple, concurrent transactions among agents to achieve the goal of four hour scenario development time.

1.4 Technical Objectives

Four main objectives as listed below were established to meet the research goal.

- 1. Establish a formal description of the scenario development process in terms of roles played by primary participants. Determine recurring transactions and processes between participants and characterize them in terms of protocols which can be used in implementing automated environments. Use the description to formulate a model suitable for assessing and identifying high payoff targets of opportunity for reducing the time and people resources needed for scenario preparation.
- 2. Define a scenario element data description structure suitable for encapsulating essential elements of information and data used to build scenario descriptions. Use this structure for design of search engines which access external data sources and repositories and for transactions among agents in the automated scenario development environment.
- 3. Define and develop a scenario description language which can efficiently implement the automation of the scenario development process. The language would include properties which facilitate human participation in the scenario development process and the capability to instantiate multiple, concurrent activities at different levels of resolution.
- 4. Provide scenario description documentation which includes explicit, auditable linkages which relate content of the synthetic battlespace used for the training exercise to the training objectives suitable to serve as a baseline for VV&A.

Progress toward meeting these objectives during the initial phase of the research is provided in the following sections of this report.

2. Survey of Current Practice

Over the course of the research, a continuing investigation of current practice used in planning and preparing for large scale, simulation based, training exercises was conducted to shape and confirm the approach for automation being developed. These investigations centered on determining the salient characteristics of the processes used, the extent the processes have been documented and used consistently, instances where automated tools have or will be incorporated to facilitate the process, and the existence of supporting data bases and other sources of stored knowledge which would be amenable to automating the process. Throughout the investigation, attention focused on what documents were produced by different participants or activities in the processes and what sources of knowledge and data were used to product these documents.

2.1 Case Study

As a result of the initial project planning review with DARPA on 1 May 1997, the research team undertook a month-long effort to explore and formulate a top level summary of the primary structure and organization of the scenario planning process to support an illustrative example of the approach to automation. Mr. Ed Ramirez along with other members of the IST staff who have extensive experience in planning and conducting training exercises for Corps level groups at the III Corps Battle Simulation Center (BSC) in Fort Hood, Texas, served as the lead subject matter expert in producing the process summary.

The method used was to task the subject matter expert with enumerating and describing the activities he would undertake in the event he were directed by his commander to design a training exercise for a very simple operational scenario.

The tasking statement provided the following paragraph as "background".

"A new Deputy Director has recently been assigned to the III Corps Battle Simulation Center (BSC) in Fort Hood, Texas. The Director wants to determine his level of expertise in developing a computer-driven simulation exercise. His mission is to design a scenario that will support a training exercise with a platoon of M1A2 Abrams tanks moving from a rear assembly area to a forward assembly area. The scenario must include an attack by two MI-24, Hind helicopters. This is all of the information available. He must determine what is necessary to support the conduct of this exercise by a platoon that resides on Fort Hood and will use the BSC.."

The subject matter expert was then asked to:

"List in outline form with bullets, all of the major tasks that the Deputy Director must accomplish to ensure the exercise scenario is well-planned and executed. List those major tasks that must be accomplished by members of the BSC staff and the unit in order for the scenario to be executed."

The initial output was limited to an enumeration of tasks. This was expanded and refined through several cycles of interaction with other team members acting as knowledge engineers. Results of this effort developed a report (Attachment A) which describes the major threads of activity and products resulting from the planning activity and an **annotated process flow diagram** (Attachment B).

The most important data items that were identified by this exercise are described in Attachment A and are listed below.

The Primary Inputs are:

- Initial Expression Of Commander's Intent
- Standard Task Lists (UJTL, JMTL, Tactical Analysis List, Service Specific lists)
- Pre-existing OPLANS
- Unit MTOE

The Primary Intermediate data items are:

- Draft Training Objective
- Communication & Electronics Operating Instruction (CEOI)
- Commander's Training Guidance
- Exercise Staff Task List
- Commander's Training Intent
- Exercise Staff Assignments List
- Mission Scenario Statement
- Draft Exercise Schedule
- Draft OPLAN
- Draft BLUFOR Plan
- Draft Exercise Plan
- Draft OPFOR Plan

The Final Products are:

- Exercise Plan Document
- Exercise Schedule
- Operations Order
- Simulation Initialization Files
- Training Objectives Document

The resulting summary of the process did identify main activities, plans and reports, information flows and process controls. Although the annotated process flow diagram provides strong hints about the importance and persistence of certain data structures, it does not contain specific information regarding the format and encoding mechanisms used to store and exchange those collections of data.

2.2 Joint Training and Analysis Center Training Exercise Process

Extensions to the case study investigation were made through visits to major simulation centers and searching other sources. At the beginning of the research period, a visit was made to the USACOM Joint Training and Analysis Center (JTASC), Suffolk, VA. Observations from this and a follow up visit are provided in trip reports [Attachment C: First JTASC visit], [Attachment D; Julia Loughran follow up visit: Significance of MSEL], and [Attachment E: R. Hofer notes on follow up visit]. At the time of the visit, JTASC was attempting to document the process flow scheme used for exercise planning and preparation by interviewing site operations personnel. It was emphasized that a wide range of resources were called upon in formulating and conducting training exercises. Events and conditions which were not played as part of the primary simulation environment were introduced through use of role players and other methods of insertion. For example, the situational environment during an exercise is enriched by introducing input from simulated CNN news broadcasts and newspaper articles about domestic and political issues. Additionally, Internet resources (e-mail and world-wide web) are used both for coordinating training exercises and as an additional means of simulated tactical communications. Inclusion of inputs provided from outside the primary battlespace simulation is integrated through use of the Master Scenario Events List (MSEL).

In addition to generating the simulation scenarios, planners at the JTASC facility must account for the administrative and logistical support involved in handling the hundreds of trainees and staff in areas such as classroom education for the training and support audiences and the requirements to house and feed the huge support staffs (as many as 700 individuals) involved in the training. While a substantial part of conducting a training exercise, the administrative and logistical support component was not considered to be of primary importance in the project's investigation of automating the Scenario Generation Process. Site managers expressed the opinion that a mechanism that would compress exercise scenario design into a matter of hours

would not reduce the remainder of the time which is spent in preparing the training audience. Mission rehearsal training, however, could be a different case.

2.3 Joint Warfighting Center Training Exercise Process

A top level baseline for describing computer assisted joint training exercise planning and preparation process was developed from contacts through other IST research projects and information obtained from the world wide web [3-10]. The most succinct description came from a presentation developed by the Joint Warfighting Center, Fort Monroe, Va.[11]. This presentation provides a top level summary of the processes and procedures occurring in the preexercise, execution and post-exercise periods in terms of a Joint Exercise Life Cycle (JELC) occurring in the execution component of the Joint Training System [7]. The JELC describes an ordered sequence of processes, products, activities, and decision points which, if applied in full, will guarantee the Joint Force Commander achievement of his exercise goals and training objectives for the given event. Five major stages - Design, Planning, Preparation, Execution, and Post-Exercise & Evaluation - make up the complete exercise life cycle. A composite of the interacting streams of activity in the first three stages which occur in planning and preparing for the exercise is shown in Figure 3 (taken from [11].) As indicated, a series of conferences is used to coordinate the integration of information and progressive development of plans from concepts to final details for implementing and executing the training exercise. This description of the process provides a good overview of what documentation must be developed for conducting an exercise, but gives little insight into how the activities which produce this documentation are performed.



Figure 3. Joint Warfighting Center Exercise Planning and Preparation Process

An integrated set of automated tools for supporting all four components of the Joint Training System (Requirements Analysis, Planning, Execution, and Assessment) is being developed under the Joint Exercise Management Program (JEMP) III and is targeted for completion in 1998. Key process features and documents which have been identified in an IDEF process diagram developed as part of the JEMP III program closely match the JELC presentation..

Of particular note in the JELC presentation is the addition of a "design" phase preceding the planning and preparation phases described in the execution component of the Joint Training System [7]. Activities and products produced in the design phase most closely match the research objectives for producing a baseline description in a four hour period. A more detailed presentation of the design phase activities is shown in Figure 4. Narrative text from the JELC presentation characterizes the activities in the design phase as follows.

"DESIGN STAGE

...Please note the location of the Initial Planning Conference (IPC). We have learned that a lot of work and some decisions must be made well before the IPC. Relying on their staff Joint Training Plan (JTP), Joint Mission Essential Task List (JMETL), and the Joint Force Commander's guidance, well-prepared exercise sponsor representatives should come to the IPC with a clear mission statement and purpose, a list of selected Joint Mission Essential Tasks (JMET)s for the event from the CINC's JMETL, a good outline of exercise and training objectives, an exercise scenario concept, and a clear view of the training audience make-up. This would enable refinement of the training objectives, from which all subsequent design and planning flows.

...Typically, however, much of what you see in the design stage occurs in association with what we call the **Concept Development Conference**, or CDC. This event is used to refine the exercise JMETs, training objectives, scenario concept, training audience make-up, review resources, and establish planning milestones. During this stage a review of associated Joint Publications and the Chairman's Commended Training Issues (CCTIs) is conducted to ensure compliance with training guidance and established Joint Doctrine in the design of the event. With training objectives established, it is also possible, through an analytical process, to select an appropriate simulation.

...Based on efforts before and during the CDC, work begins on critical exercise planning documents. These typically include the MOA between the supported Joint Force Command and the JWFC, scenario outline or core scenario, road to war (or crisis buildup), OPFOR Campaign Plan, Exercise Directive and/or Letter of Instruction, Training Plan, and the exercise Time Phased Force Deployment Data (TPFDD)."

" CONCEPT DEVELOPMENT CONFERENCE

Primary activities at the CDC center on establishing critical parameters to enable design and planning of the exercise. We term this "development of the exercise concept." Unless the CINC's staff is a part of the training audience, we generally seek his broad guidance for the event, normally including the purpose of the event, a Mission Statement, and any specific Exercise Objectives he may have.



Figure 4. Joint Exercise Life Cycle Design Phase

Most critical of all the information developed at the CDC are the information elements from the training audience. Among these are a mission statement, selected JMETs, training objectives, staff tasks necessary for achieving the training objectives, and the training audience concept of the exercise scenario.

Having established these critical exercise elements, additional activities are undertaken as necessary to ensure facilitation of follow-on exercise design and planning. Some of these activities typically include JMET refinement, JMET to training objectives crosswalk, establishment of academic training requirements, OPFOR campaign concept within the context of the proposed scenario, fleshing out of scenario parameters as necessary to develop core scenario and exercise events flow to develop the master scenario, and development of an AAR concept for the event.

Finally, the Memorandum of Agreement between the exercise sponsor and the Joint Warfighting Center is prepared for signature of respective representatives."

Making the design phase explicit in the Joint Exercise Life Cycle illuminates the interface between inputs and information drawn from previously prepared plans and the focus on preparing a specific exercise execution developed from the more general plans. Also, much of the attention in the design phase is driven by the commander's interest and the exercise training objectives. While indicated as an outcome from the CDC, there is no specific description about the content of the outline scenario and its relationship to the training objectives.

2.4 National Simulation Center Training Exercise Process

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A visit to the National Simulation Center (NSC) at Fort Leavenworth, Kansas, provided a number of insights about key factors which must be considered in rapid scenario development. The range of topics and viewpoints discussed during the visit are included in the trip report [Attachment F]. Overall, the processes currently used at the NSC for planning, preparing, executing, and after exercise review were found to be similar to those described above. However, NSC initiatives are underway to make the process more efficient and to reduce the cycle time for exercise preparation.

When attempting to rapidly develop a scenario description, one of the difficult areas relates to capturing the commander's intent for the exercise with sufficient completeness for support staff to fill in the details needed to meet the primary objectives. Much of the discussion on this topic was from the vantage point of how commanders conduct course of action analyses.

An essential element is the ability to quickly provide a "map" of the operational area of interest which shows key features which bear on military operations and can be provided to all participants in the process as a common reference for further planning. The level of detail does not need to be that found in military maps, and in fact, it may be desirable to begin with representations which are only "60 percent" correct as part of the training for commanders and their staffs to learn to work with ambiguity and uncertainty.

A second characteristic identified for rapid scenario development is the capability to quickly provide a top level depiction of the flow of events using high level abstractions or "rules of thumb" parameters for representing and linking the selected events. The MARNE manuals, written by MG W. A. Shoffner while commander of the 3rd Infantry Division (Mechanized) in Germany, provide an excellent example of how such rules of thumb have been developed for describing key ground war fighting parameters [13,14]. The parameters selected and defined in the manuals provide a conceptual model of primary warfighting factors: decisions, resources, movement, etc., which are used in formulating operational plans. The objective would be to establish a high level end-to-end "simulation of the simulation" as the way to gain assurance that the commander's intent and objectives had been appropriately captured and interpreted.

A third element of rapid scenario development is the capability to include branch and sequel nodes. For training exercises, these nodes establish the control points for framing the progression of the exercise to meet the training objectives. How to select where and when to place control nodes in the scenario comes from experience and depends on the missions selected for accomplishing the training objectives.

Reactions were highly favorable to the IST approach for developing an automated scenario development environment which would begin with an integrated collection of exercise planners working with automated tools and evolve into increasingly automated agent levels. Discussions held during the visit about how to select and implement parts of the process which could be fully automated disclosed that one of the most difficult problems lies in capturing, interpreting and expanding the level of detail provided in the initial statement of the commander's intent. For the foreseeable future, this would likely require a high level of human participation. In addition to discussing on going research projects underway at the TRADOC Analysis Command (TRAC), Fort Leavenworth Modeling and Research Directorate, IST obtained a copy of the report "Command Decision Modeling technology Assessment" [12] which provides an excellent reference on the capabilities for modeling and technologies for automating command planning and decisions processes.

2.5 The HLA FEDEP Model

While the viewpoint of the exercise developers discussed above concentrates on developing an exercise plan which is driven by the commander's intent and the operational mission context needed to meet the training objectives, the viewpoint of the simulation developer is focused on providing a simulation environment which will fully support the exercise plan and objectives. With the introduction of the DoD Modeling and Simulation High Level Architecture (HLA), advanced training simulations will have the capability to form tailored Federations of component simulations appropriate for creating the synthetic battlespace context used for joint training exercises.

The Federation Development and Execution Process (FEDEP) Model describes a high-level functional framework for the development and execution of HLA federations[15]. The intent of the FEDEP Model is to specify a set of recommended practices and guidelines for federation development and execution that federation developers can utilize as a framework to achieve the needs of their application. As shown in Figure 5, the FEDEP activities which most closely correspond to the design phase in the JELC model include Objectives Development, Conceptual Analysis, and Scenario Development. Within these activities, attention is focused on identifying and defining the objects, attributes, interactions and levels of fidelity required in the Federation developed for supporting the exercise.

Description of the individual FEDEP activities is given at a high level with emphasis on what information is expected to be developed from each of the activities. From the viewpoint of the

simulation developer, the FEDEP identifies the following information elements which must be provided during the exercise design stage for designing, implementing and executing the exercise simulation.



Figure 5. Federation and Execution Process Model

2.5.1 Objectives Development

The purpose of Objectives Development is to 1) generate and fully document the federation sponsor's problem statement, and 2) specify a complete set of objectives to be addressed through instantiation and execution of the federation. The specification of the federation objectives is composed of the following three classes of information:

- A specification of the problem domain, including a formalized problem statement, high-level descriptions of critical systems of interest, and required Measures of Merit (MOMs). Coarse indications of required fidelity and resolution for simulated entities should also be included (input to Conceptual Analysis).
- A specification of operational context requirements, such as geographic conditions, environmental conditions, threat conditions, and required tactics (input to Scenario Development).
- A specification of management considerations, such as cost constraints, schedule constraints, facility constraints, and security requirements (input to Management Requirements).

The statement of the Federation Objectives should include as much detail and specific information in each category as the sponsor can reasonably provide. Early and clear communication of intent between the federation sponsor and the ultimate developers of the federation is essential to minimizing rework in later stages of the Federation Development process.

To facilitate the use of automated tools during federation development, the specification of federation objectives should be stored electronically in a standard, well-documented format. This will allow electronic access to the sponsor's requirements for traceability during federation testing.

2.5.2 Scenario Development

The purpose of this phase is to develop a high-level specification of the federation scenario. The primary input to this activity is the operational context requirements stated in the Federation Objectives. The composition of a federation scenario includes an identification of the major entities that must be represented by the federation; a conceptual description of the capabilities, behavior, and relationships between these major entities over time, and a specification of relevant environmental conditions. Initial and termination conditions are also provided. Multiple scenarios may be developed during this phase, depending on the needs of the federation. A single scenario may support multiple vignettes, where each vignette specifies a temporally ordered set of object activities and/or interactions.

The presentation style used during scenario construction is at the discretion of the federation developers. Textual scenario descriptions, event-trace diagrams, and graphical depictions of force laydowns and communication paths all represent effective means of conveying scenario information. Graphical scenario development tools can generally be configured to produce any of these presentation forms. Reuse of existing scenario databases may also facilitate the Scenario Development process.

2.5.3 Conceptual Analysis

The purpose of Conceptual Analysis is to develop a conceptual view of the objects and interactions that must be supported by the federation to achieve the sponsor's study objectives. This is known as a federation conceptual model. The primary activity in this phase is to decompose the conceptual description of the federation scenario into explicit components expressed as objects and interactions. External resources (e.g., CMMS) are expected to be useful in this process, and may necessitate refinements to the federation scenario description.

An important element of the Conceptual Analysis phase is the characterization of federation fidelity requirements. The basis for these requirements is the high-level, coarse indication of required fidelity included in the Federation Objectives. During Conceptual Analysis, this

information is transformed and extended into specific fidelity requirements at the object/interaction level. The physical representation of these requirements may be structured and formatted so as to be directly mappable to individual Simulation Object Models (SOMs) during Federation Design. The Distributed Interactive Simulation (DIS) Fidelity Taxonomy represents a potential means for defining this structure.

Tool use is expected to be especially important during Conceptual Analysis. Besides the potential use of computer-aided software engineering tools to support development of the federation conceptual model, tools will be needed to ensure consistency between the federation conceptual model, the CMMS, the federation scenario, and the federation objectives. Specification of standard formats for each of these elements will increase the feasibility of automated tools that can perform these linkages, and thus facilitate the verification, validation, and accreditation (VV&A) process.

At the conclusion of this activity, the revised scenario description and list of required objects and interactions are presented to the federation sponsor for approval before the onset of Federation Design. Revisions to the Federation Objectives may be defined and implemented as a result of this feedback.

2.6 Observations

The investigations described above resulted in a number of insights about the scenario planning process.

- 1. Current practice for planning and preparing large, simulation assisted training exercises involves multiple, loosely coupled processes. Process descriptions place emphasis on what is done and the documents produced. The knowledge of how the internal tasks are performed for each of the activities resides in subject matter experts and is essentially undocumented. Individuals learn it by immersion and participation.
- 2. Scenario design does not strictly precede the planning and implementation of the exercise. Rather, they tend to co-evolve. Development of an initial "scenario specification" as the baseline reference used for completing exercise planning and preparation does not have a strong presence in current practice.
- 3. Creating a composite outline or concept for the scenario depends heavily on the familiarity of staff planners with the commander's priorities, intent and preferences. Very little detail concerning this is conveyed in written form. Moreover, the formulation of the scenario is initially stated in operational terms which describe military missions and context appropriate for use in meeting the exercise training objectives.

- 4. The scenario design process relies heavily on a staff of subject matter experts who possess a large store of doctrinal, tactical, and practical military expertise and experience domain knowledge. Requirements are produced, story lines are written and priorities set by these people based on this knowledge. Methods for transforming the operational descriptions into model requirements used to put together the supporting simulation are not explicitly defined.
- 5. Scenario generation is a collaborative activity. Participants work both as individuals and in groups in completing assigned actions and tasks. The process is coordinated, issues resolved and progress evaluated through scheduled Coordination Conferences. These conferences serve as phase lines for establishing increasing level of detail in the plans and other activities leading up to exercise execution.
- 6. Participants produce documents as end products and as interim media through which they communicate their progress. The organization and content of these documents is at best semi-structured.
- 7. Formats for Operational Plans, Training Plans and other such documents define primary and subordinate sections and paragraphs but say little or nothing about the syntax and semantics of the information contained in each of the parts of the document. For the most part, the process depends on use of "unstructured" information such as text and graphics.

These observations provided insight for developing a formal process model suitable for identifying, defining and linking activities and interactions occurring in the design and development of the initial scenario specification and subsequent exercise description documentation. In addition to developing a process model that would support definition of entities, behaviors and interactions, three particularly challenging areas were identified.

- 1. How would it be possible to rapidly expand the opening and abbreviated statement of the commander's intent and exercise objectives into multiple, concurrent paths of activity?
- 2. How would the description of the scenario be transformed from operational terms into descriptions of model requirements used in putting together the simulation?
- 3. How can an "information model" be designed to define the organization, relationship, and structure of the information and data contained in the documents produced during scenario generation?

An organizing concept using the idea of "document threads" was developed as the most promising for focusing the research effort. Document threads follow the production history of key documents by working backwards from the final document to define the most efficient activity path for producing the documents. How this concept is used in developing a formal process model and associated documentation information model suitable for establishing and evolving an "agent based" automated environment is discussed in the following sections.

3. A Formal Model for the Scenario Generation Process

A key aspect in developing an automated scenario generation environment lies in expressing activities and interactions in terms of behaviors. To support the definition and specification of these behaviors requires a formal method for describing the process which can identify and define the tasks and resources assigned to performing the tasks. A process model must be able to represent the activities, interactions and behaviors which take place in producing scenario documentation at various levels of abstraction in a consistent and coherent manner.

In developing the formal process model description, the logical construct of an entity is used to represent the resource or "agent" used to accomplish a task, activity or collection of tasks and activities. Using this construct allows for definition of activity segments which can be performed by humans, automated agents or a combination of the two. Additionally, the process model supports automation at two levels; an upper level and a lower level.

The upper level deals with the command and control interactions and exchanges among entities. This level concentrates on scheduling and assigning responsibility for developing the information elements that are used in the final documentation. It defines the "Who", "What" and "When" for interactions (information flow, exchange) among entities. At this level we do not necessarily need to know "How" an entity performs its task but instead we identify a task by name, describe its scheduling constraints, and specify its input and output information and data sources.

The lower level describes precisely "How" an entity performs the constructive actions that build its outputs. The knowledge about how the actions are performed is generally assumed to be known by the individuals assigned responsibility for accomplishing the task. For example, at the upper level a task might be expressed in terms such as "Write a 5-paragraph order to..." or "Generate the initial OPFOR laydown." Describing this to the level of detail needed for automation is an entirely different matter, however. Automation requires unambiguous specification down to the record and field levels in the output database, and specification of the algorithms used to interpret input, make decisions, format output, and determine completion criteria.

3.1 Basic Process Model Component

The process model uses a recursive structure which can be resolved to the level of detail required to identify and partition process segments. For each segment, activities occurring within the process component and the interactions which occur within and among the activities and process segments can be defined to form process threads. Figure 6 shows an example of how the basic recursive structure of the formal process model is used to represent the top level of the scenario generation process as a single activity. The activity that transforms inputs into outputs may be viewed as a **process segment** consisting of actions or events, tasks, and interactions between tasks.



Figure 6. Formal Process Model Basic Component

The initial input into the scenario planning process consists of some expression of the **commander's intent**. The end product is the Exercise Scenario Description Documentation (ESDD), comprising all of the plans and databases that are required for initialization of the hardware, software, and human systems for the simulation exercise.

Provisions are made for explicitly defining the start state and end state which define the process segment assigned to an entity. Emphasis is placed on defining the documentation (or component of documentation) produced by the process segment. This provides the basis for linking process segment outputs to an end state documentation information model which defines the information components used to build the documentation.

3.2 Multiple Process Paths

A second step in developing the process model recursively applies the basic model component to define multiple process paths. The concept of "document threads" is used to define the process paths. Beginning with the information content and structure required for the completed

documentation, efficient paths of activities can be "reverse engineered" by working backwards to identify and define the sources which provide the needed information.

The example of multiple, concurrent process paths given in Figure 7 uses the notional end state documentation for a training exercise as the target for defining the multiple paths of activity. These multiple paths may proceed in parallel and may be further divided into smaller and smaller segments of activity as appropriate. Also, as shown, primary paths can be associated with the major domains of interest which must be included in developing the documentation. Figure 7 shows the scenario specification and exercise control plan separated from the exercise training plan. This is done to emphasize that, in general, the same processes for developing Scenario Specifications (exercise context description) and Simulation Control Plans (exercise operations) will apply to multiple use domains in addition to Training.



Figure 7. Multiple, Concurrent Process Paths

3.3 Roles and Entities

An entity is assigned to perform each segment of the process path which has been defined. As stated earlier, an entity may be instantiated by either a human or a software agent. What the entity has responsibility for completing is expressed in terms of "roles" as an abstraction of specific organizations and people. A role is defined in terms of having a particular mission and function in the process and serves as a basis for fixing responsibility and accountability for developing or using the end state documentation. For example, Figure 8 identifies the key participants who have responsibility for both developing and using the documentation produced by the primary process paths.



Content of the second

Figure 8. Responsibilities of Key Participants

In a broad sense, roles may be thought of as characterizing resource "classes" (skills and knowledge) needed to complete missions with hierarchical relationships which express the sub allocation of *mission, responsibility, authority, and control measures*. Such a structure provides the framework for defining entities (objects) within each of the classes with assigned properties (attributes, associations, interactions, inheritance) which become the operative elements (agents, actors) used in the formal description of the Scenario Generation process. The definition of roles can transcend organizational boundaries and allow for "re-engineering" the Scenario Generation process in developing the domain representation.



Figure 9. Relationships Between Roles, Entities and Process Path Segments

Roles may be defined in class structures which provide for decomposition of larger roles into smaller roles. They provide the framework for organizing and implementing the "command and control" of the Scenario Generation process. As indicated in Figure 9, when assigned roles, entities perform the actions, tasks, and interactions required to execute the assigned mission.

A Role is defined by four criteria (Figure 10). A mission statement specifies the product or result to be accomplished by defining the conditions existing at the start of a mission and at its completion. An assignment of responsibility identifies and assigns resource classes (primary and supporting) responsible for completing the mission. An assignment of authority identifies and establishes who has authority for determining the mission has been completed and/or changing the mission statement. Finally, control measures provide scheduling, reporting, and coordinating instructions.

A ROLE IS DEFINED BY:	
<u>A MISSION STATEMENT</u>	
SPECIFIES: THE PRODUCT OR RESULT TO BE ACCOMPLISHED	
INCLUDES:	
START STATE: CONDITIONS EXISTING AT START OF MISSION	
END STATE: CRITERIA AND SPECIFICATION OF CONDITIONS WHICH MIS	
ACCOMPLISED AT COMPLETION OF MISSION	
ACCOMPLISHED AT COMPLETION OF MISSION	
A SSIGNMENT OF DESDONSIDU ITY	
ASSIGNMENT OF RESPONSIBILITY	
IDENTIFIES AND ASSIGNS RESOURCE CLASSES (PRIMARY AND SUPPORTING)	
RESPONSIBLE FOR COMPLETING THE MISSION	
ASSIGNMENT OF AUTHORITY	
IDENTIFIES AND ESTABLISHES WHO HAS AUTHORITY FOR DETERMINING THE MISSION	
HAS BEEN COMPLETED AND/OR CHANGING THE MISSION STATEMENT	
The BEER COMPETER MEDICE CHARGING THE MIDDION BIATEMENT	
CONTROL MEASURES	
PROVIDE SCHEDULING, REPORTING, AND COORDINATING INSTRUCTIONS	

Figure 10. Primary Information Elements Defining a Role

3.4 Process Model Development

Using the approach described above, a formal process model can be developed which supports evolutionary growth to achieve high levels of automation. Activity segments assigned to entities may be accomplished by either humans or software. Focusing on the information elements required to build the end state documentation provides the flexibility to introduce more efficient or effective process paths which replace earlier implementations without having to rebuild the entire process model.

Accountability achieved through the definition of roles permits constructing a process model with multiple levels of detail matched to process segments. The association of process segments

with components of end state documentation permits early and continuous implementation of upper levels of automation related to the Who, What, and When.

Lower levels of automation related to the "How" may be selectively introduced for traversing the "Paths" used in the individual process segments whenever sufficient understanding of the knowledge and data used in developing the associated information component can be expressed by algorithms.

Initially, process segments may be defined drawing from current practice. By concentrating on the use and information content for the end state documentation, more effective process segments can be defined which replace initial versions. Closely tied to the development of the process model is the development of an end state documentation information model which is discussed in the next section.

4. Document Information Models

4.1 Introduction

This section focuses on the main concepts for defining and organizing the exercise scenario documentation which is produced at the end of the initial phase of scenario planning. Scenario Generation is fundamentally a process of applying domain knowledge and manipulating data to create the Exercise Scenario Description Documentation (ESDD), comprising all of the plans and data bases that are required for initialization of the hardware, software, and human systems for the simulation exercise.

Generally, the term "documentation" infers a set of written and graphical descriptions organized using a table of contents or index. The table of contents provides a semi-structured schema for the topical organization of the information contained in the document. Details of the internal component elements of information and their syntactic and semantic descriptions are hidden or undefined. On the other hand, data models provide the highly structured definitions required for process automation. Processes and activities which produce documentation combine the knowledge of subject matter experts interacting with structured data sources to produce components of information. Thus, an "Information Model" is introduced as the method for defining the information components used in producing exercise description documents.

4.2 Organizational Strategy

The ESDD must provide a self sufficient, non-ambiguous description of the content, key events and features, roles and responsibilities, schedules and resources needed to conduct a simulation based training exercise. In general terms, a simulation exercise provides the appropriate context for achieving specific goals and objectives. For this work, Military Training provides the Use Domain for defining the case specific goals and objectives of a particular simulation exercise.

Correspondingly, the simulation exercise must be designed to provide the context and interactive environment needed to meet the training goals and objectives. Thus, the ESDD must be organized in sections.

One section provides the description of the use domain goals, objectives requirements and other related information which defines the interests and responsibilities of the user. A second section provides the description of simulation exercise context and interactive environment which will be used to meet the training goals and objectives. A third section identifies and defines the responsibilities and activities which will be performed by the simulation center in setting up and running the simulation exercise.

The current framework for organizing the ESDD identifies the following three documents which must be developed by the Exercise Scenario Generation process.

- 1. User Requirements:
 - Training Objectives
 - Training Evaluation Plan
- 2. Exercise Context:
 - Scenario Specification
- 3. Simulation Center Operations:
 - Simulation Control Plan

The outline of the type of information included in each of the above documents is included in the PIP [1]. While the selection of the final content included in each of the documents may be adjusted or grouped differently in the final versions, the set of documents described in the PIP is sufficient for this discussion.

4.3 Requirements

4.3.1 Levels of abstraction

An information model approach allows for representing components of information at different levels of detail or abstraction. Likewise, an information model allows for expressing the same information in terms of the syntax and semantics used in different domains. In essence, the ESDD information model provides the structure which must be filled in by the Scenario Generation process. Each case specific exercise Scenario Generation will produce a set of ESDD as a separate instance of the ESDD information model.

4.3.2 "Need to know"

For a variety of reasons, the ESDD information model must be capable of partitioning the representation and publication of information. For example, the exercise director has access to total "ground truth" for the exercise scenario. Members of the training audience and simulation center opposing force role players receive only their respective subset of exercise scenario ground truth.

A different type of partition would maintain separation between levels of definition. An example of this type separation would be keeping the commander's training objectives as a distinct capstone component of information used for establishing VV&A traceability. In this example, associated components of information which identify the mission context and training tasks selected to meet the training objectives would be separately partitioned.

4.3.3 Data Reuse And Linkage

Likewise, the ESDD information model must include provisions for grouping strategies which allow smaller information components to be linked to form larger information components. For example, when "publishing" the scenario documentation, some of the same information components may be included for use by different groups participating in the exercise.

A different type of grouping strategy relates to defining links between and among components of information which show threads or associations of how information components relate to one another. Examples include showing the thread which starts with a training objective, links the associated mission and task information components associated with meeting the training objective and then connects these with the specification of synthetic environment and model requirements for implementing the exercise simulation.

4.3.4 Multiple Data Formats

Data which is input into the scenario generation process comes in many forms and from many sources. These include standardized items such as orders and military messages, unstructured sources such as free text or hand drawn maps and diagrams, and extremely important but very difficult to describe, individual experience and expertise. Likewise, the output data is required to be in different forms and is forwarded to multiple destinations, or users.

4.4 Practical Considerations

4.4.1 Overloading Human Capabilities

When this process is performed totally or in part by humans, considerable effort must be expended in transferring information from one database to another, from one format to another, or from human memory to database and vice versa. Participants in scenario planning can expect to encounter data in formats such as text files, spreadsheets, schedules, flowcharts, maps with overlays, and others. Even with tools such as word processors, automatic scheduling applications, spreadsheets, or graphics editors, considerable effort is often required to set up the data formats and categories for the different databases or to enter common or repeated "boilerplate." When enumerated values must be used or fields must be filled in with specific information such as unit IDs, names of battlefield control measures, types of supplies, geographical names, etc., a large fraction of the total effort must be applied to remembering or looking up appropriate values.

4.4.2 Explicit Definitions For Machines

Software which automates the construction and population of databases must have explicit knowledge of their structure. Definitions of the records and fields of a database, along with specification of the types and ranges of permissible values must be provided or the generation of such software is impossible. In fact, code and data structures are often designed at the same time and evolve together.

4.4.3 Dual Access

When data structures are accessible to both human and automated components the capabilities and limitations of both parties must be taken into consideration. Database elements which are used as links between records may be meaningful to software. For example, they may describe memory addresses, offsets in a file, or FTP addresses. These are not the sorts of information humans are used to generating or using. Likewise, references to "my memo to you last week on initial force laydown" may make immediate sense to a human when a directory path and filename may not be immediately recognized. In any event, conditioning interfaces will have to be provided for both man and machine and where a query may not be understood immediately, special attention must be paid to providing a means to restate a question or rephrase an answer.

4.5 **Template Based Initialization**

Database reuse is desirable as a means of reducing effort. It is likely that most exercises will share a number of components such as terrain, MTOE, simulator inventory, force structures descriptions, etc. and can reuse the databases that describe them. When these cannot be reused in precisely their original form it may be that minor adjustments can make them useful in a new context and that significant portions of the databases will remain unmodified. Clearly, significant effort could be saved by using tools which provide these structures as ready-made templates to be filled in by the human participants.

In addition, tools which automatically prompt their human users with contextually appropriate choices, possibly via pull-down menus or hierarchically structured embedded selection schemes, will go a long way toward improving the efficiency of the human operators and participants.

4.6 Template Based Reasoning

Just as template based initialization schemes have the potential for increasing the efficiency of the human participant, use of standard "template" choices can simplify the design of automated aspects of the process. "Template Based Reasoning" can provide a set of choices with which an automated component can "react" to a situation. Absence of a suitable choice in a case can be a trigger for notification that human intervention is required to resolve a situation that is beyond the capability of the software.

4.7 Object Oriented Approach

Obviously, from the above discussion, the ESDD information model should be developed using object oriented technology (OOT). Separately defined information components should be treated as objects. Properties of classes and class structures should be used to define relationships and associations among the information component objects. Composite information components may be formed by defining a set of object interfaces and linkages similar to methods used in OO data base design. This approach will allow the data model to be developed using high or intermediate levels of definition for the information components without having to know specific details of supporting data base structures.

4.8 Choosing Items For Development

Initial effort should concentrate on defining the essential set of information elements required to specify the requirements for completing the set up and execution of the exercise with emphasis on defining the linkages and relationships (dependencies) among information elements.

4.9 Identifying Linkages

As the set of "output" information components becomes defined, attention will shift to identifying and defining the linkages (threads) to information components used in developing the end state output and in defining additional levels of detail in the information component class structure. For example, the initial level of definition used for defining the information element may only state what is to be represented in the exercise simulation, e.g. type and number of combat units.

4.10 Adding Detail

Additional levels of detail would identify how the combat units would be represented, e.g. role players, CGF, virtual, or possibly "live" followed by a description of "model requirements" using OO structures patterned after object model templates used for recording simulation and federation object models. A corresponding example would be the use of SEDRIS [16] as the reference data model for defining the synthetic environment parameters which will be used in the

exercise. Similar examples can be found of intermediate level structures (data models) for information components which define mission profiles and associated training tasks.

4.11 ESDD Information Model Development Approach

The document information model uses concepts for developing data models combined with "information components" used to represent the result of applying knowledge to selecting and linking data structures. Introduction of the information component construct comes from an extension of the information processing model used to formulate an architecture for information system mediators [17]. The description of the interaction and relationship between knowledge and information presented in this information processing model is well suited for use with the formal process model for exercise documentation development described in the previous section. The DARPA Intelligent Integration of Information (I3) Technology project has demonstrated and evaluated the implementation of the mediator architecture [18]. Figure 11, taken from the I3 project home page summarizes how the interaction of knowledge and data combine to form information and suggests that results of these interactions can be considered as information "states" or components.



Figure 11. Concept for Forming Information Components

Formulation of the document information model recognizes that general knowledge about the organization and relationship of information contained in the documents can be represented at higher, semi structured, levels in combination with specific, highly structured data. For example, the Joint Operations Planning and Execution System (JOPES) [19] has a well defined format for the components of information included in operational plans. This format is widely known and consistently used by the domain of military planners. In effect, the format represents a general level of knowledge used in military planning and can be represented by templates used in implementing automated tools. While the format provides structure for developing and organizing information, at the general level, it allows latitude for using a variety of specific, highly structured data sources for filling in the components of information defined by the prescribed format. Similarly, the document information model provides the general knowledge

and high level structure for defining information components used for developing exercise documentation.

Organization of the top level information model for documents defining computer assisted training exercises would begin with an outline of the primary classes of documents which will be produced. Beginning with an outline like the one shown in Figure 12, a description of the first level information components is developed. This description includes a statement of the purpose or expected use of the information component, the type information that is included in the information element (content), and linkages (dependencies) to other information elements. In effect, this will provide an annotated "road map" of the essential information components at a high to intermediate level of detail.



Figure 12. Exercise Document Information Model Outline

As part of developing and defining the main components of information, an associated set of knowledge sources will be identified which provides further definition and structure to the information components. Sources will be initially selected which provide general knowledge frameworks such as the Universal Joint Task List, Operational Plans and Conceptual Models of the Mission Space for identifying and developing the interfaces and relationships of the information components. Components of the document information model use a common organizing structure. Each section and associated components can be thought of in terms of "classes" which define the separation and organization of the document in terms of components and sub components of information which describe the exercise scenario. In this regard, the class structure provides the general framework and description of the document information model. A specific exercise scenario would be a case specific instance.

The common organizing structure like the one shown in Table 1 will link the description of the document information component to the corresponding segment in the process model responsible for developing the information component content.

Title:	As would appear in table of contents
Content:	Short description of information contained in the component
Туре:	Key code for component format, e.g. text, list, etc
Development Role Code:	Identifies which role has responsibility for developing the component.
User Role Code:	Identifies which role will use the information contained in the component
Association Index:	Identifies linkages to higher or lower level components.

Table 1. Information Component Organizing Structure

In a similar manner, document information models can be organized to define the description of an information component in different domain contexts and at different levels of detail. An example of how the information model for the scenario specification document would be developed is provided in Figure 13.



Figure 13. Example Scenario Document Information Model

5. Agents and the Automated Environment Architecture

5.1 Introduction

This section describes an architecture for a distributed, collaborative, automated Scenario Generation environment. IST's goal was to define an architecture that would permit a high degree of automation of the transactions and processes occurring in a scenario development environment while at the same time accommodating an 1) evolutionary development of the automated components and 2) the approach to process and document information modeling discussed in the previous sections.

5.2 Requirements

IST observed a number of characteristics of the scenario planning process that provide a number of valuable insights into desirable and necessary characteristics of any system which is intended to automate or expedite the process. These characteristics include:

- 1. Scenario Generation is a **collaborative** activity. Participants work in groups and as individuals. Participants interact on an individual basis as but the process is coordinated and progress is evaluated primarily through a few key periodic **staff meetings**.
- 2. Participants locate information, generate documents, and interact with others as needed. This requires an environment that facilitates **communication** and **coordination**.
- 3. Document approval is a necessary and frequent activity. The **approval process** is an important **protocol** which must be followed to **avoid ambiguity**.
- 4. The ultimate end product is **documentation** of various types but participants communicate their progress through **interim media** which are shared, exchanged, and incrementally improved.
- 5. Many different kinds of tasks and activities are chained together to produce a single document. These range from locating sources of information to selecting options to writing words on paper. The working environment must support all of these.
- 6. Participants are able and required to merge many different kinds and formats of data from disparate sources and to generate new formats.
- 7. The process depends significantly on use of "unstructured" information such as text and graphics.
- 8. Control and coordination is done by people who understand both the process and their role(s) in it. The scenario design process depends largely on a staff of SMEs with an immense store of **doctrinal, tactical, and practical military expertise** and experience. Requirements are produced, story lines are written and priorities set by these people based on this knowledge.
- 9. The planning process itself is essentially undocumented. Participants learn it by immersion.
- 10. The process depends heavily on the **familiarity** of staff planners with the commander's priorities, intent, and preferences. Very little detail concerning this is conveyed in written form.
- 11. Although tools (word processors, scheduling applications, telephones, etc) are used, people make the decisions and approvals.

On consideration of the above IST believes that:

- 1. The design of the scenario does not strictly precede the planning and implementation of the exercise. Rather, they tend to **co-evolve**. This makes it difficult or impossible to define these as separate stages in the overall process.
- 2. The overall process may be considered from at least three different points of view. It may be focused on the **tasks**, major **roles**, or the individual **participants**.
- 3. The most promising organizing concept is the idea of "document threads" i.e., following the production history of key documents through the Scenario Generation process.

5.3 Describing Human Activities Which are to be Automated

Automation may be defined as the process of replacing activities that are performed by humans with software controlled processes running on computers and communications equipment. Before trying to determine how this is to be done it is necessary to have a clear idea of what these activities are. Descriptions of the "Who, What, and When", the upper level of the process model discussed in section 3, are readily available from the participants themselves. Descriptions of the "how" of execution are not easily derived and to actually write the software that accomplishes these actions it is necessary to have a complete, precise, and unambiguous description of exactly what is to be done by the software. This requires a level of detail and specification not usually available from a subject matter expert. A process of "Knowledge Engineering" is usually required, in which software engineers who have a clear understanding of the implementation mechanisms elicit this information through repeated interactions with SMEs and tests of information thus obtained.

Human activities are the things, both covert and overt, that people do. They are sometimes referred to collectively as **behavior** (to **behave** means to act, function, or react in a particular way.) Collective behavior is often quite complex but it is usually composed of identifiable subunits which may be referred to separately as **behaviors**, **tasks**, **actions**, etc. Human behavior involves **physical actions** such as movement, manipulation of parts of the environment, or vocalization. These are detectable by outside observers. It also involves **cognitive actions**, invisible to observers, such as sensing, analysis, decision making, learning, etc. The two categories may sometimes be hard to distinguish because they usually function together. Physical actions usually follow some cognitive activity that determines what is to be done and how. For example, speech usually follows some thought about what needs to be said. Most movement is done after a decision has been reached to move and it may be used in response to analysis of sensory input when it is decided that a new location is required to continue an observational action. Reactive behavior may be considered a simple form of cognitive activity which selects predetermined (trained) actions in response to stimuli and does not require any real time reflection or analysis.

In the context of scenario generation, activities such as entering an event type and time into a schedule or drawing a phase line on a tactical overlay are physical actions. The process a person goes through to choose the date and time for the event or the start and end points for the phase line consists of cognitive actions. Spoken communication between participants in the process is a physical action used to convey the products of cognitive activity from one individual to another.

5.4 Group Behavior

Behaviors (in the discrete sense) can be described for groups as well as for individual entities. Although human group behavior can be extremely complex and may appear to be more than just the sum of the behaviors of the individuals involved it is actually the result of individuals performing physical and cognitive actions. These individual behaviors involve communication with others, observation of their actions, common goals, and common conceptions of processes to be followed.

Because of its complexity and scale, scenario generation and planning is necessarily a group behavior and to describe completely it is necessary to describe communication, observation, mutual understanding, and common goals as well as the individual actions that participants accomplish.

5.5 Behaviors Used in Scenario Generation

Human participants perform a wide range of behaviors in the process of developing scenarios. These include physical behaviors such as generating documents by writing or typing, speaking with others, reading reports and documents (sometimes via computer), walking from office to office to locate materials or other participants, etc.

The range of cognitive behaviors is extensive. At the highest levels it might include things like "compose an order" or "decide where to place a control measure". These actions involve combinations of such overwhelming numbers of other cognitive activities as to be intractable. It



is doubtful that anyone can correctly list in detail all of the mental steps that a person must go through to assimilate a situation, inventory available resources, and develop a detailed force laydown to respond to it. These activities include understanding what is read or heard, merging information with knowledge, making judgments about completeness and correctness of reports, detecting logical and procedural errors, remembering how to spell words, forming sentences and paragraphs, remembering actual operational experiences, fielding interruptions for phone calls, prioritizing efforts to meet deadlines, etc.

The doctrinal knowledge required to develop some of the parts of a scenario must be combined with knowledge of the scenario generation process itself and an awareness of who is responsible for other, related parts of the process.

5.6 What People Will Continue To Do

A large proportion of the information used in the scenario generation process is not highly structured. Descriptions of training intent, instructions on how to accomplish the planning process itself, doctrinal descriptions, etc. are often in the form of English text which uses a very large number of application specific terms and jargon whose definitions are assumed to be understood. Interpretation and processing of this sort of information will require human intervention for the foreseeable future.

5.7 What Automation Can Be Expected To Do.

Under the assumption that it is not feasible to completely automate the entire scenario design and planning process, and the best that can be expected is a well integrated combination of human and automated components, a number of requirements of such a system can be listed:

- 1. The system must allow various combinations of human and automated components to communicate and interact. In this discussion this is referred to as interspecies communication.
- 2. The system must implement high level communications protocols involving requests, acknowledgments, answers, and approvals.
- 3. Interspecies database access will require dual access methods to allow sharing of documents.
- 4. Automation of activities that deal with different forms of data must be designed to accommodate those types and be able to **convert and combine information** existing in different forms.
- 5. The planning process currently depends largely on a staff with an immense store of **domain specific, doctrinal, tactical, and practical military expertise and experience.** Requirements are produced, story lines are written, and priorities set based on this knowledge. Automating certain activities will require **encoding this experience** into machine

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executable format. Information describing the process itself will have to be encoded to direct the automated components

5.8 Challenging Problems

Examination of the exercise activities mentioned above pointed out a number of areas which present significant challenges to any effort aimed at shifting the activities of humans to software implementations. These are:

- 1. If a task (e.g. the activities of a person to produce a piece of a document) is to be automated (accomplished by software), then its component activities must be explicitly described. The personnel currently accomplishing the planning process may be intimately familiar with it **but it is essentially undocumented**. When the people who currently use the process are asked what is done they will often provide descriptions that are **limited or biased** by their roles and experience. Important parts will be left out.
- 2. The individual tasks that people accomplish are likewise not well described. Describing these activities in **sufficient detail to specify software** solutions can generally not be done by the SMEs themselves.
- 3. For a task to be executed, someone or something must trigger it. To automate the process of controlling tasks, (whether they are automated or accomplished by human participants) those **trigger conditions must be explicitly described**. Here again, SMEs cannot be relied upon to express this knowledge; they can only apply it.
- 4. The process depends significantly on the use of "unstructured" information such as text and graphics. Accommodating these sources of input and generating output in unstructured format is partly in the realms of Natural Language Understanding and Image Understanding. These are areas of extreme complexity, with few practical tools and facilities available at present.
- 5. The process depends heavily on the familiarity of staff planners with the commander's **priorities, intent, and preferences**. Very little detail concerning this is currently conveyed in written form. Because this involves personal preferences and experience it is likely to be even more difficult to deal with than the need for domain specific knowledge. If heuristics can be developed to help in this area then the system must accommodate them.

5.9 Approaches

The scope, complexity, dynamic nature, and sparsely documented character of the scenario generation/planning process preclude complete automation. Most of the activity currently performed by human participants is extremely complex and effective methods for automating many of those tasks are not yet available. Therefore a significant continued human presence in scenario planning should be expected. Solutions should recognize this and accommodate it in several ways.

First, an integrated application of automated tools, communications mechanisms, and coordination facilities will provide significant benefits. A number of tools exist that are used in scenario planning but most are not designed to work together. Email systems, word processors, scheduling systems, and database query and management systems should be linked.

A second and very powerful approach to enhancing and assisting human participants is the concept of a **software agent**. For the purposes of this discussion, an **agent** is a software facility acting on behalf of, and representing the interests of, a person who is performing a certain role. This is discussed at length in section 5.10 below.

Third is the previously mentioned idea of accommodating an **evolutionary approach**; i.e. one that automates what can be automated now, and allows for incremental replacement of human activities with automated ones as techniques are developed, can provide a strategy for continued improvement.

IST envisions a distributed system that transparently links human participants and automated components. Such a system could be configured initially to link only human participants and later, as tasks are identified to be suitable for implementation in software, they could be written and plugged into the slots formerly occupied by human participants, thus providing a path to increased automation.

Strong parallels can be drawn between the activities of participants in the planning process and those of CGF entities. The activities of these participants can be viewed as "behaviors" in the CGF sense, albeit in a domain that differs radically from battlefield interaction. The participants themselves are analogous to CGF "entities" which perform actions, send and receive messages, and cooperate to achieve common goals. These parallels suggested that many methods and techniques developed or envisioned for simulating tactical behaviors in CGF could be applied to this domain.

5.10 Agents

Communication between the parts of a distributed planning activity would employ Internet and Intranet facilities for messaging and other data transfer. Each human participant would interact directly with an **automated agent application** which would provide the communication link with the system and an interface suitable to a human operator. Participants, whether human or automated, would send requests for data or services and responses to requests to other participants. Agent applications functioning as interfaces for human participants would display messages in text form and accept input via keyboard, mouse and menu, or some other mode, along with the selection of a destination. The agent would then forward the message for the operator.

Agents may be represented (Figure 14) as collections of behaviors which may interact with the humans they represent and possibly with other agents or entities which accomplish related behaviors.



Figure 14. Agents and Operators

In addition to providing a link to the other participants, an agent would be **able to accomplish** some of the activities formerly done by that human participant. Requests for results that have already been generated could be handled automatically by retrieving and sending a copy of a document or by providing the name of a location where it might be found. Activities that have been automated may be incorporated into an agent so it can examine incoming requests and divert those to be handled by automated "behavior" transparent to the human participant.

The distributed system could be organized around notions of products, roles, or participants but the former is probably most useful because generation of the major products of the process(which are referred to as documents) is the ultimate goal of the system.

One primary agent would be created for each document and would be responsible for starting and coordinating the activities required to produce that product. Such a **Document Agent** would possess knowledge, encoded as **behaviors**, which would allow it to perform actions, ask questions, receive answers, access databases, draw conclusions, construct lists, request authorizations, etc. A Document Agent would make inquiries of other agents by sending them messages. In the cases that these other agents represented human participants, receipt of a message would result in their notifying the users they represented and displaying questions, requests, or commands for them to read. In the case that these agents represent automated processes the messages would be parsed and interpreted by the receiving agent and actions requested of the automated components (which might reside at other locations or under the control of other agents.)

Other agents would be assigned to key roles or individuals. Such a **personal agent** may have multiple concurrent responsibilities, such as receiving a request and invoking an automated behavior to accommodate it, accepting input from its human associate and forwarding it to another node or process, or receiving a response to a user's request and displaying it to be read.

5.11 Behaviors

Actions performed by human participants and automated components are referred to here as **behaviors**. Behaviors are analogous to processes in the sense of tasks as managed by a computer's operating system. An entity, whether human or automated may be required to perform multiple behaviors simultaneously. Generally, for purposes of analysis and description, complex behavior may be subdivided into less complex, more primitive sub-behaviors.

A behavior is defined to be a group of actions that, taken together, accomplish a task. In Computer Generated Forces Applications (CGF) extremely complex physical and cognitive behavior is usually synthesized from multiple concurrent, interacting less complex subbehaviors. Layers of components ultimately depend upon "primitives" which accomplish meaningful physical or cognitive actions.

A behavior is defined here to be an activity of a single entity because it simplifies things to do so. "Group behavior" (which is necessary for Scenario Generation) can be built from interactions between single entities, each of which performs its own behaviors, including communications. Although the actions expected of participants in Scenario Generation are not components of tactical behavior such as "move", "look", and "shoot", they are highly complex, yet decomposable.

C. Martin Street of

A behavior is defined if it has been encoded and made available to an entity but until it is invoked it does not actually do anything. Once an instance of a behavior is invoked by an entity it becomes an active **process**. A process may exist permanently (for the life of the simulation or scenario generation process), transiently, or repeatedly. A single entity may have multiple concurrent processes active at any one time.



Figure 15. Process Inter-relationships

Processes may be characterized by their relationships to other processes. Figure 15 illustrates this. The rectangles represent processes. The directed arcs (solid lines) represent the relationship "spawns". The dashed lines represent "exchanges information with", and the dotted lines represent "monitors." MAIN is a fundamental activity (complex and relatively high-level.) It spawns a sub-process SUB1 which in turn generates SUB2 and SUB3(child processes, less complex and at a lower relative level) to accomplish its purpose. MAIN cooperates with COOP by sharing or trading data with it. The process MON monitors the activity of SUB2 and SUB3.

5.11.1 Parallels with CGF

Although a large body of CGF behavior has been encoded and implemented in various systems such as ModSAF and CCTTSAF, limitations of their architectures complicate the process of specifying, encoding, and executing simulated behaviors and provide little support to implement interactions between human players and the players whose behaviors are generated by software. In particular, interchangability between automated components and human participants has not been significantly explored. This area is rich with problems and opportunities for research involving natural language understanding and the protocols of interaction between individuals and groups.

Recent work in CGF has refined many behaviors to a considerable level of detail, however, largely as a result of the need to focus on computational efficiency to permit the generation of large numbers of entities, the complexity of the behaviors and the sophistication of the methods used to implement them have not advanced significantly. Some promising strategies and methods have been avoided because of the computational overhead involved. In particular, approaches involving the runtime interpretation of dynamic behavioral databases have usually been rejected in favor of efficient, though cumbersome and difficult to modify, compiled methods. In less computationally restrictive environments, however, the costs involved in interpretation would not pose a problem and many advantages could be realized.

Other areas that have received little attention in most CGF systems include 1) cooperative behavior based on explicit and realistic communication between entities and 2) flexible schemes for managing and coordinating the multiple asynchronous, non hierarchical, cooperating and conflicting behavioral processes that collectively define the behavior of a single individual. These areas are critical to automating the scenario generation process.

Several ideas that were originally developed to solve some of these CGF problems are applicable to an automated scenario generation environment. These ideas are presented in the following sections.

5.11.2 Specifying Behaviors

Specification and execution of a simulated behavior requires a **language** with which it can be described and an **execution mechanism** that uses that encoded description at runtime. These descriptions should completely and unambiguously specify the activities involved in each behavior. To put these descriptions to use requires a run-time mechanism that can "execute" or perform them based on their encoded specifications. IST has defined and developed a Behavior Description Language (BDL) and a runtime execution mechanism which an automated agent application may use. The language includes properties which facilitate human participation in the scenario development process and the capability to instantiate multiple, concurrent activities at different levels of resolution.

BDL grew out of a language called ILLISH [20]. Extensions and syntactic changes make it desirable to change the name to avoid confusion.

5.11.3 Executing Behavior

BDL has been prototyped in the IST CGF system [21], a PC-based application that runs in a DOS environment, and which has been used extensively in CGF research, DIS interoperability testing, and most recently as the basis for IST's HLA Gateway.

The IST CGF provides a non-preemptive multitasking environment within which simulation entities can be dynamically instantiated and controlled. Low level "primitive" behaviors are procedures written in "C". A layer of Finite State Machines exploits these primitives to provide more complex behaviors which follow a hierarchical organizational scheme. A single state in an FSM is represented by a "C" function which can make direct calls to the primitive functions for purposes of vehicle dynamics calculations, terrain reason, sensor exploitation, and weapons system usage. The FSM mechanism implemented for the IST CGF is described in [22].

BDL forms a layer above FSMs. It does not provide any way to make direct calls to procedures so, to accomplish detailed computational tasks it depends on a layer of Finite State Machines (FSMs) which can do that. FSMs may be used to implement behaviors independently of, or in conjunction with BDL scripts. Scripts may spawn behaviors which are implemented as FSMs or as other scripts. FSMs may likewise generate children of either type. One of the characteristics of the BDL scheme is that scripts need not be created in a hierarchical arrangement. This allows behaviors to be defined which can communicate and cooperate more flexibly, more closely mirroring the irregular and dynamic relationships between cognitive processes in the human mind.

Processes are scheduled and data exchanged between behaviors and entities via messages. Receipt of a message by an entity may result in execution of a new behavior, termination of an active one, or awakening of a suspended behavior. Messages are typed so that receiving entities know what to do with them. A message, for example, that tells an entity to start executing a behavior, will be examined to find the name of the behavior. That behavior will be located in a catalog of possible behaviors, and it will then be started. The message contains no indication of HOW the behavior is to be performed (by a BDL script or by and FSM) but only its symbolic name and formal parameters.

5.11.4 BDL Scripts

Like ILLISH, BDL is intended to be used as an interpreted language. Behavior is encoded in BDL as ASCII text. A statement is a single line of text (terminated by an end-of-line character) that can be recognized as a terminal token. A statement expresses one complete action.

Statements may be encountered singly, as **commands** sent to a simulated entity, or they may be grouped into **scripts** which an entity will execute. When a command is sent to an entity it is encoded as an ASCII string in a text message.

A script is stored as a series of statements under a name which identifies the behavior. A typical CGF behavior such as "maneuver_to_location" might include statements starting sub-behaviors to compute the desired route, followed by statements to drive from one intermediate location to

the next, signaling a parent behavior when finished. In like fashion, a scenario generation behavior such as "add_event_to MSEL" might open a pre-existing database, insert a new item, and then close the database, signaling the behavior that spawned it that it has completed successfully.

5.11.5 Interpretation

The run-time mechanism that executes BDL specifications is an interpreter. The interpreter consists of three main parts:

- 1. A Message Handler
- 2. A Lexical Analyzer and Parser
- 3. A Script Handler

The message handler determines what an entity does with a message it receives. If it is a text message the data portion will contain a BDL statement. The message handler passes this statement to the lexical analyzer and parser which determines which action is specified and what values are to be used when that action is performed. If the message contains a command to "START" or "STOP" executing a behavior, or to awaken a dormant behavior, the name of the behavior is embedded in the message. The Script handler isolates this name, looks for a corresponding entry in a table of available behaviors, and uses information in that entry to locate a copy of the script's text in memory. Starting a script involves beginning to interpret that script, line at a time. Stopping a script involves removing a script instance's records from an entity, an awakening a dormant script involves restarting the interpretation of a script that has been suspended.

5.12 Interspecies Communication and an Evolutionary Approach

If humans and software processes are to be used interchangeably then it is necessary for interactions between them to be intelligible to both humans and machines. A compromise is an English-like communications syntax that is sufficiently limited to make it recognizable by machine using state of the art parsing techniques developed for computer programming languages.

The proposed architecture links participants of either species via BDL messages. Because the message are displayed to human participants as text or synthesized voice, the human operators have no way of knowing from the phrasing whether the messages were generated by man or machine. Therefore, if the actions performed by a human can be automated and the automated version uses the same BDL syntax and conventions, the human operator will not be able to detect a change in the origin of the messages he is receiving.

6. Conclusions and Recommendations

Automation can significantly reduce the time and resources required for planning and preparing for large scale simulation assisted exercises.

An initial automated environment which links people and automated tools would provide substantial improvements (efficiencies) and would provide the framework needed for continuing evolution to higher levels of automation.

Achieving higher levels of automation using semi or fully autonomous agents will depend on how quickly knowledge of the process and corresponding templates can be established which are suitable for automated manipulation. There are currently several efforts underway such as JEMPS III, Conceptual Modeling of the Mission Space (CMMS), and others which will provide the knowledge representation needed for moving to next (or higher) levels of scenario generation.

The work described in this report should be continued. The potential payoff is immense and many of the concepts developed for automating scenario generation can be applied to other areas such as mission rehearsal, course of action analysis, industrial and administrative processes. The BDL language, which was originally envisioned for CGF but developed for ASGE, can be redirected back into CGF and constructive simulation.

IST recommends that the architecture described in the previous sections be further investigated by prototyping a small set of networked interface nodes driven by the sorts of agents discussed herein. With the prototype, experiments should be conducted wherein individuals would conduct small scale scenario generation efforts using the system as the only communication mechanism. The system would be augmented with additional messaging facilities as deficiencies were noted. Communications traffic would be recorded and analyzed to determine the message content and data exchange protocols used by the scenario planners. As common and repeated patterns became apparent automated modules would be developed to replace human effort where most cost effective. This page intentionally left blank

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8. Attachments

8.1 Attachment A: BSC Process Description

Administrative and Functional Processes of Battle Simulation Center (BSC) Exercise Staff To Conduct Simulation Training

(DRAFT)

25 July 1997

By Edward Ramirez

Fundamentals of Joint Exercises

Introduction. Joint distributed computer-driven exercises have been conducted for over 10 years.¹ When considering how JSIMS will be used, it is useful to consider how previous distributed exercises were conducted. The conduct of these exercises can be separated into three phases: construction, execution, and evaluation.

1. Exercise Construction

Exercise construction is the process of creating the starting position for the exercise. This phase can be divided into scenario definition; scenario composition; data initialization; and exercise design and set-up.

1.1. Scenario Definition

This initial phase of an exercise is where the concepts and purposes for the exercise are determined. Exercise sponsors determine whether the exercise is for training of exercise participants, evaluation of operations plans, or exercise and evaluation of headquarters' coordination procedures. From this determination, several other basic characteristics of the exercise are established:

- Geographic area and situation which will be the focus of the exercise (location, season, special weather conditions).
- Simulated forces that will participate in the exercise (US, coalition, enemy, neutral).

¹ ALSP JTC at WPC, Korea, JWFC; Prairie Warrior; Blue Flag; Naval War College; Air University; etc.

- General mission of the participating simulated forces and the consequent types of military activities expected in the exercise (deployment, combat, peacekeeping, guerrilla warfare, etc.).
- Headquarters that will participate in the exercise as players.

1.2. Scenario Composition

During this phase, exercise sponsors working with exercise developers determine the components of the simulation that will be necessary to meet the objectives of the exercise.

A part of the process is resolving whether desired capabilities can be included in the exercise, where possible answers to the question include,

- 1. The capability is present in the simulation
- 2. The capability can be added to the simulation (designed, implemented, tested) in time for the exercise.
- 3. The capability can be "modeled manually" by role players.²
- 4. The capability will not be used in the exercise but should be considered for long-term inclusion in the simulation.

Issues that will be resolved in this phase include

- Level of abstraction of the simulated entities (Should military forces be represented as vehicles, or platoons, or companies?)
- Types of simulated entities that may be present in the exercise (are engineering units needed?)
- Types of training audience interfaces that will be needed for the exercise, particularly military C4I systems
- Types of role players that will be needed for the exercise (higher headquarters, subordinates, and peers), and the consequent user interfaces needed for them.
- Allocation of simulated forces among the training audience and role players.
- Types of post- and during-exercise analysis that are desired (and consequently, the plan for gathering that data during the exercise and analyzing it later).

1.3. Data Initialization

The data initialization phase establishes the data necessary to execute the exercise. Where possible, exercise developers draw on standard military databases, appropriate civilian databases, and previously designed exercise databases to construct the initial data for the exercise.

² This presumes that the capability requires little maintenance on the part of the role player and that the training audience has no ability to see the capability on C4I systems.

Some information is readily available in standard databases (e.g., TO&E). Other data is exercisespecific but can be resolved by a single data developer or organization (e.g., logistics relationships). Still other data is exercise-specific and requires negotiation among organizations to resolve (e.g., expected damage to ground units from a new air-to-ground weapon).

An important aspect of this phase is the generation of "run-up" data—information that assures that logistics and intelligence pipelines are filled with meaningful data.

Changes to this database often occur up to the start of the exercise.

1.4. Exercise Design and Set-up

This phase associates physical entities (buildings and rooms where exercise participants will work, computers that will host the exercise software, networks that will carry exercise traffic, workstations that will be used by exercise participants, operational C4I systems) with each other and with software entities. This is a design activity, matching known requirements of simulations with available computers, workstations, and networks. The resulting system is often unique (never used before in an exercise) and untestable (the hardware and networks will not be available until shortly before the exercise).

A test and training session immediately precedes the exercise. This is where the final configuration can finally be tested, where exercise participants can finally use their workstations for hands-on training, and where exercise designers can finally see their complete scenario on exercise computers. Since these three activities occur simultaneously, they incur frequent interruptions as networks are refined, training is restarted, and databases are corrected.

The final step of this phase is to initiate and initialize all software components of the exercise on their assigned hardware.

2. Exercise Execution

The execution of an exercise entails the simultaneous activities of a number of people, computers, networks, and software programs. In order for the exercise to be successful, each of these components must coordinate its activities with all other relevant components.

2.1. Simulation

The simulation provides the illusion of physical activity that reacts to input from human players and provides stimuli to those players during the exercise. The simulation models all activity that is relevant to the exercise with the level of aggregation appropriate to the human exercise participants.

The simulation shares information

• Within itself (one simulated battlefield unit is aware of the activities of another simulated battlefield unit)

- With the training audience (the status of simulated battlefield units is presented via reports and on-line displays)
- With role players (the status of simulated battlefield units is available via interactive workstations; the units can be ordered via the same workstations)
- With exercise control personnel (the modeling state of a simulated battlefield unit is available for manipulation via a workstation)
- With after action review (the activity of a simulated battlefield unit is saved for later replay or analysis).

2.2. Training Audience

The training audience is a group of people who are in ultimate control of the exercise. Where possible, they operate using their wartime command and control devices. However, in most cases, they interface with other members of the control audience and with role players using simulated voice radio. Real-world like printed reports are provided by the simulation for added data. In all cases, they deal with perceived data (information that is filtered by sensors and role players) rather than ground truth (the situation controlled by the simulation).

2.3. Technical Control

Technical control personnel monitor and control the execution of the exercise. They initiate the execution of all exercise components, monitor the health of all components (hardware, software, and networks), alter the execution of the exercise components to overcome difficulties, and control the advance of simulated time.

Some exercise systems (e.g., ALSP) provide a workstation to monitor and control the components of the exercise; others require monitoring of each component.

2.4. Exercise Control

Exercise control personnel assure that events in the exercise don't deviate excessively from those expected. For example, if the destruction of a bridge skewed the exercise away from its intended path, an exercise controller could restore the utility of the bridge; if a data initialization oversight resulted in an incorrect location for a unit, he could reposition it.

Exercise controllers have access to all data (ground truth and truth as perceived by other players) and have the ability to change the characteristics of all data regardless of side or affiliation. Exercise controllers typically monitor a "birds-eye" view of the simulated activity, tracking key parameters, and scanning the activity of important participants in the exercise.

2.5. Role Player

Role players are present for all command elements that must communicate with the training audience and where the interface for that training audience is insufficient for automatic operation.

For example, if the training audience needed to communicate with the National Command Authority and that communication would normally consist of free text messages (voice or electronic), then a National Command Authority role player would be established and automated facilities would be provided to support him.

Information available to the role player is restricted to that normally available to a person occupying his position. His mechanisms for viewing and control of the simulation will be adapted for his role in the exercise.

Roles assumed by role players include training audience subordinates, superiors, and peers (the blue cell); opposing force commanders (the red cell); and, in some cases, neutral forces (the green cell).

3. Post-Exercise Evaluation

After action review is an on-going activity that gathers data during the exercise and makes it available for analysis during and after the exercise. The classes of data gathered by this aspect were determined during the scenario composition phase and programmed during the data initialization phase. During the conduct of the exercise, typical activities will include monitoring a "birds-eye" view of the simulated activity, tracking key parameters, and scanning the activity of important participants in the exercise.

Post-exercise evaluation relies on data gathered during the conduct of the exercise. This data is manipulated during post-exercise analysis to assist in the evaluation.

- For training of exercise participants, those participants are evaluated regarding completion of appropriate Mission Essential Task Lists during the exercise. The most common tool to accomplish this is a playback of key portions of the exercise.
- For evaluation of operations plans, situations at key points in the exercise are evaluated for clarity and consistency in the operation plan and for optimal use of resources by the plan. This evaluation primarily relies on data gathered manually during the exercise.
- For exercise and evaluation of headquarters' coordination procedures, communications processes are evaluated for timeliness, inclusion of appropriate participants and effective processes and formats. This evaluation primarily relies on data gathered manually during the exercise.

In addition to these purpose-specific activities, a hot wash-up will usually be provided. It occurs within hours of the completion of a portion of the exercise and apprises the exercise participants of the simulated activity that took place.

TASK GUIDANCE

1. The following list, is the tasks necessary to be completed by the Exercise staff and the BSC staff for training scenario preparation.

2. After receipt and review of the *Training Guidance*, perform an analysis and identify/develop Training Objectives.

3. Convert Training Guidance and Training Objectives into a Mission Statement for the development of training Scenario and the Operations Plan, (OPLAN).

3.1. Example. One US Army Tank Platoon (4 tanks) is to conduct a tactical road march from a secure position at grid location NB12345678 in the Brigade Assembly Area (BSA) to a Forward Assembly Area (FSA) position at grid location NB87654321. Enemy contact is not likely. (1)

Note. Interpretation of the training guidance indicates that enemy contact is *not likely*. This is because the platoon is moving from one secure area to another within a zone of friendly occupation. Therefore, the posture and Operational State (Opstate) would be *displacing*. If the platoon was to move to the Forward Line Of Troops (FLOT), than the conditions would be that enemy contact is *possible*, and the Opstate posture would be *traveling*. If the platoon were to move to the Forward Edge of the battlefield (FEBA), than enemy contact would be *likely* and the Opstate posture would be *Traveling Overwatch*. If contact was imminent, or the unit was to move beyond the FEBA in a movement to contact or attack mission, the Opstate would be *bounding overwatch*. In any case, once a unit is in contact with the enemy, the Opstate would always become *fire and maneuver*.

4. BSC Staffing. Typical BSC staffing includes the following:

a)	Site Manager/Director	Contractor
b)	Deputy Site Manager	Contractor
c)	Systems Manager	Contractor
d)	Intelligence Technician	Contractor
e)	Exercise Leader x 3	Contractor
f)	Systems Engineer	Contractor
g)	Database Manager	Contractor
h)	Simulation Technician x 3	Contractor
i)	Communications Technician	Contractor
j) -	Logistics Technician	Contractor
k)	Administrative Technician	Contractor
l)	Officer In Charge	Military
m)	Operations NCO	Military
n)	Exercise Director	Military*
o)	Exercise Director's staff	Military*

* Exercise Director is the Commander of the unit being trained and the Principal Trainer. The Exercise Director's staff is included as exercise coordinators between the BSC staff and their units. They are not permanent members of the BSC Staff.

4.1. Duty Descriptions.

- a) Site Manager. The Site Manager supervises overall simulation center operations and personnel. He is the senior advisor to the military base commander, and has overall responsibility for the day-to-day affairs of the BSC which include, staff liaison between the simulations center and base military commanders, scheduling, site management, personnel, operations, training events, staff training and skill proficiency, equipment readiness and accountability, and resources management.
- b) Deputy Site Management. The Deputy Site Manager is the principle assistant to the site management and is responsible to the site manager for the daily supervision of all contractor personnel. His duties include scheduling and approving all training events, facilitating IPC's and IPRs, assigning Exercise Leaders, ensuring that all site technical and simulations equipment are maintained and ready for use, training of all contractor personnel, supporting the OIC, resolving conflicts, and acting on behalf of the site Manager in his absence.
- c) Systems Manager. The Systems Manager has overall responsibility for all Training Aid Devices, Simulators and Simulations (TADSS) under simulation center control. His responsibilities include ensuring availability, operational readiness and maintenance of equipment, scheduling, networking, training and skill proficiency of simulation technicians and other designated staff employees, advising the deputy and Site Managers on system capabilities, and direction of the Systems Engineer.
- d) Intelligence Technician. Responsible for the planning, development and execution of all matters pertaining to OPFOR. He is the BSC's principle advisor on OPFOR issues and assists the military staff on the development of the OPFOR portion of the OPORD, the simulation execution plan, and develops the OPFOR scheme of maneuver, executes the OPFOR, and presents the OPFOR portion of the AAR.
- e) Exercise leader. The Exercise Leader is the principle exercise event leader and advisor on all training events. His duties include overall supervision and direction of *assigned* training events. He interacts directly with the exercise staff and assists them is developing all plans, orders, and logistics in support of their training event. Develops the AAR plan in coordination with the military staff and training audience. Assigns work stations, directs the development of the unit database, and directs all supporting personnel for training events.
- f) Systems Engineer. The Systems Engineer is the technical expert for all TADSS, networking, and system operations. He performs daily checks, performs necessary maintenance services, ensures simulation readiness, and is the chief technical advisor to the BSC staff on all matters pertaining to technical equipment.
- g) Database Manager. The Database Manager is responsible for the development and maintenance of all unit databases used for simulation training. He is the facility subject matter expert and advisor on BLUEFOR and OPFOR unit force structures, coordinates directly with unit representatives for the collection, updating and validation of all MTOEs and unit entity system characteristics, and is the approving authority for database validation.

- h) Simulation Technicians (SimTechs). The Simulation Technicians are subordinates to the senior BSC staff and assists in all daily operations during the preparation, execution and AAR phases of simulation training. They are the primary trainers to visiting units on system use and capabilities. During exercise training events, they are positioned with the role players to assist them in configuring and operating the simulation equipment. They also advise unit representatives, role players and the BSC staff on all phases of simulations operations. SimTechs are also responsible for validating station initialization and providing input to the staff for inclusion into the AAR.
- i) Communications Technician. The primary role of the Communication technical is to assist and advise units on C2 and radio communications schemes for simulation training. He also assists training unit in establishing a communication plan for the event and ensures that adequate systems are constructed to support the training event. He is the principle advisor to the senior staff on all matters related to communications. During the training event, he continually monitors the communication system and provides comments on effective C2 for inclusion into the AAR.
- j) Logistics Technician. Responsible for real world facility property accountability and availability, and principle advisor to the staff and training unit on all matters related to logistics for the preparation and execution of training events. He also assists units in developing the logistical Annex of the OPORD and contributes comments to the AAR.
- k) Administrative Assistant. The Administrative Assistant produces all BSC documentation both internal and external that include operating rules, policy memorandums, training calendars, schedules, SOPs, reports, exercise drafts, lessons learned, training plans, AAR reports, OPORDs, Exercise plans, and evaluation reports. Other duties include assisting training units in developing training documents.
- 1) Officer In Charge (OIC). The OIC is the senior military officer of the BSC. He is the military liaison between the BSC and military units, principle military advisor, and is responsible for all military matters within the BSC. He coordinates directly with the unit exercise staff to develop all phases of training events, settles scheduling disputes, and is the military spokesperson representing the BSC to the commander. He assists the exercise unit in developing the training plan and OPORD, and publishes the Exercise Plan. He is also a principle evaluator and contributor to the AAR.
- m) Operations NCO, (NCOIC). The NCOIC is the chief assistant to the OIC. His duties include assisting the BSC and staff and BSC staff on all matters of daily operations of the facility. He is primarily the facility and grounds custodian and is responsible for all facility security, shipping and receiving, facility maintenance, accountability of all military equipment, coordinating the AAR facility, and assists both the training unit and BSC staff on administrative and logistical issues.

- n) Exercise Director. The Exercise Director it the principle trainer and usually the Commander, or his designated representative. The Exercise Director/Commander provides the training guidance, approves the OPORD and the Exercise Plan, and facilitates the training event.
- o) The Exercise Director's Staff. The Exercise Director's Staff are the Commander's principle training managers. They conduct analysis of the training guidance, develop the training objectives, schedule the training event, ensure the training event achieves it's training objectives, develops the OPLAN and OPORD, briefs the commander, and develops the overall training event in coordination with the OIC and the BSC staff.
- 5. The following is a sample listing of training audiences.

Sample Training Audience

<u>Primary</u>

- Task Force Commander
- J/G/S-1 & Admin Section
- J/G/S-2 & Intel Section
- J/G/S-3 & Operations Section
- J/G/S-4 & Logistics Section
- NBC Element Leader
- Fire Support Element
- Forward Air Controller

Secondary

- Company/Team Commanders
- FIST Chiefs
- Support Element Leader
- Mortar Platoon Leader
- Scout Platoon/Troop Leader
- Bn/Bde/Division Staff
- Fire Support Officer
- Air Liaison Officer
- DS Engineer Leader
- DS ADA Leader
- NBC Element

Note. This is a sample listing of players reflecting Bn/Bde/Div levels. Higher echelons of training audiences will differ and at the joint training level the primary and secondary audiences will include other staff activity representatives.

- 6. The following is a list of coordination and exercise tasks that must be performed by the BSC Staff/Exercise Developer(s) and the systemic conditions that must be developed to replicate the (mission) *Training Scenario* using simulations.
- 7. PHASE ONE, pre exercise planning and coordination conference tasks.
 - A. Conduct mission analysis with selected BSC exercise staff members (a,b,l,o).
 - B. Select and recommend ideal simulation system to for training (a,b,l,o).
 - C. Review BSC training calendar and identify system availability dates (a,b,l,o).
 - D. Set up Initial Planning Conference (IPC) between BSC exercise staff and representative(s) from the unit to be trained (a,b,l,o).
 - E. 5-Conduct the IPC with unit representatives and BSC staff (a,b,c,e,l,o).
 - 1. Establish exercise date (l,o)
 - 2. Obtain training objectives (l,o)

- 3. Obtain/formulate Commander's intent (l,o)
- 4. Request unit Modified Table of Organization and Equipment (MTOE) (1,0)
- 5. Confirm Primary training audience (Commander and his Staff), and Secondary training audience (Role Players) (1,0)
- 6. Confirm number of stations to be used (l,o)
- 7. Identify exercise duration and times (startex/endex) (1,0)
- 8. Select terrain (Europe, NTC, JRTC, Sinai, Korea, other) and type (1,0)
- 9. Select scenario weather conditions (clear, overcast, rain, fog, dust, snow, other, day/night) (l,o)
- 10. Identify higher, lower, adjacent, and other units (l,o)
- 11. Develop/review communications plan In Accordance With (IAW), Communication-Electronic Operating Instructions (CEOI) (e,I,o)
- 12. Conduct Battlefield Operating System (BOS) analysis (e,m,o)
- 13. Develop draft Opposing Forces (OPFOR) plan (d,o)
- 14. Schedule next interim planning review (startex < 30 days, approx.) (e,o)
- 15. Request Operations Plans (OPLANS), Annexes, graphic overlays and Intelligence Preparation of the Battlefield (IPB) (1)
- F. Develop draft Exercise Plan (b,e,I,o).
- G. Conduct initial (BSC) Exercise Staff briefing (e,-n,o).
- H. Construct draft unit database (BLUEFOR/OPFOR) ((e,f,g,h).
- I. Assign tentative (BSC) exercise support personnel (staffing assignments) (a,b,l).
- 8. PHASE TWO, In Progress Review (IPR) planning and coordination conference tasks.
 - A. Receive OPLANS, overlays and IPB (e,I,o).
 - B. Review rules of engagement (initial and contact firing posture) (e,g,m).
 - C. Determine if auto or manual play is desired for maintenance, medical, Intelligence and Electronic Warfare (IEW), NBC, Engineer, Fire Support (FS), Air Defense Artillery (ADA), S1, and S4 (e,g,m,o).
 - D. Confirm FS/obstacle plan (includes Army Aviation) (e,g,m,o).
 - E. Confirm BOS trace/analysis (TRADOC Pam 11-9) (e,m,o).
 - F. Review/revise exercise plan (b,e,I,o).
 - G. Confirm unit database, systems (g).
 - H. Confirm startex posture (opstate, unit startex location, logistics, MOPP level, graphics, overlay, routs, control lines, areas, and points, other control measures, OPFOR, basic loads, cache's, C3 plan, other logistical issues (e,g).
 - I. Confirm OPFOR plan (d).
 - J. Set data collection/evaluation plan (e).
 - K. Set security plan (b,l).
 - L. After Action Report (AAR) Plan (b,e).
 - M. Schedule final coordination conference (startex < 5 days) (e).
 - N. Review findings (b,c,e,g,o).
 - O. Modify draft Exercise Plan (b,e).
 - P. Develop draft Exercise Schedule (b,e).
 - Q. Brief exercise staff (b).

- R. Assign tasks (b).
- S. Construct first iteration of scenario, (begin initialization) (g).
- T. Approve draft Exercise Plan (n,m,a)
- U. Publish draft Exercise Plan (l,e,b).
- 9. PHASE THREE, conduct final IPR.
 - A. Review/confirm Commander's intent (e,l,o).
 - B. Review/confirm training objectives (e,l,o).
 - C. Review/modify/approve Exercise Plan and Schedule (e,l,o).
 - D. Review/modify/approve initialization (l,o).
 - E. Save initialization (h).
 - F. Publish final Exercise Plan (1).
 - G. Review/confirm OPORD and overlays (e,l,o).
- 10. PHASE FOUR, Startex.
 - A. Startex < 3 hours, load initialization (c).
 - B. Review final unit of initialization (b,c,e,g,l,o).
 - C. Conduct final coordination, C3, security, reporting, observing, and other systems checks (l).
 - D. Startex (c).
 - E. Endex (c).
- 11. PHASE FIVE, Post Operations Procedures, AAR.
 - A. Conduct AAR data collection (c,e,m).
 - B. Review Scenario (replay) (b,d,e).
 - C. Receive staff and unit input (l).
 - D. Develop AAR (b,d,e,l).
 - E. Conduct AAR (b,I,e).
 - F. Publish interim Executive AAR Report for the Commander (Endex + 5 days) (1).
 - G. Publish final AAR Report, (Endex + 90 days) (l).

12. <u>Target Focus.</u> Goal is to identify (from an engineering perspective) what processes (pieces) can be automated and what can't. Confirm those that can/should, and isolate (identify) the difficult ones or those that cannot/should not be automated.

13. The above tasks are those that are primarily performed by the BSC and support staff in preparation *for* and conducting simulation training events. There are however, unit *Exercise Staff* procedures that are performed by the unit concurrently and during the exercise. These are identified as observable and measurable staff training objectives, which make up the *Training Evaluation Factors* of the "Training & Scenario Documentation" set. A sample list is provided below by staff activity category.

1. Commander

- a) Evaluate Mission
- b) Formulate Tentative Plans
- c) Conduct Commander & Staff Planning Procedures
- d) Conduct preliminary Analysis
- e) Issue Warning Order
- f) Complete Mission Analysis
- g) Issue Planning Guidance
- h) Prepare Estimates
- i) Prepare/Plan orders
- j) Plan Maneuver Control Measures
- k) Plan Direct Fires
- 1) Plan Fire Support
- m) Issue OPORD
- n) Control and Coordinate TF Operations
- o) Maintain Orientation
- p) Control Unit Movement & Fires Using Control Measures
- q) Issue FRAGO
- r) Control Direct Fires
- s) Control Fire Support
- t) React to Indirect Fire
- 2. J/G/S-1
 - a) Prepare Estimates
 - b) Prepare Plan/Order
 - c) Issue OPORD
 - d) Process Casualty Feeder Reports
 - e) Process Replacements
 - f) Prepare and Submit Personnel Daily Summary
 - g) Forecast Losses
 - h) Coordinate Medical Support
- 3. J/G/S-2
 - a) Prepare Analysis of Area Operation (IPB)
 - b) Prepare Intelligence Estimates
 - c) Identify Intelligence Requirements
 - d) Obtain Information and Intelligence
 - e) Coordinate within TF HQS
 - f) React to Indirect Fires
- 4. J/G/S-3
 - a) Evaluate Mission
 - b) Formulate Tentative Plan
 - c) Conduct Preliminary Analysis
 - d) Issue Warning Order

- e) Complete Mission Analysis
- f) Prepare Operations Estimates
- g) Prepare/Plan Order
- h) Develop task Organization/Concept of Operation
- i) Plan Maneuver Control Measures
- j) Plan Fire Support
- k) Plan Direct Fires
- 1) Develop Fire Support Plans
- m) Coordinate Joint Air Attack Teams (JAAT) Operations
- n) Coordinate Engineer Support
- o) Coordinate Air Defense Support
- p) Prepare and Issue Orders
- q) Monitor Operations
- r) Maintain Orientation
- s) Control Unit Movement & Fires Using Graphic Control Measures
- t) Issue FRAGO
- u) Control and Coordinate TF Operations
- v) Control Direct Fires
- w) Control Fire Support
- x) React to Indirect Fires
- 5. J/G/S-4
 - a) Prepare Logistical Estimates
 - b) Prepare/Plan Order
 - c) Plan & Coordinate Logistical Support
 - d) Supervise Logistical Operations
 - e) Request Supplies
 - f) Receive Supplies
- 6. TF FSO
 - a) Plan Fire Support
 - b) Develop Fire Support Plans
 - c) Coordinate Joint Air Attack (JAAT) Operations
 - d) React to Indirect Fires

Note. The above list represents those staff actions that are common at the battalion, brigade and division echelons and appropriate at the joint level. However, real-world joint level actions may differ.

14. The Following are a sample list of Mission-Oriented Training Objectives

- c) Improve Commander/Staff Coordination
- d) Conduct Effective METT-T Analysis
- e) Conduct Effective Tactical Intelligence Functions
- f) Plan and Control Combat Operations
- g) Improve Tactical Decision Making
- h) Maintain Operations security

- i) Conduct Effective Force Projection Operations
- j) Improve Combat Reporting
- k) Conduct Effective Fire and Maneuver
- 1) Integrate Obstacle Plans into Combat Operations
- m) Concentrate Combat Power at the Critical Time and Place
- n) Employ All Indirect Fire Systems Efficiently
- o) Integrate NBC Defensive Operations
- p) Preserve the Force
- q) Sustain the Force During Combat Operations
- r) Conduct Effective Offensive Operations
- s) Conduct Effective Defensive Operations
- t) Evaluate Units Tactical SOP

15. The Above Objectives are assembled and reorganized by Battlefield Operating System (BOS) Category as ARTEP Tasks as listed in FM 71-2 and are attached at Enclosure 1. At the subordinate level, these BOS tasks are assembled as subordinate mission tasks to the Training Objectives and are at enclosure 2, also displayed by BOS Category. For engineering purposes, the definitions for these are at enclosure 3. These are all depicted on the <u>Blueprint of the Battlefield</u> Chart published by HQ's Department of the Army. The BOS category depicts the listing of each area at the sub level, and are *the Training Objectives*, that are part of the "Training & Scenario Documentation."

16. Based on the "Commanders Training Guidance" statement, the automated analysis would identify those training objectives that are screened against training weaknesses as derived from Lessons Learned, ARTEP, and other training evaluations results, and directly support the training guidance. This list, then, would be from where the commander selects his training objectives for a specific training event. This is because not all of the available/identified objectives will be included in a given scenario, though under certain unusual circumstances, they may be. This (commander's) selection is called the *Scenario Specification* portion of the "Training and Scenario Documentation" set. Joint level training objectives and tasks can be derived from the Universal Joint Task List (UJTL), CJCSM 3500.04, Version 3.0, 13 September 1996.

17. The Simulation Control Plan is the Exercise Plan that is developed by the OIC in coordination with the BSC staff and the unit exercise staff. It is an administrative document that outlines the training event procedures, critical events, staffing assignments, timelines, schedules, and overall concept of how the training event is to proceed. It is the who, what, where, when, why and how, of the training event. (1,0)

18. Remaining research/analysis tasks:

What input is required to accomplish each task? Identify what *product* is produced as a result of performing each process (task). Determine what tasks lead into other tasks. Identify links and/or groups for possible consolidation. 19. In selecting several of the above, examples of the (input-analysis-output) process that produce usable products are as follows:

- a) From Phase One,
 - 1. Receive Training Guidance→conduct analysis→select ideal simulation to conduct training, (i.e. Janus).
 - 2. Receive Exercise information from staff→conduct the Staff Planning process/analysis→develop Exercise Plan

b) From Phase Two,

- 1. Receive OPLANS, overlays and IPB-construct Scenario
- 2. Receive MTOE from unit staff \rightarrow Build unit database

c) From Phase Three,

1. Review updated Scenario input from unit→modify draft Exercise Plan→publish final Exercise Plan

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8.2 Attachment B: IST Process Flow Diagram

Following 5 Pages.





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8.3 Attachment C: IST Trip Report - JTASC Visit

講師 作士

TRIP REPORT S. H. Smith

7 April 1997

U.S. Atlantic Command Joint Training, Analysis & Simulation Center April 3-4 1997 Under DARPA Contract "Automated Scenario Generation Environment"

The author traveled to JTASC in Suffolk VA on 3 April 1997 for a day of meetings on 4 April. Others in the group were:

Larry Willis DPM ASTT	DARPA	(703) 696-7448	lwillis@darpa.mil
Julia Loughran	IDA	(703) 845-6681	loughran@ida.org
Richard James	Orion	(407) 628-3835	dick@odgi.com
Russ Richardson	SAIC	(703) 907-2540	rrichardson@std.saic.com
Eric Raitch	SAIC/JPSD	(703) 907-2250	eraitch@jpsd.std.saic.com

The above listed group drove to JTASC at 0800 and met with the following personnel from that facility

Joan Conover	SAIC	(757) 686 7131	conover@acom.mil
Steve Moone	JTASC	(757) 686 7000	moone@acom.mil
Gene Newman DIRECTOR	JTASC	(757) 686 7000	newmane@acom.mil
Greg Knapp	NRAD/JTASC	(757) 686 7115	knapp@acom.mil
MAJ Walizer	J72	(757) 686 7394	walizer@acom.mil
Karen McBee	NAWCTSD/JTASC liaison		
		(757 686-7956	mcbee@acom.mil
Fred Snowden	Logicon	(757) 686 7285	snowden@acom.mil
Bill Sheehan	Logicon	(757) 6867934	shehan@acom.mil
CDR Grundmeir	J72	(757) 686 7459	grundy@acom.mil

Initial discussions between Larry Willis of DARPA and Gene Newman, Director of JTASC, were focused on establishing a working relationship between the parties. JTASC is a heavy user of simulation, not a developer and they are interested in extracting mainstream technologies as well as assisting developers of new technologies which may eventually find their way to facilities such as theirs.

The group was given a tour of the building by Greg Knapp and Joan Conover. There is an impressive array of computing, communications, and video equipment there.

Newman said he has had discussions with CAPT Drew Beasley and that it would be better for JTASC to upgrade its facility to be consistent with the needs of JSIMS rather than having JSIMS invest heavily in a duplicate testbed. Newman said he promised Congress that ACOM could greatly decrease their operational costs later if they invested heavily in technological improvements early. They have done so; the facility appears to have many millions of dollars invested in computer, networking and video facilities.

JTASC is putting together what they call a digital library which will be a WEB accessible collection of all the simulation tools and data they generate. They have several terabytes of storage now and plan to have several hundred soon.

The Joint Battle Center, a separate command under the JCS, and commanded by CAPT Tom Lang, is located in the same building. Newman said the two groups plan to work together to try to use JTASC resources for operational mission planning as well as training.

We were given two presentations by officers assigned to JTASC. MAJ Walizer, USMC, Maj Walizer gave the group an overview of the exercise development process at JTASC. He explained the way the facility has been used about 4 times per year for exercises to train commanders and their staff. For what they call Tier 3 exercises, approximately 400 civilian and military employees are used to train a staff of roughly five general officers and support staff of about 700. A training session will typically take about two months. It begins with tier 1: two weeks of ACADEMIC TRAINING. For this they have 52 different courses on such things as Joint Task Force Operations, Peace Keeping, Rules of Engagement, etc, at the higher levels for flag rank. This is followed by tier 2: several weeks of CRISIS ACTION PLANNING which is partly scenario and mission planning. This is where they decide how the different levels such as the National Command Authority, the CINCs, and the JTF, will coordinate and exchange authorizations for actions during the "crisis." Finally they get to the third tier which is the exercise which runs all the way from the "road to conflict" to the end of the exercise.

A mechanism that would compress exercise scenario design into a matter of hours would not reduce the remainder of the time which is spent in preparing the training audience. Mission rehearsal training, however, could be a different case.

Walizer develops the Master Exercise Control Plan and Master Scenario Events List. Once the simulation is underway he is the Master Scenario Manager. He says they include "everything" in their consideration such as simulated CNN broadcasts from the war zone, newspaper articles about sexual harassment investigations (which may compete with battle management crises for the attention of commanders), chemical accidents and exposures, rumors that crashed airliners were actually shot down, etc. He uses the Internet and the WEB to spread rumors amongst the trainees. He also said that the trainees made much more use of Email than traditional military messaging during the last several exercises.

In addition to planning the simulation scenarios, they also have huge logistical problems handling the hundreds of trainees and staff. Development of a JTF exercise involves much more than just the simulation component. They have to deal with logistical concerns such as classroom education for the training and support audiences and the requirements to house provide food for the huge support staffs involved in the training. Walizer thinks there are numerous applications for "AI-like" technology in their facility. Scenario design could be helped here. He would like to use automated tools to look at certain UJTLs and correlate them with the various themes of the different exercise.

CDR Scott Grundmeier spoke to the group about the process they are going through to document all of the activities they go through in planning and setting up for an exercise. He said when they set up JTASC they had to jump right into training without planning it. They are now interviewing all of the staff who support their "UNIFIED ENDEAVOR" exercises to derive process charts and lists of data input and output from each process. They are also trying to document the level of effort and duration of each. From their interviews they have found that "there is a lot of information being produced for people who don't want it using information they think they got from people who didn't do it."

They are setting up a WEB page for each activity and tying these to the inputs and products which are in Word, Excel, Powerpoint, HTML, etc. Once they finish this they should have pretty good and useful specifications which would allow them to define all the transactions that would be necessary between automated implementations of each. Those transactions and the behaviors that generate them could be encoded in a behavioral specification language and used to facilitate communication between the planning parties.

Grundmeier mentioned his desire to use a facility called "BACK WEB" to disseminate changes asynchronously. This facility will supposedly will allow a data source to transmit something and specify a later instant in time when all recipients will simultaneously "discover" it. He said that another tool, called "POINTCAST", was not too useful in his situation. It would be worth investigation to learn more about new tools like this that are available for interaction on the WEB.

Most of the slides that Grundmeier and Walizer used should be available on the limited access JTASC WEB pages. JTASC provided Julia Loughran with a CDROM containing most of this and it may be possible to provide the other members of the group with access to those pages.

The meeting was concluded at approximately 1300. The author had discussions at lunch afterward with Loughran and Willis who both agreed to meet with Dr. R. Hofer next week during his trip to Washington.

This was a familiarization trip. Larry Willis told the author that the ASTT effort is concerned with the scenario planning and not the logistics planning that JTASC described. He expects to set up a visit in the near future by the same group to NSC at Ft. Leavenworth. Visits to other simulation facilities will follow and the group's discussions will ultimately narrow down the focus to DARPA's goals. Willis said he expects IST to work quite closely with Richard James who is an independent consultant but currently officed at Nations in the CFRP.

8.4 Attachment D: J. Loughran Follow Up Visit to JTASC

DARPA ASTT Rapid Scenario Generation Follow-up Visit to ACOM/JTASC 6/10 - 6/12/97

1. Purpose of Visit

Dick James and Julia Loughran of the Advanced Simulation Technology Thrust (ASTT) program's Rapid Scenario Generation Team returned to USACOM's Joint Training, Analysis and Simulation Center (JTASC) to follow-up on their previous visit in early April 1997. The purpose of this visit was to gather additional information from the JTASC Logicon team regarding the Exercise Development Process Decomposition Flowchart and to potentially augment their effort by mining information from the Joint Digital Library. In addition to meeting with Logicon representatives, they also had meetings with LTC Bob Strini, Chief STOW Branch, Analysis And Simulation Division, and representatives from the TRW subcontractor group (ProSoft and Veda) responsible for building the UE exercise Master Scenario Events List (MSEL). An overview of the agenda and the results of this visit follow.

VISIT OVERVIEW

Dick James Arrival	6/10
Mtg.s/Discussion	6/10
Digital Library Doc. Review	6/10
Julia Loughran Arrival	6/11
Mtg.s/Discussion	6/11
Mtg.s/Discussion	6/10-12
Mtg.s/Discussion	6/12
Mtg.s/Discussion	6/12

Met by Victor Felarca Greg Knapp

LTC Bob Strini Bill Sheehan, Fred Snowden MSEL Representatives Fred Snowden, Ed Devlon

2. Digital Library

Dick James arrived at JTASC on Tuesday, June 10. He was met by Victor Felarca, a MITRE employee and member of the Joint Digital Library development team. Dick learned that the Digital Library effort is still in process. JTASC has an existing Oracle database that they plan to use for the digital library. SAIC is the contractor working on a specification of the functionality and architecture for the library. Currently, there is over 500 gigabytes of data that have been collected from the UE97-1 exercise. This data is from the actual execution of the exercise and contains data such as the ALSP logger tapes, over 12,000 e-mail messages sent during the exercise, descriptions of AAR videotapes, etc. The data is not easily searchable and also could not give us insight into the pre-execution process timeline, so Dick did not spend a great deal of

time mining for information. Greg Knapp provided Dick with a draft specification document for the Joint Library written by SAIC. Dick reviewed this document and provided comments back to Greg. We were not allowed to keep the hard copy of this document but were promised a copy in the near future by Greg. We have now learned that the document is on the JTASC Web Site and we can continue our review of it. We also received a draft plan for data collection for the next scheduled training exercise at JTASC, Coherent Defense.

The JTASC Digital Library plan is very ambitious and will require several technology advancements/breakthroughs to fulfill all of JTASC's specified needs and desires. The plan is based on their existing hardware/software systems plus the additional hardware they expect to receive as part of the STOW project. The plan appears to be high risk and not fully leveraging the latest research in digital library/information retrieval technology.

3. Meetings with Logicon

In addition, Dick spent time on Tuesday and Wednesday (June 10-11) reviewing the changes that the Logicon team had made to the Exercise Development Process Flowchart. Since our visit in April, they have migrated the process data into Scitor's Project Scheduler software. Bill Sheehan and Fred Snowden, the Logicon POCs for this effort, explained that Cdr. Grundmeier had left in late May and since that time process on the effort had been slow. They fear that because the training calendar is so packed for the next 3-4 months that they will be unable to collect more detailed data that is needed. The information is collected by interviews with the JTASC groups that actually do the various parts of an exercise development. Currently their process representation shows a great deal of slack time, there are inconsistencies in the time estimates provided and they need a higher degree of specificity to continue this work.

Dick analyzed the process diagrams and Gantt charts that they have wrapped around the walls in Cdr. Grundmeier's old office and looked for dependencies in the process flow for just scenario development. There are many tasks that are being documented that do not relate directly to the scenario development process. These include tasks related to billeting, food service, etc. Prior to departure, Julia and Dick received copies of the Project Scheduler data and were told how to get a trial version of the Scitor software from the World Wide Web. If necessary, continued analysis of their process data can be conducted in our offices.

One of the items that seemed to be on the critical path throughout the exercise management process was the development of the Master Scenario Events List (MSEL). Victor arranged a meeting with the MSEL development team which occurred on Thursday, June 12.

4. Meeting with LTC Bob Strini, Chief STOW Branch, Analysis and Simulation Division

Julia and Dick met with LTC Strini to update him on the Rapid Scenario Generation Team's effort for the ASTT program and explain to him the relationship to the ASTT COAA program. LTC Strini is very interested in any information we might gather on available planning tools. He feels there is a tool deficiency in the process of taking mission plans to the scenario specification.

LTC Strini would like to identify all of the tools that are available and look at if they are the right fidelity for the right purpose. Tools that he mentioned include: tools for the Advanced Joint Planning ACTD, CTAPS (Air Force), EOPS-E (Army), AF Mission Support System, and JCMIS (a GCCS maritime information tool). LTC Strini mentioned that with the STOW tools, he expects that in the future it will "only take 2 days to go from scenario to action." He believes ASTT can help in providing the technology needed to get to the scenario faster. LTC Strini is interested in staying in touch with ASTT's Rapid Scenario Generation effort. He mentioned that this effort is particularly important if ACOM decides that conducting crises rehearsals is a good idea. The time period to create a valid scenario needs to be reduced to achieve this goal.

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5. Meeting with MSEL-iers

in the total

Julia and Dick met with 5-6 TRW subcontractor representatives responsible for generating the Master Scenario Events List (MSEL). The MSEL is the script (scenario) for the training event. TRW is the prime contractor for the JTASC Support but their sub-contractors perform the MSEL activity. After Julia provided an overview on the ASTT Rapid Scenario Generation effort, the MSEL-iers (as they call themselves) described their work in supporting UE training exercises.

The first step is receiving the training objectives, theater, and training audience for the exercise. From this info, a believable storyline is written that defines how the specified forces found themselves in this conflict. They call this document the "Road to Conflict" and it is a brief document that describes the setting for the training event. After this is approved, the MSEL is developed. MSEL-iers decide on key events, which are a series of information feeds for the training audience, that will achieve the various training objectives. There are no automated tools for this task, however they do use the Internet and its crude search tools to look for related, current events to keep the scenario as realistic as possible. They also search the MIDSIDB to identify the enemy's characteristics. They occasionally use variations on previous training events they have developed for other exercises. These are not stored electronically because they find it faster to find the MSEL and specific event they are looking for in a paper file and go to another paper file that will contain a floppy disk with an electronic version of the description of the event they want to "reuse".

The MSEL is documented as an Excel spreadsheet that details the events in the scenario. The MSEL tells in chronological order what the event is, what the intended action is, and the mode of injection into the training exercise (i.e., how to provide the event's information to the training audience). Mode of injection might be radio, manual, or the outcome of a specific Joint Training Confederation (JTC) model or models. During Phase 2 of the training, the training audience writes their Operational Order in response to the Road to Conflict scenario. This OPORD is returned to the MSEL-iers and the MSEL is refined to match the BLUFOR mission plan. During this period, the database builds are completed for all of the JTC systems to be used to support the training exercise and a MSEL wargame is held with all of the principals which include the OPFOR commander and the exercise designer. The MSEL wargame is just a talk-through of the MSEL so everyone knows their roles and any problem areas are identified. All of this activity takes two to three months after the completion of Phase 2. Then, the participants return and Phase 3, the training exercise execution, begins. Two days prior to the start of Phase 3, an

Exercise Synchronization drill is conducted and all critical events are tested (e.g., communications, models, etc.).

The amount of time between Phase 2 and Phase 3 varies depending on the amount of rework needed for the MSEL and the amount of time needed to construct the databases for the JTC models that will be used in the exercise. We were given a document, *JTASC Modeling and Simulation Handbook, Version 2.0*, dated April 1997, that mentions that some of the databases take 2 to 3 months to prepare. This appears to be an area where advanced technology tools can be applied to have a significant impact on the overall training operation. There is bound to be some "momentum" lost by the training audience when they have to wait for 2 to 3 months to execute their OPORD. In addition, tools need to be considered for assisting the development of the MSEL itself.

MSEL-ier Michael Jallo from Prosoft told us that the JCS J5 is developing a tool called JEMP (Joint Exercise Management Program). It is not yet on-line, but when developed it will allow military modelers to create and store scenario events and then download them into JEMP. Conversely, if they are looking for scenario events, they can search JEMP and find events that match their query, e.g., mining event.

6. Meeting with Fred Snowden and Ed Devlon

Julia and Dick met with Fred Snowden (Logicon) and Ed Devlon (JTASC) to discuss the process decomposition timeline. They estimate that the process from start to finish equals approximately nine months. The process timeline they have developed shows a 14 month period, but they are currently trying to identify the slack time between process steps. Julia and Dick received a copy of the latest Project Scheduler data which they will use to derive the dependencies between the different tasks involved in scenario development.

7. Summary/Next Steps

Dick and Julia plan to download the Project Scheduler software and review the process data provided by Logicon. They would also like to return to JTASC to meet with some of the M&S representatives. One suggestion is that they might return to witness the MSEL wargame and the Exercise Synchronization for an upcoming exercise. This visit proved to be very educational in terms of how a UE exercise is developed and executed. Another visit with a closer look at actual exercise activities would also be valuable.

8.5 Attachment E: Notes on J. Loughran Follow Up Visit to JTASC

- 1. Met with Julia to compare notes and obtain an update of recent activities.
- 2. In addition to the JTASC CD ROM, the JTASC web site contains additional information describing the exercise planning and execution process. Access to the web site is controlled by Gregg Knapp. Check JTASC home page at www.jtasc.acom.mil under Joint Technical Library for information on how to contact Gregg. CDR Grundmeir left in May. His replacement has not placed the same interest in the work that Bill Shehan and Fred Snowdon of Logicon are doing to lay out the end to end process.
- 3. Dick James and Julia visited JTASC last week and found that the JTASC library currently contains primarily Unified Endeavor (UE-1) Data. This data (over 500 giga bytes) is of many types and lacks structure. Little to no data is included for the UE-1 pre-exercise planning phases; all the data came from the exercise execution phase. Julia plans to publish a trip report on the Scenario Generation reflector by next week which will describe what was learned from the visit.
- 4. Work is underway to build a process chart for everything needed to put on a UE exercise. Each element in the process is tied to a product. Identification and separation of tasks occurring within the process elements has not been easy. Julia and Dick are trying to strip away the "administrative and logistics" elements which do not bear directly on the development and execution of the exercise.
- 5. In the overall process, the Master Scenario Events List (MSEL) was identified as a most important (critical) element of the process. Julia has put together a chart depicting how the MSEL activities begin and the role the MSEL plays in guiding the build and control of the scenario and exercise plan. Currently, a cell of approximately five subject matter experts (retired military) build and control the MSEL. They draw heavily on their own experience and knowledge in constructing the "Road to Conflict" (pre exercise situational setting) in combination with Training Objectives to form the MSEL. From their viewpoint, the MSEL serves as the "script" for identifying event injections during the exercise. The simulation serves as one mode of event injection. Other events may be injected by role players or other mechanisms present in the exercise context.
- 6. The MSEL used at JTASC has fields for each event which describe "Objective", Proposed Action", and "Insertion Point". I said that IST was working on converting the MSEL tool developed by J-7 from a DOS to a Windows environment and would send her a copy of the field structure used in the tool to determine if they matched what is used at JTASC.
- 7. JTASC currently does about four exercises per year. They would like to be able to run at least twelve. They are attempting to do three exercises in the next few months which will be an indicator of where some of the more time consuming activities occur. Current practice

conducts a "MSEL Wargame" approximately three weeks before STARTEX where they walk through the MSEL to check for consistency and completeness. About one week before the exercise, they conduct an "Exercise Synchronization Drill" which is a detailed walk through of all events and parts for role players and controllers. Final refinements to the MSEL are made at this time.

- 8. I briefly walked through what the IST team had been doing. I left her a copy of the description of the Exercise Scenario activities which Ed Ramirez prepared along with the five page flow chart. Also, left copies of the presentation package used for Larry Willis visit on May 27 and the Scenario Generation Process Description presentation given during the follow up visit on June 10 with Del Lunceford. Julia was curious as to what "ABASGE" referred to on the cover page of the May 27 presentation. (Note: ABASGE translates to "Agent Based Automated Scenario Generation Environment".)
- 9. We agreed to keep in touch. I said we hoped to make a visit to the National Simulation Center in July and invited her to join us if her schedule allows. Also, it may be worthwhile to arrange a visit with Dick James in Orlando to learn his assessment and approach for how to describe the process.

Ron Hofer

8.6 Attachment F: IST Trip Report NSC Visit

Trip Report

Institute for Simulation and Training (IST) Automated Scenario Generation Environment (ASGE) Team Visit National Simulation Center (NSC) Fort Leavenworth, KS

16-18 July, 1997

Purpose: To solicit viewpoints and gain understanding from the NSC about large simulation exercise planning and preparation with focus on scenario generation. To provide NSC an update on current ASTT ASGE status and obtain comments and feedback on the approach.

ASGE Team: Ron Hofer, Scott Smith, Robert Franceschini, and Ed Ramirez

Principal Persons Contacted:

Dr. Robert La Rocque, Director, National Simulation Center (NSC)
Mr. Ken Bernard, Deputy Director, NSC
Ms. Annette Ratzenberger, NSC WARSIM Program Director
Mr. Herb Westmorland, NSC WARSIM Deputy Program Director
Mr. James Fox, Director, Fort Leavenworth TRADOC Analysis Command (TRAC)
Mr. Kent Pickett, Director, TRAC Modeling and Research Directorate
Major Tim Metivier, NSC ASGE Point of Contact
Mr. James Pittman, MITRE Corporation

Main themes throughout the visit:

Rapid, automated scenario generation is an important and critically needed capability. Scenario generation is complex; more art than science with a limited population of subject matter experts.

An integrated scenario generation environment connecting people and automated tools would be a significant accomplishment.

Strong support and endorsement of the IST/ASTT ASGE project.

Much attention and interest in modeling and representing "Information Operations" in both training and analytic simulations.

NSC/TRAC focus on developing automated Course of Action Analysis (COAA) tools. Willingness to provide reference information and critical feedback related to ASGE.

Dr. La Rocque main points:

(Not necessarily in order discussed)

Scenario Generation

Scenario Generation is among the most difficult requirements to automate.

Scenario backbone built on the course of action stream. C2 structure (sequencing of command and staff activities) and pivotal events provide primary framework.

Don't concentrate on micro order of detail. 60% solution good enough. Force the commander to make assessments to consider "what happens if...."

Will not accept scripting. Need to provide flexibility in the scenario context while maintaining "unity of command" and "consistency" as the exercise progresses.

Scenario needs to include control measures which provide "branch and sequel" options for maintaining the scenario flow during the exercise. Include provisions to issue fragmentary orders (FRAGOs) which instruct exercise controllers/software code to change during execution to keep the exercise flowing to meet the training objectives. (In effect, the scenario description should be constructed in "frames" with planned transitions from one frame to the next during exercise execution.)

Scenario development and definition includes three parts. First, establish (define) the gaming area (Synthetic Natural Environment). This capability must be provided quickly and for geospecific regions. Second, describe doctrinally correct order of battle and movement of forces to conduct the operational mission. Third, tailor the operational description to meet training objectives. Scenario description should be based on reality and stylized to meet exercise objectives.

The two top priorities in Scenario Generation (and COAA) are to (1) capture the synthetic environment (the phenomena) and (2) to make sure the behavior trains the METL tasks.

Course of Action Analysis

There is a need for a common Course Of Action (COA) capability that should provide "what if Scenarios" for commanders.

COAA capabilities are resident in C4I system tools. Current capabilities are very basic, and are not even a good job aid. Mission rehearsal requires simulations and simulators.

WARSIM is targeting on COAA capability at the operational level. They would like company level but would settle for battalion level resolution and intend to establish an initial capability with a low level of reasoning, growing and evolving capability to increasingly higher levels of intelligence.

You cannot model what you don't understand. EAGLE is a good example of what the model has to understand about Command and Control. The EAGLE pre-processor is particularly suited for scenario development. EAGLE's Adversarial Planner provides a general COA development capability.

Use of a synchronization matrix as described in the MARNE Division manuals prepared by General Shoffner and CGSC "Battle Book" student text is an important and useful construct for describing COAs.

NSC is doing collaborative work with the UK in developing a capability to represent the cognitive and C2 components of the COA stream. Hard stuff to do! Results also would be of interest for scenario development capability.

Draper Labs, Joe Henry, is doing some particularly interesting work in this area. Should request copies of technical reports through Major Metivier.

After Action Reviews (AAR)

AAR needs structure, not a global post processor approach. There is a big difference between an AAR and post-processing of recorded data.

It is necessary to be able to tailor data collection for the AAR. An Object Oriented Relational Database that captures the state variables of the simulation coupled with capability to compose tailored models from the database may lead to the next big jump in the evolution of AAR methodology.

Tapestry is doing some interesting work in this area. They have introduced some unique concepts and processes used in software development. Their work relates to both AAR and scenario development. Ken Bernard is point of contact for more detailed information.

Annette Ratzenberger's main points:

(Not necessarily in order discussed)

Scenario development should include consideration of several factors. A list of these factors as presented in the discussion follows this report as an attachment.

She said that some parts of the scenario development will always be done by humans working with the aid of automated tools. Examples included the Eagle Adversarial Planner and the decomposition and selection of tasks, conditions and standards.

It is important to have the capability to do the things people do now on a map board. This includes providing an initial high level (low-resolution) schematic layout of the scenario COA stream. Initially highly abstract symbolic icons could be used to represent force location on a "blank" map. For example, an oval could show the center of mass and area occupied by a force component. Then refine the layout in parts. Draw "boxes" around areas of interest and develop higher levels of detail for these areas as needed.

We need capabilities to "Simulate the Simulation" as a sanity check after the initial laydown using rules of thumb. The capability is needed for two reasons:

1. Technical. To get an idea of the resources needed such as the numbers of CPUs or T1lines/person or the estimated planning time to get a general idea of the size of the exercise.

2. Training. To allow us to see if the scenario is reasonably going to hit the training objectives. Will it meet the standard? Likewise, there should be a similar capability to "Simulate the Collection Plan".

Training objectives should drive what you collect out of an exercise. They currently include a collection plan for Observer/Controllers in Training Support Packages (TSPs). We need to extend concept to have ways to construct a "made to order" data file which supports a more comprehensive data collection plan. Information about TSPs is available on the CALL (Center for Army Lessons Learned) home page. Just about everything in the TSP needs automation. There are a number of questions regarding how much "composability" you give the Exercise Director. For example, where do you draw the line on what latitude or limits the Exercise Director has in selecting the combination of forces, maneuver, and other elements of the simulation context? WARSIM requires an element of uncertainty to teach the training audience to ask the right questions. The simulation then provides the consequences for not acting properly.

WARSIM and JSIMS have the same requirement for scenario generation tools.

A means to form an integrated environment linking the people and various automated tools used in scenario development and exercise preparation would be a significant accomplishment. Some metrics:

WARSIM must support up to 380,000 training tasks. Ratzenberger estimates 100,000 active objects.

When orders for full mission profile are included we could have up to 2.5 mil. objects.

Currently an SME working with the EAGLE preplanner can generate orders for a battalion or brigade.

An army division operating over a period of two weeks may require a gaming area that covers a continent size geographic region.

The simulation must be able to play a multisided conflict.

Comments on the overall process for generating scenarios.

There will always be a need for human oversight and review no matter how much we automate. Generating Plans/Overlays/Orders is one of the hardest areas as the level of detail increases. The initial concept of the exercise probably cannot be automated. The key is to use collaborative tools (distance collaboration) to put the initial plan together.

TSPs are mission specific. Some are on the WEB. They exist for Corps or Division level training and are being written for Division Level AWE (Advanced Warfighter Experiments) by CUBIC at Fort Leavenworth. Look at the overall structure of a TSP and see how it is used. Do not pay attention to the details of the instantiation..

A survey was done of all the BTCP people to identify what work currently being done by the BCTP support staff could be automated. This was done for front end planning as well as for the exercise.

VEDA's FDB web site, along with Ltc. Stone and Frank Rhinesmith have much useful information on describing battlefield functionality.

The Training Requirements Analysis Process (TRAP) is being built by validated sources (SMEs). Scenario Generation should consider:

"What tasks stimulate training tasks to be accomplished?" and

"What objects are needed to stimulate the tasks"

The "operational army" does not want to believe it can be assisted much by automation in planning, but that even if it could, it might say it is unwise to use it because a staff learns so much in actually doing the planning. It is considered a valuable opportunity to learn "how to think".

Mr. James Pittman main points:

(Not necessarily in order discussed)

Eagle: Eagle started as a tool to build scenarios. It cannot do that in 4 hours but it does include good tools to help the process. Events must be generated to stimulate the training audience. Knowing the general missions, the operator can choose guideline missions and assign objectives to units or he can let the model generate the objectives. Eagle will generate a battle plan to let the division accomplish the stated mission. The operator can examine this, then go back and modify conditions. Eagle will also help build branches and sequels that will depend on runtime conditions. Even with all the help Eagle provides it still takes 2+ weeks for a good operator to build a good division level scenario. The result is a database that can output 5-paragraph orders in BML "Battle Management Language." Eagle does not generate overlays. The Eagle OPFOR uses fairly standard mission typical laydowns.

<u>Joint Countermine Operational Simulation (JCOS)</u>: Joe Manzo, is MITRE, JCOS Project Manager. Automated Exercise Manager and Control System and Netscape Browser AAR Systems provide capabilities, which could be used in scenario development. It allows JTF commanders to extract tasks from UJTL as the baseline for designing the exercise and data collection plans. This is different from the JEMPS Mission Requirements Module, but similar.

<u>Force Level Control Module</u>: Developed by Lockheed Martin for CECOM. It looks at a G3's tasks and uses automated pieces to help in terrain mission analysis and in building force laydown. Mr. Pittman did not know how well it worked.

Synchronization matrix initiatives: The synchronization matrix is good for planning and Scenario Generation if you can build an automated tool that can do task analysis and identify the necessary key events and put them in the matrix. A Mystech tool provides structure for building synchronization matrices but has incomplete automation for building the matrix. The NSC and BCBL are working with Draper Lab tools for Automatically constructing Synchronization matrices linking to combat adjudication through key events which trigger branches and sequels.

<u>BP</u>: A Battlefield Planning and Visualization Tool at Fort Bragg. It uses automated tools to link real world C4I tools into the simulators. Network address books take a long time to build. This tool helps speed that up. It allows one to upload/download and save the current state of the C4I systems.

COMPASS: An Integrated Environment like Tom Clancy's "Op-Center".

<u>CVW "The Collaborative Workspace"</u>: Virtual Workspace System POC is Esther Rhoade, at MITRE's Bedford Office. Mr. Pittman provided Ed Ramirez with hard copy of an overview of this program.

Mr. James Fox main points:

The J-8 sponsored CAPS (Contingency analysis and Planning System) which builds force structure for an OOTW operation may have some features useful for scenario development.

Mr. Kent Pickett main points:

(not necessarily in order discussed)

The big problem with scenario generation is generating the underlying unit templates (unit geometry) so the sub-units have reasonable positions.

Work being done as a part of the DARPA Dynamic Multi Information fusion (DMIF) project may be useful for automated scenario development. DMIF is constructed to operate on USMTF message formats. Messages have both fixed format sections and free text sections. DMIF is doing well with the fixed format parts of the messages but is having difficulty with the free text parts.

Agile models, aggregate unit models, and emergent behavior approach to developing models may all have something to consider for automated scenario development.

IST obtained a number of documents from the NSC and TRAC during and after the trip. These are listed in a bibliography, which is included as attachment 2.

Factors to Consider in Scenario Development

NSC Visit 17 July 1997

ID the training audience - the actual people who will be involved.

State the overall training objectives, then decompose these into tasks, conditions, and standards. Exercise planning requires at least a machine that can present logical, related subsets of these to a planner who can make decisions about which ones to include. Much time is currently spent selecting tasks related to objectives; an automated utility would be very useful.

ID the forces to be portrayed, i.e. Brigade, Corps, Joint?

ID the OPFOR level to be portrayed. Have the capability to provide a stylized OPFOR which may use organization structures from one country, doctrine from another country and equipment from a third country. CAC Threats Directorate has UNCLASS manuals that state how to portray the threat. For more information contact Penny Mellies at (913) 684-7925. Melliesp@leav-emh1.army.mil, Threats Support Division, Fort Leavenworth, KS 66027 and Janet Marrow at NGIC.

Identify the geographic region. Mrs. Ratzenberger said that rather than a 95% solution in two years she needs a 40% solution tomorrow with tools to modify it. For her purpose it would be OK to work on statistical terrain. She would like to use fractal geometry to generate something close to 10 meter terrain from 100 meter data

Refine the arrangement once the initial Force laydown is complete. Start with divisions and work back to battalion level.

Do COAs at all levels. Tools are typically too broad here (1/world). Initial COAs are tools for the exercise director and his staff to use before the exercise to see if their initial conditions (at STARTEX, including initial orders) will lead to a simulation that will satisfy the training objectives.

Use simulation to insure that the initial orders and laydown will tend to lead to a situation where training objectives can be accomplished. There should be less emphasis on the MSELs list. There is probably even more need for detail for the OPFOR than for the BLUFOR because the training audience will probably plan and adjust their situation before the exercise.

Define phases/frames to help determine where in the course of the exercise different training objectives will be met.

Do the communications model laydown. All communications must go through the simulation, especially for fully automated units and the OPFOR. She says there is quite often a lot of

confusion about what is simulated communications and what is the simulation infrastructure communications.

Develop supply and logistics plans.

Develop a Simulation Data Collection Plan. Training objectives should drive some of the things that will be abstracted. This can be automated!

Develop a plan for Observers/Controllers. This is a plan for what data people will collect during the exercise. Training Support Packages on the Army Digitization web page provide good examples of what should be included in the plan.

Organize the data files. It all starts with MTOEs. Tools are needed to pull appropriate data from appropriate repositories.

Consider other forces. Neutrals, participants in multisided conflict, civilians, etc. Here Spectrum could be a useful tool to include political and sociological factors. CBS accounts for some neutrals now. Spectrum and CBS can both deal with POWs and civilians. WARSIM allows an unlimited number of factions.

Determine who will have real, live C4I systems. Before the exercise is designed, so that communications equipment and other interfaces will be present where the people will be located.

Some other soft factors are also important. For example, setting thresholds. What is the commander's SOP for reporting things like "At Objective"? ...when completely stopped and sitting on top of the exact X-Y location, or just near enough to see it?

Other difficult Problems include: Doctrinal Issues, SOP's, and Commander's Intent.

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3. Army Research Institute (ARI) field office Mrs. Alice Smith: Post Directory listing activities, names and phone numbers.

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7. Dennis Chrisman at the SPECTRUM office will mail Ed:
a copy of their TSP's
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Chap 1 of the Regional Analysis Guide which commanders use for SPECTRUM exercises.

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