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INSTITUTE FOR SIMULATION AND TRAINING

October 17, 1989

Technical Issues Related to Mission Rehearsal

An Industry Perspective

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AN INDUSTRY PERSPECTIVE**

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I. Introduction

During September, 1989, the Institute for Simulation and Training at the University of Central Florida investigated technical issues related to Mission Rehearsal. This investigation was performed to support a tutorial on Mission Rehearsal to be presented at the Interservice/Industry Training Systems Conference to be held in Dallas, Texas in November, 1989. The method of accumulating information on the technical issues related to Mission Rehearsal was to conduct interviews of several companies and universities who have had an active interest in the Common Training Device Data Base Program, known as Project 2851, to attend a meeting on September 27-28, 1989 dealing with Mission Rehearsal to gather additional information, to discuss Mission Rehearsal issues with several organizations attending the September 27-28 meeting, and to use expertise within the Institute for Simulation and Training to augment and confirm data gained from other sources. The method of conducting interviews was unstructured. Individuals were asked to provide non-proprietary information on current issues pertinent to Mission Rehearsal. The discussions were oriented to technical issues. Most discussions centered around the Special Operations Forces Aircrew Training Systems (SOF ATS) program. This program represents a current initiative by the Air Force Simulator Systems Project Office to develop a family SOF training devices. This program represents a consolidated effort on the part of the Air Force to meet a critical need to practice potential missions in realistic environments prior to mission execution. Individual contributors were assured of anonymity, but their inputs were crucial in preparing this report.

Many issues were raised in the various discussions and interviews conducted by IST. It appears that the majority of individual issues can be confined to five broad categories. These issues in decreasing order of importance are; 1) articulation of requirements; 2) data base issues; 3) the relationship between mission rehearsal, mission planning, and mission execution; 4) threat simulation methods; and 5) Command, Control, Communication, and Intelligence (C³I) issues. Each of these areas will be addressed and issues summarized in the following paragraphs.

II. Articulation of Requirements

Requirements articulation and requirements verification in a SOF environment is different than a conventional training device. Conventional devices have relatively clear statements of requirements. These requirements can, for the most part, be verified against a known aircraft configuration, using crews experienced in the training and operation of the weapon systems platform. These devices often have the mission to provide initial or sustainment training to a specific population. Requirements in the SOF environment are different. Missions will be varied with respect to location, participants involved, etc. In addition, validation of a Mission Rehearsal Training Device's ability to meet its training requirements cannot be validated using conventional methods. This situation, where a standard definition of mission rehearsal has not been articulated, changes the relationship between the government and the contractor and has an accompanying impact on the system design. Modularity becomes a critical issue. Modular design is necessary for flexibility. Modular designs must be provided at all levels. These include such traditional areas as aircraft and weapons systems simulation, operational flight program updates, and equipment updates. New, non-traditional areas, must also be considered and provided. These include, networking with other devices to achieve team training and rehearsal goals, potential interfaces with operational systems, such as on-board mission planning systems, fielding in remote areas, performance monitoring requirements for individuals and crews, etc. These requirements, while achievable if articulated correctly, become difficult when crew requirements are varied or unknown. Just as Mission Rehearsal requires as one Air Force Officer said, "Crews always on the edge and ready to go anywhere at anytime", so now is a training device necessary to support these broad and far reaching requirements statements.

The contractor/government relationship will also be different, by necessity. Some contractors feel that because of the lack of specificity, traditional methods of contracting simulators will not work. Innovative, but undefined methods of contracting will need to be developed to allow useful Mission Rehearsal products to be developed. Traditional fixed price contract vehicles will not be sufficient to allow the government to reach their goals because of undefined requirements. Products similar to testbeds will need to be developed to allow different mission rehearsal concepts to be developed and evaluated. There is a perception by some in industry that the government is generating training requirements prior to demonstration of concepts.

Utilization of standards for interfacing will be a critical factor in the success of any Mission Rehearsal device. A tier of interfaces will need to be developed to allow replacement of hardware and/or software as requirements for different mission rehearsal scenarios change. Clear interfaces both above and below the Modular Simulator Program level will need to be provided to allow non-prime contractors the opportunity to provide modifications to software and hardware to meet emerging requirements. This will require a well organized effort on the part of the procuring agency to ensure an adequate Systems Engineering effort is performed by either the procuring agency or the contractors.

III. Data Base Issues

This area is probably the most defined with respect to the types of efforts and products needed to support Mission Rehearsal requirements. Only the most significant topics will be addressed in this paper. The following topics within the data base area appear most important: correlation, speed of creation, ability to change, fidelity, and methods to address flaws, omissions, inconsistencies, etc. Each of the preceding topics deals with problems with either difficult, unknown, or costly solutions. The issues related to data base development are currently receiving much attention in the industrial and academic sectors due to high priorities from government sponsoring agencies. Specific issues related to each topical area will be separately addressed.

Correlation of data bases between various spectral regions continues to be a problem. Because of different rendering algorithms and capacities between visual simulation systems, radar simulation systems, and systems which simulate other regions in the electromagnetic spectrum, correlation has to be either compromised or fidelity must suffer. Polygonal representation of terrain has traditionally limited correlation in radar imagery which is able to directly render images from elevation data and avoid the polygonization process. Infra-red imagery and Synthetic Aperture Radar suffer from similar problems with respect to correlation with other spectral regions without accompanying loss of fidelity. Correlation issues were also raised with respect to generation of maps and the ability to coordinate data bases between air and ground forces.

Speed of data base creation and ability to change data bases rapidly is another technical challenge with current technology. Mission Rehearsal requirements dictate something on the order of 48 to 72 hour turnaround of data bases from receipt of information. In addition, updated information is often received just prior to mission execution. It is desirable to rehearse the mission with

the new source imagery. This requirement cannot currently be demonstrated. In addition, the factors which would alleviate this problem are not known in a comprehensive manner. Issues affecting this area are related to both hardware, software conversion techniques, software management techniques, artificial intelligence, and data base verification to terrain methods. Several respondents to interviews questioned the wisdom of the Project 2851 and RRDB fielding plan. The plan calls for central location of facilities. It appears that rapid data base generation and modification would be enhanced by locating facilities in the field so that up-to-date intelligence information and the effect of different times of day, weather conditions, etc. could be practiced by the crews. Centralized facilities could be used in a Configuration Management role. The DIGITS program fielding plan with the CINC's was preferred by respondents.

Fidelity remains a problem with respect to connecting with Mission Planning systems, use of Nap of Earth or Terrain Following/Terrain Avoidance techniques, and threat avoidance methods. Air and ground crews require accurate and sufficiently detailed terrain representation in order to practice combined operations, perform route planning, practice threat avoidance, and to utilize many navigational, communication, and data transfer systems.

Methods must be developed to deal with flaws, inconsistencies and voids in data. Currently, data bases require a large amount of human intervention in order to correct inconsistencies or fill data voids (e.g., due to cloud cover). In addition, systems must be developed which can infer information from information available in other spectral regions, times of day, or where no data exists. For example, derivation of night scenes from day scenes, FLIR scenes from radar imagery, and typical door locations on buildings must be presented in manners both apparent and not apparent to trainees. Scene content which is derived from inferred information must be used judiciously.

Many of the data base issues are known at this point. Comprehensive methods to deal with individual issues are being developed. Methods to address broad data base issues are not being dealt with in a consistent manner to industry. Industry seems to be asking for a comprehensive program of research to address the voids noted above.

IV. Mission Rehearsal, Planning, and Execution Issues

The relationship between mission rehearsal systems, mission planning systems, and the actual execution of a mission requires definition to ensure the pieces fit together in a proper manner. For example, Mission Planning Systems have a low emphasis on fidelity and a high emphasis on terrain and feature accuracy so that routes can be planned which minimize exposure. Mission Rehearsal Systems appear to have an opposite emphasis. Therefore, a logical question arises as to methods which allow one system to use the other. The utility of these relationships must be explored prior to implementation. In a similar way the relationship between Mission Rehearsal and Mission Execution needs clear definition. For example, it is not clear to what extent Mission Rehearsal systems should account for aircraft system failures or contingency situations which might arise in Mission Execution. Finally, critical tasks derived from either Mission Rehearsal or Mission Planning systems need to be executed on complementary systems to validated. However, because Mission Planning and Rehearsal systems are both in development, opportunities exist to take advantage of the development situation. Conflicting goals of Mission Rehearsal and Mission Planning systems must also be recognized.

V. Threat Simulation Issues

The situation imposed on Mission Rehearsal systems by simulation of the threat is similar to one of the first problems noted above with respect to Mission Rehearsal; namely those of characteristics and validation techniques. The problem of threat simulation is not unique to mission rehearsal. Threats are normally characterized using two methods; physical characteristics and tactical characteristics.

Universal threat characteristics are currently not available in a form agreeable to all services. While this situation is workable with respect to physical characteristics, no ready solution is currently available to address tactical characteristics. Physical characteristics can be addressed by developing a common data base of threat physical characteristics which are usable by all military services. A much harder problem exists with respect to threat tactical characteristics. Most companies feel that while threat physical characteristics can be created, tactical characteristics are much more difficult. The reason is due to the human operator cast into the loop of the threat model and individual experiences with a particular threat tactic. Modeling human processes is a problem which continues to be an active research area, but no concrete viable approaches to simulating human behavior were offered by industrial or academic entities. The human is what makes the difference in tactical decision making.

Validation of threat characteristics is another problem for industry, not only with respect to mission rehearsal, but with respect to threat simulation in general. As in the case of Mission Rehearsal systems as alluded to above, one needs to execute a mission to determine if the threat model was accurate. One simply cannot validate threat models in the same manner as the handling qualities of an aircraft.

The Universal Threat Simulation System (UTSS) was mentioned as a means to at least create a common threat. This concept was viewed as critical to the ultimate success of Mission Rehearsal devices. The critical area UTSS could address is a baseline system for interoperability and a system which would create a systematic approach to update threat data.

VI. Command, Control, Communications, and Intelligence Issues

Industry expressed several concerns with respect to C³I. The concerns dealt with varied, and in some instances unknown, communication requirements, interface to operational equipment and operational situations, and interoperability needs. On-going efforts to standardize communications systems between services was cited as an area which could have an impact on Mission Rehearsal systems. - The effect would be in the form of changing system requirements and unknown impact on technical approaches with respect to training systems. There was a perceived need to interface with operational systems and operational situations in order to validate mission planning concepts and to play "What if games" during the actual execution of a mission. The primary concern was a perceived requirement to interface with many and in some cases unknown C³I systems.

