MISSION TRAINING AND REHEARSAL EMPLOYING SIMULATION TO ITS FULL POTENTIAL

CW4 Robert Monette, U.S. Army
Fort Rucker, AL

Gary George and Samuel Knight
Link Flight Simulation Division of CAE-Link Corporation
Binghamton, NY

ABSTRACT

Potentially one of the most significant applications of today's simulator technology is the employment of advanced training systems to accomplish mission rehearsals. The initial challenge in this pursuit has been finding an acceptable definition for the term "mission rehearsal." Until recently, available literature on mission rehearsal provided a diverse and often inconsistent and confusing collection of definitions and terminology. However, in 1989 a paper was published which offered concise definitions of mission preparation, mission preview, combat mission training, and mission rehearsal. With these definitions, concepts relating to the performance of mission rehearsals can be considered. Furthermore, the interaction of the subfunctions of preview, preparation, and mission training and how they support the end result can be analyzed. Pursuing this analysis, however, quickly leads to the realization that it is counterproductive for the military to consider mission rehearsal as a stand-alone function. This assessment is further supported by studies of mission training and rehearsal concepts employed in the space program. Accordingly, this paper recommends an integrated mission training rehearsal program to effectively and efficiently prepare our aviation crews for today's complex military missions.

INTRODUCTION

Numerous historical events occurring in the last year have changed military emphases on a worldwide level. In the free world these events continue to affect military strategies and priorities, seemingly on a daily basis. However, while uncertainty surrounds the perception of a diminishing threat of world war, there is little question that there exists an inevitable threat of armed conflicts with radicals, revolutionaries, terrorists, and drug cartels. It can also be anticipated that the severity of these conflicts will continue to increase as these forces become more aggressive and lethal in their guerrilla tactics and more sophisticated in their weaponry.

Accordingly, it is evident that many of our future military combat activities will be in the form of special operations, such as hostage rescues, and on a larger scale, low-intensity conflicts (LIC) such as Operation Just Cause. However, the nonconventional nature of these types of conflict has dictated changes in the way our forces fight and in the way they need to train.

In a more conventional type of warfare, a force can cross from a friendly territory into an unfriendly territory and expect to engage an enemy under generally common rules of war which historically seek to protect innocent civilians. Today, however, our forces are required to engage an enemy practicing irregular warfare concepts which do not distinguish between combatant and non=combatant. The enemy in such conflicts consciously uses civilians to serve his means while relying on Western perceptions of non-combatant immunity.

Our forces are adapting to this moral and philosophical dilemma with increased emphasis on accurate and timely intelligence and communications, quick and covert responses, precision maneuvering, and extremely accurate weapons engagements. The workloads and stress factors imposed are a tremendous challenge to all the mission participants, especially the aviators.

Aviation operations will generally be conducted at night and may often be required in adverse weather. Rotary-wing and many types of fixed-wing vehicles must be flown at extremely low levels and at high speeds using night vision devices, forward-looking infrared (FLIR) (or a combination of both), and possibly terrain following/terrain avoidance radar. Passive electronic warfare equipment must be operated to aid in the detection and avoidance of threats. Planned engagements with threats must be quickly and precisely executed. Throughout the mission the crew must maintain the planned route using conventional or digital maps and charts in conjunction with on-board navigational equipment and must identify waypoints using their night vision devices and/or sensors. Navigation must be precise, even though the flight is through unfamiliar territory. Missions will often include multiple ground or aerial refuelings which must be precisely coordinated.

In addition to these workloads imposed by the aircraft systems and the environment, there will also often be stringent requirements for timing in each and every stage of the mission. These requirements apply not only to individual crew tasks but also to team and force interactions, many of which must be conducted in a silent communications mode. Some missions may be aborted when the timing of force movement becomes off-schedule by as little as a minute.

When considering the complexities of the aviator's mission workloads as well as requirements for timely and error-free performance, it is easy to understand that training is a significant and essential element of the mission. The success or failure of each and every mission will generally have its roots in the quality of the training that precedes the mission. The employment of emerging technologies to allow the use of advanced simulation devices for mission rehearsals promises to significantly enhance training effectiveness and dramatically improve mission readiness.

Training has traditionally consisted of gaining knowledge and expertise in the operation of the aircraft and its on-board systems and gaining knowledge through memorization of the mission plan and of the known characteristics of the threat environment.

Supplementing traditional training with detailed mission rehearsals will allow our forces to assess the training they've received and to evaluate performance of the mission plan in a realistic threat environment. Mission rehearsal in effect will allow training in the execution of the mission and will answer such questions as: Is the crew familiar with the mission plan, the route, and the threat? Can they maintain situational awareness? Can the crew and team coordinate and synchronize operations as scheduled, or is the plan too complex? Are the avionics adequate for the mission? Are the weapon selections and allocations optimized? Is the C3I interaction appropriate and adequate? And possibly most important, although the mission can be completed, do the gains outway the losses?

In addition, when time is available, mission rehearsal devices can be used to evaluate the "what ifs" of unplanned but somewhat probable disruptions to the mission. This would enhance the crew's proficiency in tactical decisionmaking, especially in relationship to the specific mission, which in turn would allow for more acceptable alternative actions in the mission plan, thus increasing the probability of mission success.

LESSONS FROM THE SPACE PROGRAM

In support of today's manned space activities, mission rehearsals continue to be (as in the past) an integral element of the total crew training program. This program includes training in the classroom, in various specialized aircraft, and in several types of simulators. A primary training tool for the shuttle astronauts is the Shuttle Mission Simulator (SMS), which is a high-fidelity simulator capable of training flight crews for all phases of a shuttle mission. The SMS complex consists of a fixed-base simulator, a motion-base simulator, a Network Simulation System (simulating tracking and communication systems), a Spacelab Simulator, and supporting instructor station, operator stations, and computer facilities. The SMS is also networked to the shuttle operational Mission Control Center (MCC) to allow integrated training sessions with actual flight controllers.

SMS training sessions are divided into two categories, "pilot pool" sessions and "mission specific" sessions. The pilot pool training is for astronauts who have completed their basic training and are awaiting a specific flight assignment. This training is of generic missions and emphasizes understanding of system operations, crew coordination, and responses to system failures. Once assigned to a flight, astronauts begin mission-specific training (usually eight to nine months before the scheduled launch date). This training starts with a familiarization phase, after which the crews begin "flight-similar" training. This phase uses simulator software from a previous shuttle flight that is "similar" to the planned flight configuration, thus allowing training before the "flight-specific" software is completed. The first part of "flight similar" training is stand-alone, during which the instructors act as mission controllers. The next phase includes flight-similar integrated sessions where the crews train with participation of the mission flight controllers in the Mission Control Center.

Flight-specific training begins when the training load for the actual mission is available (approximately eleven weeks before the scheduled launch date). Stand-alone and MCC integrated sessions are conducted, with emphasis on mission objectives and contingency plans. The facilities of mission payload controal centers are also networked into many of these sessions. For many flights, a special joint integrated simulation is scheduled to practice the entire flight. These special simulations are clearly mission rehearsals. However, it can also be observed that many of the earlier sessions constitute partial rehearsals of specific aspects of the mission. Accordingly, we can see how NASA has developed a mission training hierarchy which, in an efficiently controlled manner, evolves from generic training into a full mission-specific rehearsal. It should also be noted that throughout the hierarchy there is significant emphasis on contingency operations.

The effectiveness of today's space mission training has evolved from many years of experience. As noted in the Mercury Project Summary[3] in 1963: "The network and launch simulations held prior to the actual mission were found to be a necessity." Today's military forces should be able to benefit from NASA's years of experience in conducting mission training. Existing and past programs can be studied and discussed with space training experts. These efforts would provide an established baseline which the military could modify and supplement to support their own unique mission training and rehearsal requirements. In addition, by studying the lessons learned by space training experts, many pitfalls may be avoided in the evolving military programs.

MILITARY MISSION TRAINING/REHEARSAL RECOMMENDATIONS

In the future, we will indeed see many studies and hear much debate on military mission training and rehearsals. Close teamwork will be required between DOD planners and users, training analysts, and industry so that simulation technology can be effectively applied to meet the stringent training requirements imposed by today's missions. This paper proposes two general recommendations for consideration by the experts who will be involved in these activities.

The first recommendation is that the military should pursue an integrated mission training/rehearsal program which would include dedicated simulation facilities. The program should support crew training, including mission generic training, mission qualification, mission-similar training, mission-specific training, mission rehearsals, and sustainment training. The facilities should also support the involvement of mission specialists and analysts who would be responsible for such tasks as assessing mission performance, studying crew reliability, and evaluating the impact of new systems of tactics on generic or specific missions.

The second recommendation is that the simulation facilities should be designed to be interoperable with other critical mission planning stations, communications facilities, and potentially in the future with the aircraft employed in specific missions.

The framework for an integrated mission training/rehearsal program has been established through four interrelated definitions provided by Wiggers et.al:[4]

Combat Mission Training:

Tactical forces/crews conducting training scenarios, to which some factors, including a moderate level of uncertainty, have been realistically applied with the intent of training for a particular type of mission.

Mission Preparation:

Tactical planners/commanders developing and refining tasks required for tactical forces/crews to execute a specific mission.

Mission Preview:

Tactical forces/crews conducting initial familiarization for a specific mission. This can be performed utilizing personal computers or similar equipment.

Mission Rehearsal:

Tactical forces/crews conducting trial performances, to which all factors, including an appropriate level of uncertainty, have been realistically applied to a situation with the intent of preparing for a specific mission.

Many of today's mission rehearsal development activities are concentrating on exploiting new database technologies to allow simulated visualization of the mission routes and terminal engagement area. There is good reason for this emphasis since the resulting systems will assist crews in overcoming a major deficiency in previous training systems. That deficiency is the lack of a means to provide the crews detailed familiarity with the geospecifc area over which the mission is to take place. While these advances are significant, the ability to create and display such databases does not in itself fully support mission rehearsal requirements, at least not the level defined by Wiggers.

Technical advancements and refinements in interoperability, networking, reconfigurability, threat modeling, and uncertainty modeling are also important elements in achieving a full mission rehearsal capability. It is important to note, moreover, that once developed, these same technologies will significantly enhance support of the mission training, preparation, and preview functions which were also defined by Wiggers. This leads us to postulate that a common simulation facility can support all four functions as well as the other functions previously proposed in the recommended integrated mission training/rehearsal program. The following paragraphs provide further details on the various mission-related functions that could be implemented.

Pilots entering mission training will have successfully completed training and qualification in their individual aviation duty tasks. Initial mission training will employ a sequence of generic missions in which the crews will be exposed in a building block approach to gradually increasing mission workloads. This phase will concentrate on the operation of mission equipment, the refinement of mission communication and coordination tasks, and tactical decisionmaking, especially in relationship to contingencies. The devices used for training will also be employed for crew mission qualification testing.

After receiving mission qualification, the crews will enter continuation training. This phase would most likely involve specific types of anticipated missions. Emphasis would be on mission performance and contingency operations. To maintain the high proficiency levels required of the crews, subsequent sustainment training would be conducted using similar missions. This phase would also include additional training required when new systems or tactics are employed.

Two mission rehearsal operational concepts are integral to this program. The first concept is the development of preparedness through extensive continuation training and mission-similar training relative to areas of potential activity as indicated by current intelligence reports. The second, more obvious concept is to create a capability to perform specific rehearsals of assigned missions.

A typical operation would be initiated by a strategic warning which would put an initial priority on an area of interest and alert associated commands of an upcoming possible threat. At this point in time, mission-similar training would be conducted using databases of (or similar to) the designated area and scenarios and tactics based on knowledge of the identified threat. During this period, activities may also be initiated to develop more detailed databases in preparation for a specific mission.

When a specific operation is required, an alert order would be issued and mission tasking subsequently transmitted to the respective units. The appropriate simulation resources would then be prioritized to support mission planning, mission preparation, mission-specific training, and mission rehearsals. The simulation facilities could also support enhanced mission preparation activities such as using the crews to try alternative plans before deciding on a specific plan. Mission preview capabilities would be supported using the databases developed for the rehearsals. Some resources may also be prepared to support continued rehearsal activities during deployment (i.e., via embedded training).

As in the space program, the fixed site simulation facilities could also be manned by backup crews during mission deployment. These crews could perform such activities as evaluating updated intelligence reports and assisting in determining alternate mission plans when necessary.

After the mission the databases could be updated based on real-world data and video collected via on-board sensors during the mission. The simulation system could then be used for post-facto assessments of the mission and to support any redeployments that might be required.

Another important function which could be supported is mission analysis. Trained mission experts assisted by specialized performance monitoring software could assess the mission during the rehearsals. These specialists could address such analyses as how close was a successful mission to being unsuccessful and what changes to the mission plans would be required to increase that margin.

Analysts could also employ the simulation facilities to perform such tests as crew reliability studies for varying mission complexities and durations as have been previously conducted in the space program. Tests could also be conducted to evaluate the differences in mission performance using different systems and/or tactics. Systems configurations (such as weapons allocations) and tactics could also be optimized for specific missions.

CONCLUSIONS

The changing world environment is focusing increased emphasis on special operations and low-intensity conflicts. The irregular warfighting tactics of the anticipated threats necessitates the development of enhanced combat techniques emphasizing precision in virtually every aspect of an engagement. The risks of adverse consequences due to mission failure are enormous, including the loss of military and civilian lives, property loss, and the possibility of unconstrained reprisals as well as national and/or international political repercussions. Advance training techniques are essential to prepare our forces for these complex, stress-loaded missions.

An initial baseline for such training may be derived from mission training experience acquired on the space programs. One recommendation, based on those programs, is that the military should develop an integrated mission training/rehearsal program for our aviators which would include dedicated simulation facilities. Another recommendation is that those facilities should be designed to be interoperable with other mission critical resources. Numerous mission training, rehearsal, and analysis functions could be supported by such a facility.

The correlated integration of these functions, coupled with the application of advanced training technologies, can significantly enhance the mission readiness of our aviation forces. The authors recognize that we need to walk before we run and that early, more specialized systems are essential for today's crews. We hope, however, that the vision we've described will lead to continued future activities and teamwork which in turn will eventually allow simulation to reach its full potential.

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ABOUT THE AUTHORS

Gary R. George is a Staff Engineer with the Link Flight Simulation Division of CAE-Link Corporation in Binghamton, New York. He is a mission simulation expert with experience involving the AH-64 Combat Mission Simulator, Multiple Simulator Networking, Special Operations Aircraft Combat Mission Simulator, and LHX simulation requirements. Mr. George has 12 years of experience in sensor and weapons simulation. He has a M.S. in Mechanical Engineering from the State University of New York at Buffalo and a M.S. in Electrical Engineering from Syracuse University. Mr. George has published work in the area of optimization applications, vehicle dynamics, and simulation.

Samuel N. Knight is a Staff Scientist with the Link Flight Simulation Division of CAE-Link Corporation in Binghamton, New York. He is currently the Principal Investigator for the Multiple Simulator Networking (MULTISIM) program, and was also a technical advisor for the LHX DEM/VAL program. He was previously the Tactical Systems Lead Engineer throughout the conceptual and development phases of the prototype AH-64 Combat Mission Simulator. He has over 19 years of experience in visual and tactical systems simulation. He has a Master of Electrical Engineering degree from Cornell University and a B.S. in Electrical Engineering from Clarkson University. Mr. Knight has published work in the areas of tactical simulation, simulator networking, simulator fidelity, and mission rehearsal.

CW4 Robert Monette is a Senior AH-64 Instructor Pilot assigned to D Co. 1-14 Avn. Reg., Ft. Rucker, Alabama. With 19 years of experience and two aviation tours to Vietnam logging over 1400 hours of combat missions, he is a subject matter expert in attack helicopters and simulators. He previously evaluated both the AH-1Q and modernized Cobra Flight and Weapons System Simulators from 1979-1982. Presently his special duties include being a member of the AH-64 CMS acceptance team and also an assignment as the AVSCOM New Equipment Training team chief for all CMS device training. He received the AAAA Trainer of the Year Award in 1988. He has an A.S. degree in Aviation Science from Embry Riddle University. CW4 Monette has published work in the areas of simulator networking, simulator fidelity, and mission rehearsal.