MISSION REHEARSAL: MORE THAN JUST ANOTHER SIMULATION

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ABSTRACT

A battle commander, in planning and accomplishing a mission for today's battlefield, must consider an infinite number of variables and uncertainties, including a complex combination of individuals, equipment, terrain, and environment. With these myriad decisions by individuals and crews, the need for training in decision making and tactical operation has become critical. However, without prior preparation and an in-depth and timely rehearsal, dealing with this combination of complex variables can lead to disaster. Mission rehearsal is required by all crews to be fully qualified for today's complex battlefield. Rehearsing missions utilizing fielded mission equipment fulfills only a part of the requirement. A full system that could evaluate situational awareness, decision making, team coordination, and employment of units in combat is needed to bridge this gap. With simulation, the environment would represent crucial aspects of the real world by properly preparing the crew and weapon system to complete specific missions. This paper discusses the definition of mission rehearsal, mission training, and mission simulation. It further addresses mission rehearsal from a training standpoint, makes a comparison and a subjective analogy between the mission and mission rehearsal, and proposes a set of requirements necessary to provide simulation systems capable of supporting mission rehearsal.

INTRODUCTION: WHY MISSION REHEARSAL?

"Mission rehearsal" has become one of the major objectives of the military training community within the last few years. Many see mission rehearsal as the next major development in training — one which will develop and revolutionize the way units/crews are utilized in the future. As efforts continue toward developing this method of mission preparation it must be noted that mission rehearsal is not a new idea. In fact, it has been successfully utilized as an integral part of complex operations throughout history, including missions as diverse as major World War II offensives[1], precision rescue missions[2], and lunar exploration.[3]

Vietnam is an example of implemented mission rehearsals. Until the spring offensive of 1972, the Viet Cong and North Vietnamese forces relied on hit and run operations to maintain pressure on U.S., ARVN, and allied forces in South Vietnam. Despite massive allied fire power, force mobility, and total air dominance, a large percentage of those attacks were successful in terms of their objective. The main reason for success is that virtually every mission had been meticulously planned and rehearsed — the value of which had been learned over the preceding 25 years.

The Viet Cong mission rehearsal was not a one-day episode. In fact, days, weeks, even months of preparation for a one- or two-day operation was not uncommon. It first started by watching, listening, probing, plotting, and then infiltration. Units were then assembled and put in place, and rehearsal began. Rehearsal did not consist of a full-scale troop operation, but rather cadre/command structure practice. Sandpile facsimiles of the objective were built, including stick buildings and defenses. Terrain relief, as detailed as possible, was included. Many times, this was accomplished using hand-drawn maps. Using this "sandbox" simulation, troop leaders were briefed and rebriefed as to their part of the mission. Each commander would spend hours using his stick to trace routes his forces would follow before, during, and after the attack. The follow-on to individual tasks would be the simultaneous rehearsal of all troop commanders. Through the "joint" practice, everyone saw where and how he fit in. It was during this phase that coordination was worked out to ensure proper occurrence of events. Refining the details prior to beginning a mission resulted in uncertainties being eliminated, or at least reduced.

The result of these mission rehearsals was a quick, coordinated attack from which the enemy disappeared before the weight of a massive military machine could be brought upon them.

In contrast to mission rehearsal is an example of apparent planning shortcoming: the TET offensive of 1968. In this operation almost every major city in South Vietnam was attacked over a two-day period. The attacks were planned as psychological and political setbacks for the allies, and in these terms they were successful. However, with the exception of Hue[4], no initial plans had been made to defend the cities. Perhaps the North Vietnamese leaders were counting on slow reaction and reinforcement problems to give them time for defense planning. One can only imagine the outcome had defenses been included in the planning as they were for Hue, where the battle continued long after all other cities had been recaptured.

In this example, and throughout history, military planners and strategists have used various plans and rehearsal formats to prepare for a battle. Even today these theories are viable, but on a much more sophisticated level.

Sophistication in planning has led to the utilization of simulation technology. Simulation technology has progressed to a point where it is possible to plan and implement mission rehearsals to a higher degree that has been done in the past. Instead of word of mouth, handwritten and drawn details, we now have access to aerial, satellite, and electronic intelligence and photographs. In lieu of a sandpile topography, we can use Defense Mapping Agency (DMA) enhanced Computer Generated Imagery (CGI). High-resolution two- and three-dimensional images of objectives and defenses now replace the stick and rock models. And in lieu of players simultaneously making lines in the sand and looking at their watches, they may now use full-fidelity, networked simulators and additional networks of lower or selective fidelity devices. Allowing "threat smart" computers to choose ingress/egress routes and probable courses of action means no longer relying on a best guess estimate.

Finally, we can allow the unit to rehearse multiple times until a successful end-of-mission is assured. We no longer need to imagine the progress, but we can see it as it is rehearsed. Even the bothersome "home court" advantage could be overcome.

Recent events illustrate what can occur when competent, well trained crews are placed in situations where no specific training has been addressed. The Iraqi missile attack on the USS Stark in May, 1987 and the subsequent downing of an Iranian airliner by the USS Vincennes in the summer of 1988 are prime examples of this. In both cases, quick, decisive action in response to an unusual situation was required. These instances may have had different outcomes had practice for specific situations been available.

WHAT IS MISSION REHEARSAL?

Joint Chiefs of Staff Publication 1 (JCS 1) defines mission as:

"The task, together with the purpose, which clearly indicates the action to be taken and the reason therefor." [5]

In general, military missions involve tactics. JCS 1 defines tactics as:

"Employment of units in combat. The ordered arrangement and maneuver of units in relation to each other and or the enemy in order to utilize their full potentialities." [5]

Every mission, regardless of how large or small in scope, goes through a series of processes as it passes from idea to action. These processes are a sequence of stages which start with planners, then commanders, then troops, and so on. Generally categorized, these process steps are:

1) Inception/High Level Tasking
2) Force/Unit Selection and Brief
3) Force/Unit Preparation and Coordination
4) Execution
5) Debrief

Rehearsal is an integral part of Force/Unit Preparation and Coordination. Because of today's complex interactive system/counter-system technology, the increasing number of variables influencing the outcomes of tactical exercises, the need for coordinated team efforts, and the increasing difficulty in predicting their combined effects, rehearsal has become a critical item of preparation, and should probably stand alone in the generalized list. If mission rehearsal were a stand-alone process it could and probably would affect the preceding phases of mission preparation as well as the most important phase: execution. Not all missions require the same degree of rehearsal because the range of variables encountered differs from mission to mission. While "more is better" tends to be true of rehearsal, there are limits to what is feasible. A large armor force on a battlefield can rarely pull its troops off the line to practice for a planned attack, but map and chalk-talk coordination between commanders and subordinates with question and answer sessions can be a highly effective rehearsal.

However, where the selected units/crews are not directly involved in an ongoing mission, and where political, psychological, and reaction considerations are key, complete rehearsal takes on a major role, a role that could be supported by state-of-the-art simulation technology.

Much effort is being expended by both the industrial and user communities toward developing Mission Rehearsal. However, JCS 1 does not define the term "Mission Rehearsal" and a common meaning for the term has not yet been agreed to by the industrial/user communities.

In order to understand the concept of mission rehearsal, we must first define uncertainty and how it affects the mission. Uncertainty in warfare is defined as a situation or condition which is vague or not exactly described. It can be broken down further into three general categories:

Situational Uncertainty — Uncertainty which arises from known conditions which cannot be controlled but may be included in planning (e.g., variance in weather conditions).

Probabilistic Uncertainty — Uncertainty which arises from known conditions which cannot be controlled but may be statistically predicted (e.g., the P_K of a missile).

Operational Uncertainty — Uncertainty which arises from unknown conditions which may be neither controlled nor predicted (e.g., the intentions and actions of other human operators, including those of opposing forces).

In order to put these categories of uncertainty into perspective, consider the Normandy invasion of World War II. In preparation for the invasion, the allies massed forces in England and time after time actually landed troops from ships onto terrain that was similar to their intended invasion sight. During one such rehearsal off the coast of Scotland, German U-boats suddenly appeared and attacked numerous landing craft and ships at a high cost in lives. Within this event, weather and conditions for North Sea operations (situational uncertainty) were considered and practiced. The accuracy and effect of friendly weapons against a submarine attack (probabilistic uncertainty) could have been statistically predicted and accounted for in the mission plan. The possibility of submarines in the area during the actual invasion (operational uncertainty) was considered, but not during the rehearsals.

Indeed, the "what ifs" must be an active part of both planning and rehearsal concepts.

In recent years, development of simulation training concepts by the industrial/user communities has resulted in the specification and design of systems which advertise mission rehearsal capabilities. While most of these concepts do not allow for mission rehearsal,they do form an important hierarchy of training leading toward successful execution of a mission. Mission training concepts can be broken into three categories:

1) Mission Preparation: Tactical planners/commanders developing and refining tasks required for tactical forces/crews to execute a specific mission.
2) Mission Preview: Tactical forces/crews conducting initial familiarization for a specific mission. This can be performed utilizing personal computers or similar equipment.
3) 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 rehearsal differs from other forms of mission training and may be seen as being similar to an acceptance trial. JCS Pub 1 defines acceptance trial as: "Trial carried out by nominated representatives of the eventual military users of the weapon or equipment to determine if the specified performance and characteristics have been met." [5]

Thus, mission rehearsal can be viewed as an acceptance trial of a mission. It provides the ability to analyze and adjust a mission plan based upon lessons learned during the rehearsal. If the specified performance and characteristics of the mission have been met during the rehearsal, the mission plan is acceptable. Mission rehearsal can provide an objective method of analyzing the performance and characteristics of a mission only if the requirements driving mission rehearsal allow it.

Based on the discussion thus far, mission rehearsal could be defined as follows:

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.

Specifying a system capable of providing mission rehearsal necessitates defining a set of requirements to which the system must adhere.

DEFINING THE REQUIREMENTS FOR MISSION REHEARSAL

When creating his vision of reality, the cartoonist does not attempt to draw a complete picture. Instead, he selects a finite set of images which convey the message of the cartoon. Each image selected and each piece of information shown must have meaning. Similarly, it is not necessary to recreate the real world in its entirety during rehearsal. Each piece of information used to create a mission rehearsal environment must contribute toward a successful execution of the mission. In addition, each factor capable of influencing the outcome of a mission must be accounted for during mission rehearsal efforts. Simplifying reality is lethal.

Before attempting to specify any particular requirements, consider the nature of warfare. "The science of war is in a constant state of change, driven by new technological developments which can radically change the nature of the battlefield." [9] Although this quote is directed at the particular act of war and the methods used to fight it, it could also apply to methods used to train or rehearse for hostilities.

The science of war is in a constant state of change due largely to changes in the relative technologies. Any approach to mission rehearsal must have the flexibility to allow growth and quick adaptation to this constant change.

The famed Georgi Zhukov, Marshall of the Soviet Armed Forces, stated that "War is a science, a series of mathematical problems to be solved through proper integration and coordination of men and weapons in time and space." While advances in technology require adaptability, the nature of warfare as described by Zhukov requires coordination in both time and space. These divergent principles of war must be reflected in any set of requirements for mission rehearsal.

By definition, mission rehearsal requires the following:

- Forces/crews
- Realism
- A specific mission
- Tactics
- Uncertainty

Each of these defines a set of requirements which must be applied in order for a system or method of mission preparation to be considered "mission rehearsal."

Forces/crews. Ordinarily, forces/crews utilized during a rehearsal (and presumably during a mission) will already be trained in the basic operations of their assigned equipment. However, even experienced crews have difficulty initially integrating multiple tasks under high-stress workloads. [7] Therefore, forces/crews will require the ability to work under high-stress conditions.

Mission rehearsal provides stresses and workloads associated with performing specific missions in a realistic environment. Grodsky et al. found that the introduction of realistic workloads and stress factors is important in predicting crew reliability during mission execution. [6] The use of simplified tasks, crews other than the actual crew, lack of appropriate temporal sequencing of tasks, and the lack of stress (both psychological and physiological) were found to place the reliability data obtained from non-realistic rehearsal environments in doubt. Additionally, exposure to high-stress workloads during rehearsal has been found to reduce the level of stress and workloads during actual mission execution. [7] It should be noted that a partial overlap between team members has been shown to provide an overall reduction in team workload. [8] Thus, mission rehearsal provides a valuable means of gauging crew reliability during the actual mission, and has the potential benefit of increasing crew reliability by reducing stress during actual mission execution.

Realism. Realism refers to the kinds, amount, and complexity of the information needed in performing a mission. A realistic simulated environment is important since differences in task information between the simulation and the real world may produce errors in planning or executing a mission. There are two primary ingredients of realism: appearance and behavior. Appearance is what the simulated environment is sensed to be (i.e., what it looks like, what it sounds like, etc.). Behavior is how significant elements in the environment act and react. Both appearance and behavior must be considered in developing a realistic environment.

Appearance is associated with visual scenes. The real-world terrain provides important cues for forces/crews to perform missions. Historically, terrain has played an important role in the outcome of military actions.

Accurate terrain portrayal and detail is paramount for any form of mission rehearsal. Centuries ago, the city-state of Sparta in Greece sent its army of 300 soldiers to stop the advance of the Persians under King Xerxes at the Thermopylae Pass. Using the narrow entrance to the pass as an advantage, the Spartans successfully held off an army roughly 10 to 15 times their size until the Persians learned of a goat trail, known only by local shepherds, that led to the opposite side of the pass. Once outflanked, the Spartans were trapped and quickly defeated. The Persians were successful because they obtained a key piece of intelligence and used it to their advantage. Had the Spartans known of this weakness, they could have made plans to counter its possible effects. By providing accurate terrain in rehearsal, pitfalls of this nature could be identified and mission plans adjusted accordingly.

Cues are also required for other senses (such as kinesthetic, aural, and tactile cues) when these cues affect the outcome of a mission. There is also a need to correlate the various sensors (such as radar, IR, sonar, etc.) and out-the-window imagery to the extent that crews/forces can use and cross-check each source of information as it would be used and verified in real-world operations.

Behavior, on the other hand, is usually associated with threats, although it also relates to terrain and weather. Threat behavior is extremely important in practicing and evaluating tactics for a specific mission. It is therefore necessary to model not only the physical characteristics of the threat, but also the underlying doctrine and force employment of the specific threat to be encountered during the actual mission. Threat systems must portray full capabilities within rehearsal. Special efforts should be put forward in threat portrayal. Partial or "close enough" portrayal should be avoided. It is also important to model friendly and neutral forces in a manner similar to the threat in order to provide a realistic, balanced conflict. Behavior of terrain, weather, and the interaction between the two must also be appropriately modeled. For example, during the Iranian rescue, mission planning did not include a local weather phenomenon known as a "haboob" (dust cloud of suspended particles). This haboob made the ingress very difficult, and was indirectly responsible for the decision to abort the mission.

A final consideration in realism deals with the fidelity of the simulated system(s). In order to practice a mission, all mission-critical equipment must be simulated and the simulated design must be concurrent with the system which will be used for the mission. The fidelity of the system must allow all performance limitations and characteristics necessary to perform the mission to be accurately recreated.

Required fidelity is a function of operational needs. What are considered as valid needs today may be inappropriate for the next potential conflict. The equipment to be used may not be configured in a manner which is today considered standard. Therefore, any devices developed or modified for mission rehearsal must have the ability to "add on" or replace economically and quickly. Fidelity for mission rehearsal is a question of providing the minimum task information needed to replicate those aspects of the appearance and the reactions of the equipment to be used. Rehearsing on devices with different operational formats, panels, controls, etc., may seriously detract from the overall effectiveness of the rehearsal. For example, if a PC-type device were used to train a tank crew, it would provide little or no positive transfer to the actual mission stresses. A table and chair is by no means the same as the inside of a tank turret in the midday sun. Added to this loss of realism is a possible loss in crew proficiency due to rehearsing on dissimilar controls.

Mission Rehearsal realism imposes the following requirements:

- Ability to grow or quickly adapt to operational needs.
- Detailed, real-world mission terrain with scene complexity commensurate with the real world.
- Correlation of all visual and sensor imagery.
- System fidelity which allows all mission-critical functions to be performed.
- System simulation concurrent with actual systems.
- Threats, correct in appearance and behavior, with doctrine specific to threats which will be encountered during a specified mission.
- Threat and friendly C2/3.
- Balanced red vs. blue vs. other conflict simulation.
- Realistic simulation of weather, terrain, and interaction between the two.
- Simulation of seasonal and time-of-day changes.

A specific mission. Since mission rehearsal is a method of practicing a specific mission, all aspects of the rehearsal must be compatible with the mission. Specifically, the tasking, preparation, briefing, execution, and debriefing should occur in the mission rehearsal in a manner consistent with the execution of the real mission. This also implies that some set of security requirements must be addressed for mission rehearsal, since operational security (OPSEC) is an integral part of mission planning.

Utilizing a specific mission imposes the following requirements:

- Compatibility with existing and future mission planning, and briefing facilities.
- Ability to start mission rehearsal no later than 54 hours after notification (48 hours is preferable). This assumes a minimum of 72 hours between tasking and deployment, 12 hours of crew rest prior to deployment, and 6 hours of rehearsal time.
- Ability to accept real-time updates to the simulation based upon intelligence data, aerial photographs, etc.
- Security provisions to whatever level necessary for the rehearsal.
- Ability to provide real-time weather information for update into the rehearsal scenario.
- Simulator-unique functions of freeze, reposition, record/playback, performance evaluation, condition override, and mission critical faults, malfunctions, and emergencies.
- Risk/feasibility assessment (defining success for the mission).
- Ability to reconfigure mission equipment in the rehearsal to the same configuration as will be in place during the mission.

Tactics. Tactics requires units coordinating activities with other units. All services today practice what is known as Combined Arms Warfare (CAW). Air, land, and sea forces work together in a supportive and complementary role to assure mission success. This requires that devices used by a particular branch of the armed services must not only link and work with each other, but must also link and work with the devices of other branches and with those of allied forces. "Every action of every soldier, system, or unit reinforces the effectiveness of other soldiers, systems, or units to create an overall violent effect." [9]

Tactics thus imposes the following requirement:

- Networking between participants to allow air, land, sea coordination for joint operations within services, between services, and with allies.

Uncertainty. All three forms of uncertainty (situational, probabilistic, and operational) are required in order to provide realistic stresses and mission workloads and to support the "what if" aspect of the rehearsal.

The requirement to provide uncertainty imposes the following requirements:

- Uncertainties appropriate to the mission including situational, probabilistic, and operational uncertainty.
- Stress workloads similar to mission stresses.

CONCLUSIONS

As time has progressed, missions have become more complex. Sophisticated simulation and synthetic mission

environments do allow mission planners to do better today what they have always done in the past: rehearse missions and adjust plans accordingly.

In general, mission planning is driven by specific mission objectives. The final plan, however, is driven by a combination of three factors: mission objectives, OPSEC, and time. Mission Rehearsal applies to more than hostage rescues; however, four rescues from the past decade serve to underscore the factors involved in mission planning. In the Son Tay rescue mission (21 November 1970) and the Iranian hostage rescue mission (24 April 1980) OPSEC was the driving factor for mission rehearsal. For the Mayaguez rescue mission (15 May 1975), time was the driver. In the Israeli raid on Entebbe airport (4 July 1976), time and OPSEC were both considered major drivers. In the aftermath of aborting the Iranian hostage rescue the Holloway commission found that the lack of full-dress rehearsal, simultaneously involving all participants, resulted in operational problems during mission execution which could have been identified during full-dress rehearsal. In this case, a full-dress rehearsal was not completed due to perceived security risks.

This paper addresses only the requirements necessary for a full mission rehearsal capability. Given the complexity of the modern-day battlefield and the stress factors and workloads it imposes on tactical forces/crews, these requirements represent the minimum set which will allow a full-dress rehearsal as recommended by the Holloway commission.

The technological implications of mission rehearsal could fill volumes of technical journals, and the exact technological constraints have been intentionally omitted from this discussion. Industry/government joint initiatives have already been started on the multifaceted problem of mission rehearsal, such as Project 2851, the Universal Threat Simulator System (UTSS), and simulator networking projects like SIMNET, MULTISIM, and ACME.

There is great promise in these technologies. However, interpretation and implementation of mission rehearsal capabilities must be done in conjunction with the end user. User inputs are invaluable in developing rehearsal objectives and implementations. Government and industry working together can help avoid repeating the words of Nicolo Machiavelli:

"The measure of war is not the tally of forces but rather in the responses to its uncertainty."

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