THE NEXT TRAINING CHALLENGE FOR SIMULATION
-- TEAM TRAINING --

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Summary

Simulation has greatly enhanced the training of individuals and crews through their systematic exposure to essential elements of the environments in which they must perform. Similar benefits will be available to aviation, infantry, armor, and command teams when simulation and instructional technologies are applied to the unique problems of team training. Training systems geared to the development and consolidation of specific elements of team skill will employ computerized models of many battlefield environments and of the essential characteristics of friendly and hostile forces that comprise them. The team trainers of the future will make extensive use of modern computer technology in controlling the interactions among the team members and their practice environment, but they will also permit a high degree of flexibility in team response. Teams will practice in standardized environments in developing skill in fundamental procedures, but they will also be able to practice in free play settings to encourage the development and evaluation of innovative techniques. Simulation technology holds great promise for the training of many kinds of teams. The value of its impact depends heavily, however, on the care with which requirements on each kind of team are defined and on the care with which these requirements are analyzed and expressed as requirements on the training system.

Overview

The most challenging task a tactical unit commander faces is to develop his unit's combat skills to a level that ensures the greatest possible success in its first combat engagement. To meet this goal, each member of the unit must master:

- o Basic individual skills
- o Individual combat skills
- o Crew skills
- o Team skills

The problem of keeping these skills at peak combat proficiency has plagued military leaders throughout history. Training device technology has kept pace with weapon systems fielding and has provided effective training to meet individual and crew skill requirements, but the area that requires the greatest allocation of resources -- team training -- is only beginning to be addressed by training system technology. Most of the resources allocated for training in the Department of Defense are consumed in units, but, while the major responsibility of the unit is training teams, the limited mastery of team skills is a major factor in the attrition of units on the battlefield. Team skills are not only the skills most critical to battlefield success, but they are the most difficult skills to develop in a non-battlefield environment. To provide for this type of training, the U.S. Air Force and Army have developed training areas that closely simulate real-world battlefield conditions. The USAF Red Flag program provides real-world threat scenarios, with crew tasks and task loadings that approach those expected in active combat. Similarly, the Army, at its National Training Center at Ft. Irwin, California, has developed an instrumented combat environment to provide combatlike practice for both ground and air units. These programs have proven invaluable in achieving high levels of individual and unit readiness, but, because of their high cost, relatively few units have had the opportunity to participate.

So that all units can be provided with the opportunity to train as teams in high task-loaded combat environments, we must reduce the cost of this critical training. It is essential that the available technology be organized to provide cost-effective ways to meet this training need.

Objectives of Team Training

A crew's chances of survival increase dramatically if it can survive its first 10 combat missions, and it is reasonable to assume that a team (whether a flight of aircraft or helicopters or a team of combat vehicles), if exposed to training programs that properly simulate the real-world combat environment, would achieve better performance and experience higher probabilities of survival in its first battlefield engagement. The Air Force developed its Red Flag program to provide the training needed to substitute for a crew's initial combat missions.

The purpose of team training is to permit combat units to attain the highest possible levels of proficiency and to ensure that these proficiency levels are available when required. Field exercises can expose units to conditions as close to those encountered in real-world combat environments as safety and cost permit. This training is inordinately expensive, however, and few units can be exposed to this type of training, either in recurrent or in sustainment training. Achieving and maintaining essential levels of combat readiness will require extensive and frequent team training, and the only feasible way to provide this is through synthetic training and simulation.

Near-Term Training Challenge

As sophisticated methods and tools of modern warfare have evolved, the United States has decided to depend upon the superior capability of its military personnel and their equipment as the way to overcome larger forces. To maintain the balance between East and West, the NATO forces in Europe, since they are far outnumbered, must be more effective than any potential adversaries. Our dependence upon nuclear weapons to counter a massive conventional attack is now being reduced by adopting a new battle philosophy, embodied in the Airland Battle Doctrine, whose principles require more than ever that the level of effectiveness in our fielded soldier be far higher than that of his potential enemy.

Historically, the United States has fielded the best trained military force in the world, and the needs of the military have encouraged and supported an extensive training analysis and training system design community in this country. Our use of a wide range of training media, which includes flight

simulators and weapon system trainers, has resulted in a level of cost-effective competence in our combat personnel that we could not otherwise have attained.

Until now, we have focused primarily on instruction in skills at relatively elementary levels. Although trainers for multiplace systems have supported extensive crew training, these systems have, in large part, been extensions of, or combinations of, devices aimed at training the operation of individual systems.

Since rapid advances in a variety of technologies have made it possible for a relatively large number of combatants to communicate, coordinate, and prosecute war on an enemy in concert, researchers have, for some years, been interested in the interactions among team members.

The work of Marshall[1,2,3,4] is classic in providing an understanding of the roles of individual and team skills in actual combat operations. Marshall's work, which is based upon postcombat interviews with individuals and units, provides a baseline of the types of problems that can profit from specialized team training.

Simulators have been used to study and quantify problems in team interaction. The study by Siskel, et al.[5] evaluated crew performance in B-52 and KC-135 simulators. In 1966, Sidorsky and Houseman[9] studied team performance in tactical decisionmaking in antisubmarine and antiaircraft warfare. More recently, Emurian, et al.[6] conducted more formal team studies in a carefully controlled laboratory environment. These efforts have helped define team-specific tasks and identify learning objectives for complex team activities.

Although the individual skills taught in the past are excellent baselines, they are quite different from the complex skills required to coordinate multiple weapon systems into cohesive combat teams. Advances in other technologies now make it possible for us to consider designing training systems to support team proficiency. Because the training challenge is unique, however, we cannot take for granted that the systems required to support learning of team skills are simply extensions of previous systems.

The large armor and attack helicopter teams fielded by the U.S. Army are typical of the units that require application of these new technologies. Both types of team involve coordination, complex and interactive decisionmaking, and operation of expensive equipment[7]. Traditional approaches to team training are neither widely available nor practicable. To develop and maintain acceptable levels of team proficiency, it is essential that we use alternative approaches.

A report by Gurwitz, et al.[8] discusses a possible approach to this problem -- the SIMNET system, which consists of many trainers brought together in a network to support the training of widely separated armor teams. The training stations incorporate representations of the information needed by armor unit personnel for practice in team skills, and they permit combatlike communication among the trainees. Other teams of military personnel will need other, similar (and more complex) systems to permit the economical development and maintenance of the unique skills they require.

In team performance and team training, two classes of behavior are of special concern, i.e., coordinating team responses to specific but varied battlefield conditions and individual decisionmaking in the battlefield environment. These behaviors are absolutely critical to team success, and they are so complex that they require deliberate and extensive training. For training in coordinating team responses, the training system must realistically represent the range of battlefield conditions to which the team must learn to respond. For training in individual decisionmaking, the system must permit trainees to exercise related individual skills within the workload, time pressures, and stresses that typify team operations on the battlefield.

Most industry experience has been in developing trainers and simulators for individual and crew training, and many of these systems have required the analysis and representation of elements, units, threats, and events external to the immediate system being simulated. These analyses have provided a great deal of information about a wide variety of battlefield situations and about the manner in which individual units and teams must interact, in many kinds of combat operations. To support crew training and training in weapon system operation, many friendly and threat models and a variety of tactical scenarios have been incorporated into various training devices. In the process, the need for coordinating the training of many of the elements being modeled has become apparent. Specific concerns with the coordination required within Scout and Attack helicopter teams has indicated the complexity of team skills and of the training needed in the development of proficiency in the many operations in which these teams will participate.

Industry interest in the Scout-Attack team has led to an exploration of the role of individual and team skills, and to the identification of team training objectives and environments that need special attention. It is clear from these initial investigations that team proficiency requires extensive training in individual and crew responsibilities, as well as specialized training in a variety of team-specific skills. Teams must learn to observe complex battlefield situations, develop mutually supportive courses of action, anticipate and observe the effects of each team member's performance, assess the results of each individual and team activity, and modify individual performance to support and/or compensate for the performance of the rest of the team.

Since effective team performance involves competence in many kinds of individual and collective behavior, it requires a number of specialized training approaches and settings. Cognitive, procedural, perceptual, judgmental, and decisionmaking processes are all heavily involved, and skill in each must be developed deliberately, within the context of the battlefield environments in which the team can be expected to operate. Although proficiency in psychomotor skills is also crucial in team performance, and these skills represent important parts of the context in which team skills are developed, such individual flight control, navigation, and weapon system skills need not be developed in the battlefield environment.

Efficient and cost-effective team training requires systematic application of a variety of simulation and instructional technologies. In anticipating the structure for a system to support tactical team training, we developed four general system design principles that seem fundamental for providing effective, yet economical training. These principles, each of which is consistent with

the utilization, operation, and support capabilities available within the organizations and the individuals who will use them, can be stated as follows:

1) The team training system must permit conceptualizing, implementing, and testing team tactics. The training system must include a variety of settings designed to support discrete team skills, and it must also give the team opportunities to consolidate these skills in a context that represents the major features and dynamics of a variety of tactical situations. Since skill training, whether it involves individual or team skills, is a matter of learning to understand, process, and respond to information, the training system must also include the information the team needs for developing and practicing tactical operations. The system must provide:

- Visual cues that define relevant characteristics of terrain and cultural features and of friendly and hostile elements on and over the battlefield
- Communication systems
- Essential crew station equipment
- Ownship and friendly and hostile system characteristics

Teams will carry out their missions in a variety of ways. The doctrine will be defined to encourage flexibility in the way individual teams define their own battle practices. While preset lesson plans and predetermined scenarios can contribute to elementary team training requirements, the system must also permit the team to exercise a spectrum of tactical methods in a "free play" capability, where the interactions between trainees and battlefield permit developing and rehearsing a range of team activities and techniques.

2) The team training system must support continuation as well as initial training. The training system must provide for progressive development of essential team skills by exposing a team to a hierarchy of training settings. It must at the same time also represent realistic tactical situations in which experienced teams can practice and refine important team skills. Much of the training will rely upon highly detailed, dynamic models of supported, supporting, and threat elements. The system must also be flexible enough to develop advanced levels of proficiency. There are two possible approaches:

a) Trainees could be divided into a "red army" and a "blue army" which engage in force-on-force exercises. This makes it unnecessary to model and/or control the aggressor force and permits training two teams simultaneously. Teams train against an aggressor force (which fights in accordance with U.S. battle doctrine), or they roleplay as Soviet teams (also in the mode of a Red Flag or National Training Center aggressor force).

b) An automated, intelligent aggressor force could also be modeled. In this approach, instructor control of enemy units or programming responses by simple algorithmic methods can cause instructor overload and/or oversimplification of tactical situations, but artificial intelligence technology appears able to provide the levels of automation and flexibility needed.

The system must provide environmental and performance data in briefing, exercise, and debriefing settings. Real-time monitors, which display key elements of battle operations, can provide useful instructional benefits and can also be used for tactics development.

3) The team training system must introduce the team concept systematically to inexperienced team members. The system must have facilities that permit novice teams to exercise their individual skills in a team environment without overwhelming them with challenges they cannot yet meet. Even though the system cannot be expected to train "non-team" skills, it must support progressively more realistic and complex team training objectives.

Training devices that comprise a team training system probably need not be identical. Institutional training needs can be tailored, so that they introduce trainees to team operations without intimidating them by involvement in excessively complex tactical scenarios. For less-experienced trainees, the tactical scenarios can be less complex than those used by more experienced teams and can probably be less expensive.

The team trainer will differ from typical individual or crew training devices in another respect. Team training objectives are defined less readily or precisely than those associated with individual and crew performance. Teams are challenged to implement doctrine and directives in ways that result in successful enemy engagement and defeat. An effective team training system must permit teams to originate innovative and creative solutions to realistic battlefield problems. Although analysis of team training requirements will focus on learning issues, many requirements for the system will not be related directly to training per se, but to the skills to be exercised in a combat team context. Team skills must be exercised realistically, and individual skills already learned, reinforced.

4) Team training systems must be designed and deployed as integral parts of the overall training program for team members. The proper mix of device capabilities and the basing plans for team trainers must be consistent with the overall basing and training situation of the teams. This consideration will influence not only the number and distribution of devices, but also the complexity and cost of each device set. Many existing devices can be adapted for training team skills. Cost-effective approaches to training will require a combination of relevant current training media and a suite of new devices to address skills not trained in current equipment. The training load and utilization factors associated with team training indicate a need for centralizing training resources, so that training- and cost-effectiveness can be maximized. As in any training system engineering process, training needs, functions, and constraints must be defined carefully, so that the most relevant, effective, and economical mix of training approaches, media, and personnel interactions can be implemented.

Cost vs. Capability

A team training system composed of available simulators, interconnected with network and battlefield simulation systems, would be inordinately expensive. Although the need for effective battlefield training does warrant a considerable investment, training costs can be minimized by

defining, formalizing, and articulating specific training system elements to accomplish specific, required training functions. Each element can be defined so it supports a specific class of training objective, consistent with the class of media available to support that training. While a degree of vehicle simulation is needed to support team practice, considerable savings can be realized by incorporating only the characteristics and computational functions of the vehicle that are needed to support team (as opposed to individual and crew) training objectives.

Although cost effectiveness is necessarily a primary consideration, compromising training quality in the interest of cost savings can easily be counterproductive. The costs associated with team training systems must be considered in terms of the inherent value of such training. According to the U.S. Army, current training opportunities provide only 20% of the training required for combat readiness. The remaining 80% of the required training which will be provided by team training systems, must be considered of proportionate value. Team training systems are elements of a total spectrum of training opportunities which must be provided to combat teams, and the costs of developing such systems must be weighed against their benefits.

There are four main elements in the team training system: a training plan, courseware development, and instructional system; computer and networking branches; crew station modeling; and visual representation of the external scene.

Although analyzing and defining the training plan and its attendant course content is one of the least costly elements in developing a team training system, it is the most critical step in ensuring an effective training system. The analysis of training needs and the development of learning objectives for attack teams will define the requirements to be addressed by each element of the process. At this stage, the entire range of task and educational requirements must be considered. In allocating training needs to elements, the various functions the training system must perform must be defined. Careful and expert planning and description of the requirements for the team training system are essential in running offline approaches to training needs.

The instructional system is also crucial in determining the value of the team trainer. The role of the team training instructor is not that of the typical lesson deliverer, but rather that of monitor, mentor, and facilitator. Since the trainees are challenged to carry out doctrinal-level procedures, considerable latitude for methods of application is needed. To monitor the team's activities, the instructor requires comprehensive information about the status of the battlefield. The training system must include automated recording and rapid playback capabilities, a wide variety of viewpoints to select for viewing the battlefield, and easy access to the systems status of team members. Since the instructor must maintain control of the battlefield situation and update aggressor tactical activities, the automated systems must be easy to control.

The most critical feature is that the instructor be able to monitor team activities closely, record pertinent bits of "evidence," judge the outcome of the engagement, and use the system to debrief the teams involved in the training exercise. The evidence collected and replayed for the teams is essential for maximizing the value of the system for training. The degree of realism with which losses and victories at the National Training Center are represented by the MILES system have significantly enhanced trainee motivation and perception of the value of NTC training.

Computer Systems

Computer systems embedded in team trainers will provide a variety of services. Network control functions will couple crew station nodes to each other, to the simulated battlefield, and to the instructor. Data transfers will provide each team player up-to-date versions of battlefield conditions.

Computer modeling of the teams' vehicles will allow simplified vehicle dynamics, although drastic performance variances will not be acceptable. Selected functions of weapon-related systems will have to be modeled faithfully to real-world performance, within the dynamics of the tasks being practiced and learned. Sets of models will be used to simulate the battlefield; the models will be sufficiently complete to permit tactical planning and control of aggressor force activity in accordance with the best available data on the behavior patterns of potential enemy commanders, equipment, and troops. In the area of sensor and weapon system simulation the simulation requirements will be stringent. For example, attack helicopter teams operate in a highly lethal environment. It is not uncommon for an attack crew to launch multiple, laser-guided missiles in the general direction of a group of targets, while the team remains masked behind available terrain as much as possible. As the airborne missiles approach the target areas, an element of the team designates each target in turn. This type of activity requires functional simulation of the relevant fire control and weapon control systems and visual-image display of enemy positions and activity, weapon launch by team components, and missile flight to the target.

Major Technological Challenges

The critical element of a team trainer will be to simulate the battlefield and the visual information that defines it. There must be scene detail sufficient to provide appropriate tactical cues; battlefield views must be coordinated among team players. One way to provide a common, coordinated database for all team members is to use a large-capacity image generation system that provides multiple-eyepoint data to all participants. This simplifies interfacing and data communications and makes it possible to shift image generation capability as needed among team members. The team trainer mission does not require 100% scene "realism" but rather that the scene provide essential, task-relevant cues.

Conclusion

The systems that are fielded during the next few years to satisfy team training objectives promise to be among the most challenging and exciting to date. The technological challenges noted above, the complex nature of the tasks involved, and the need for modularity and expandability, all within an affordable budget, will require the designer to use the full range of systems available. These same factors will also drive system managers to carefully and closely control the cost-benefit performance of every subsystem. The final payoff that flows from this structuring of realistic battlefield gaming will be

significant enhancement of our combat teams' first-day battle performance, along with a commensurate reduction in first-day losses. As part of an overall program of training and rehearsal, team trainers promise to make every soldier an experienced combat team member on the first day of a future conflict.

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