REPORT OF THE ARMY SCIENTIFIC ADVISORY PANEL

AD HOC GROUP ON TRAINING TECHNOLOGY

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Summary

The manner in which Army personnel are trained so as to achieve maximum combat effectiveness and a state of continuing combat readiness is the responsibility of the Training and Doctrine Command of the Army. Recent reviews have produced major revisions in plans and programs, with a greater emphasis on the actual performance of critical tasks and the explicit measurement of the degree to which training has been effective. This process has made it painfully obvious that ways must be developed to simulate combat, to simulate use of technical equipment, and to simulate use of complex weapons systems to approximate as nearly as possible combat conditions.

The Ad Hoc Group on Training Technology has reviewed the instructional programs of TRADOC programs with an eye toward the appropriateness of training methods as they relate to initial learning and later retention of skills, and the adequacy of the exploitation of the state of the art in technology as it promises support for these Army programs. We believe that the underlying educational principles being employed are sound, that many of the ways in which new technologies are being used are imaginative and effective, but that there are numerous shortfalls both in the educational practices employed and the exploitation of available technologies.

The Ad Hoc Group visited almost all of the major School Commands of the Army, held meetings and discussions with personnel in the Army Research Institute of the Behavioral and Social Sciences, visited PM-TRADE in Orlando, Florida, and held discussions with the Training Directorate at Fort Monroe. We visited some non-Army installations on an informal basis to acquire some perspective about Army programs. On the basis of our study, we make the following recommendations:

1. That TRADOC establish a major research and development laboratory to support its efforts in training.

2. That the Army Research Institute for the Behavioral and Social Sciences (ARI) be tasked to provide a greater technical base for the Army's training effort.

3. That all Army components give higher priority to training requirements in the development of new weapons systems within involvement of training personnel early in the developmental process.

4. That the Army take whatever steps are appropriate to increase incentives for commanders to give higher priority to training requirements.

5. That PM-TRADE be relocated either to an Army R&D facility or to a location nearer to Fort Monroe.

6. That an administrative move of ARI from DCSPER to TRADOC be considered.

hat a review be made at the highest levels in the Army of policies relating to personnel rotation as they affect the status of training.

. That a simulator for helicopter flight to be dedicated to training research and development be funded.

9. That TRADOC establish some form of quality review mechanism to bring the quality of instruction and the level of exploitation of available technology at all School Commands up to the level of the best of those Commands.

ew of Assignment

The Army Scientific Advisory Panel Ad Hoc Group on Training Technology was established at the request of the Army's Training and Doctrine Command, primarily as an outgrowth of questions and comments that were produced during the summer study of the Army Scientific Advisory Panel in 1976. The eloquent descriptions by General DePuy of the problems faced in efforts to win the first battle, and the review of the contents of FM 100-5 made it clear to the summer group, and particularly to the section dealing with Soldier Support, that substantial strengthening of Army training procedures would be required to accomplish the goals of combat readiness for the first battle.

Training objectives in peacetime are hard to attain, for the expenses and hazards involved in large-scale maneuvers with a substantial use of live ammunition imposes costs, not all financial, that the society finds intolerable. When such exercises do not occur frequently, substitutes must be found which will permit not merely the qualification of individuals on weapons and combat systems, but also the testing and revision of doctrine, the sorting of qualified leaders from unqualified leaders, and assessments of the degree to which materiel acquired will maximize combat effectiveness. If we are to have all elements of the United States Army well prepared, and with equipment that is appropriate to the mission and at the state of the art, and with plans to engage in such ways as to maximize the effectiveness of such equipment, we must devise ways to gain experience in small-scale and large-scale engagements that, if acquired for the first time in actual combat, will have been acquired too late.

Such a mission poses a major burden in the Training and Doctrine Command for the procurement and use of varieties of training materiels, and for a capability to disseminate these materials to the wide variety of T&O units in the army. The problem is not a simple one. Certain forms of simulation will be sufficiently unrealistic so that participants will not take the events seriously, or will not accept the scoring as "real". Simulation of weapon effects must have sufficient realism so that participants do not learn the wrong tactics, and develop unrealistic engagement plans. Simulations must be "psychologically" close to the real action so that there may be appropriate transfer from the simulated situation to the real situation. When well done a simulation will produce increased motivation on the part of the participants. (The interesting experience at TCATA with the evaluation of three-tank versus five-tank platoons is relevant to our study. In that test a Weapons Engagement Scoring System (WESS) enabled the tank commanders to determine whether or not they had achieved a kill and whether or not they had been killed. The entire exercise was sufficiently real so that the players felt that they were getting a realistic test of their capability. "Individual tank crews boasted of the number of aggressor tanks 'killed' by them and attempted to avoid the stigma of being 'killed' which was indicated by a flashing yellow light and a 'smoking tank'." Tank crews started using the sort of tactics they were supposed to use, in placing tanks in firing position, in camouflaging, in testing out the effectiveness of their camouflage, and in learning to move immediately after each shoot.)

An effective use of current technology would make it possible to provide substitutes for actual firing and for large-scale maneuvers. The substitutes could be less expensive and less hazardous, but might also be more widely

available for training purposes so as to provide continuing opportunities for practice. The data on the loss of learned capability over time are sufficiently alarming to warrant high priority for the provision of such substitutes. The evidence for tank crews is that they are effective for a very short period after the annual firing exercise. The Field Artillery School found that six months, twelve months, and eighteen months later, graduates of Forward Observer Training Schools were no longer effective, and perhaps were initially not as effective as they had thought. It is critical that such deficiencies be discovered, and that appropriate technologies be developed so that the learning can be more effective in the first place, and can be maintianed at a high level even when the primary equipment or facilities are not available for practice.

The Ad Hoc Group accepted the task of reviewing the ways in which the Army is attempting to meet this challenge. We have been interested not only in the question of whether the technology is being used at the state of the art, but also whether it is being used in a cost-effective manner, and whether appropriate principles of learning and retention are being observed. We have also been concerned that the Army not invent something new to replace something that has proven to be very effective in the past. In view of the magnitude of the effort, we also gave attention to questions of priorities.

cedures of the Ad Hoc Group

At the request of the TRADOC, DCST, and MG Paul F. Gorman, a meeting was held with Dr. Marvin Lasser, Chief Scientific Adviser of the Army, to request support in examining the application of advanced technology to training and training developments in the Army. The meeting was held in Dr. Lasser's office in the Pentagon in September 1976 and was attended by Dr. Lasser, Dr. Kenneth E. Clark, dean of the College of Arts and Sciences at the University of Rochester, Colonel L. N. Cosby, Chief, Training Developments Division, DCST, and Major A. R. Amos, Research and Program Management Branch, TDD, DCST. Agreements were made to draft Terms of Reference for the establishment of a special ad hoc group and to present these to the Executive Council of the ASAP at the next general meeting.

Dr. Kenneth E. Clark was appointed as the chairman of the group. In the weeks that followed, correspondence was exchanged between the ASAP and the TRADOC to clearly define the objectives of the group. On 17 October 1976 at Ft. Benning, Georgia, the draft Terms of Reference were presented to the Executive Committee of the ASAP, were approved, and authorization to appoint the ad hoc group granted. During late October and November 1976 the ad hoc group was appointed. A list of members is in Appendix B.

On 8 December 1976 our Ad Hoc Group met with MG Paul F. Gorman in his office at Ft. Monroe, Virginia. MG Gorman spent practically a full day outlining his perception of the training and training developments of the Army. He emphasized the importance of exporting training from the institutions to the units in the field. This was vividly outlined in his videotape "How the Army Will Train - 1985." He also stressed the importance of applying advanced technology to improving simulative and communicative training methods, media, and programs for training in units and in institutions. Particular stress was given to the development of technologies required for the development of a National Training Center to exercise the entire Combined Arms Team in a realistic simulated combat environment.

Based upon the Terms of Reference and the problems outlined by MG Gorman, we developed a plan to collect the data necessary to attack the problem and formulate meaningful recommendations to the Army for the improvement of training. This plan began with a series of fact-finding visits to installations involved in training and training developments. A review of these visits follows.

List of Staff Visits

Ft. Eustis. During the period 8-9 December 1976, we visited the Army Training Support Center (ATSC) at Ft. Eustis. We were briefed on the mission and functions of the ATSC to include the Training Aids Support Office (TASO) system, the Training Management Institute, the Training Device Requirements Office (TRADER), and provided a review of systems under development by PM Engagement Simulation.

Leavenworth. During the period 5-7 January 1977 we visited the Combined Arms Center at Ft. Leavenworth, Kansas. Meetings were held with MG Therman and BG Menetrey. Briefings and demonstrations were conducted on the following subjects: Command and control training conducted on the Combined Arms Tactical Training Simulator (CATTS), the Computer Assisted Map Maneuver System (CAMMS) and manual war games such as Dunn Kempf, Fire Fight, Long Thrust, Pegasus and War Eagle. We were also briefed on the development and operation of the Tactical Operations System (TOS).

Ft. Knox. During the period 23-25 January 1977 we visited the U. S. Army Armor Center at Ft. Knox. Briefings and discussions were conducted on the following subjects: missions and functions of the Armor School, training developments activities, self-paced instruction, training device strategy, tank gunnery, new firing tables, training devices for tank gunnery, night vision devices, tank crew turbulence, and concepts for the development of a total crew interactive simulator. Following a briefing on the Advanced Attack Helicopter, a demonstration was conducted of Cavalry Operations and NOE flight. We also toured the training facilities of the 1st Training Brigade and participated in field exercises on the M60 Tank.

Lawrence Livermore Laboratories: After a general meeting of the ASAP on 8 February, we met with representatives of the Conflict Simulation Laboratory at Lawrence Livermore. Here, we were briefed on Jeremiah, its relationship to the TETAM tests conducted at Hunter Liggett and presented with an analysis of the Jeremiah-TETAM normalization effort. In addition to a briefing on computer-supported video image production we were introduced to an interactive war game called DWEEPS which simulates the effects of special weapons in a dynamic tactical scenario in central Europe. Our briefing was conducted by Roger Barker, Ken Froeschner, Charles Taylor, Don Patterson and other members of the staff.

Ft. Ord and Hunter Liggett. During the period 9-11 February we visited the Combat Development Experimentation Command (CDEC) at Ft. Ord, California. We were accompanied by a team of scientists from Lawrence Livermore Laboratories and personally escorted throughout the visit by BG Packard. Briefings and demonstrations were conducted on the following subjects: orientation on the mission and operation of CDEC, the instrumentation capabilities, to include computer control of experiments, position location systems, range measuring systems, simulated fire systems for engagement, data acquisition and recording systems and live fire systems. A review of the instrumentation capabilities at Ft. Hunter Liggett was conducted with a practical exercise on engagement simulation using M16 rifles equipeed with GaAs lasers.

Ft. Bliss. During the period 27-29 March we visisted the U. S. Army Air Defense Center at Ft. Bliss, Texas. Meetings were held with MG Lunn and his staff and briefings and demonstrations conducted on the following subjects: targets, Redeye tests, Vulcan tests, Redeye Moving Target Screen, Vulcan training systems, DIVAD Gun, Patriot system training, Roland system training, AN/TSQ 73 system training, aircraft recognition, and self-pacing.

Sill. During the period 31 March - 1 April we visited the U. S. Army Field Artillery School at Ft. Sill, Oklahoma. Meetings were held with MG Keith and his staff and briefings conducted on the Swedish BT33 forward observer trainer, the U. S. Observed Fire Trainer (OFT), the Firing Battery Evaluator, the M31 artillery trainer, self-paced instruction, the SQT, ARTEP and TACFIRE. We also discussed the need for evaluating the performance of graduates and providing this feedback to support the development of improved performance based training. The critical need for the development of a total Artillery System Simulator and the development of a method of integrating indirect fire into engagement simulation were also discussed.

Ft. Gordon. During the period 8-9 May we visited the U. S. Army Signal School at Ft. Gordon, Georgia. We met with MG Myer and his staff and were briefed on the following subjects: Video training via Satellite (VIDEOSAT), Simulator, Tester, Analyser, Responder (STAR), Reactive Electronic Equipment Simulator (REES), and the Computerized Systems Project (ABACUS).

Ft. Rucker. During the period 10-11 May 1977 we visisted the U. S. Army Aviation Center at Ft. Rucker, Alabama. Meetings were held with MG Smith and his staff and briefings conducted on the following subjects: Dual Track Initial Entry Rotary Wing Training, Air Traffic Control Laboratory and Night Vision Goggles. Tours were conducted of the UH-1 and Ch47 flight simulators, the nap-of-the-earth training device, night vision goggle trainer, and associated visual simulation systems. We also participated in a night NOE flight using the new night goggles.

PM Trade. During the period 11-12 May we visited PM Trade in Orlando, Florida. We were brief on the organization and mission of PM Trade. This was followed by a discussion of the relationship between the role of PM Trade and the training developments activities of the TRADOC, the Science and Technology Objectives Guide (STOG), the Army Training Device Exploratory Development Studies Program and the research and development activities of civilian industry.

On 18 April 1977 we drafted a letter to MG Gorman indicating where we were in our efforts. He responded with a request that the chairman provide him with an informal summary of our observations to date. This meeting was later held at Ft. Monroe, during which MG Gorman indicated that progress was "on target" and requested that the conclusions and recommendations of the group be presented in a briefing to the CG TRADOC by the group. We agreed to do this.

In May 1977 members of the Ad Hoc Group exchanged observations and conclusions developed from the fact-finding tours and divided the large volume of data thus collected into functional areas for further analysis and preparation of a final report. The first draft was published on 10 June with successive refinements being prepared on 19 July and 18 August 1977, respectively. The following sections summarize our more salient observations and our recommendations.

General Observations

The policies underlying this new thrust in Army training have been expounded very well by the Training and Doctrine Command. Both General DePuy and General Gorman have described the problem in explicit detail, and have set the goals for attainment within the Training and Doctrine Command. Army programs now make explicit the objectives of training, the actual performance to be expected of participants, and provide a method for testing the effectiveness of units after training. School commands have been given explicit instructions with regard to their responsibilities for developing manuals, programs of instruction, and for using existing technology so that training might be made more realistic and more effective both in school settings and in field units.

In our visits to the various commands we heard many descriptions of efforts aimed to meet the general goals of improving training programs, of making better use of training technologies, and of developing plans for devices to simulate those features of combat where there are problems in maintaining readiness. We have not found in any installation an absence of awareness of the problem, or any evidence of lack of willingness to work on the problems or the assignments which have been assigned. We have seen variations in the degrees of imaginative and innovativeness, and have observed some degrees of variation in the degree of total commitment to the concept. All of these, however, are in the range of moderate positive to outstandingly favorable. We have found variations in local capabilities to deal with the problems that arise in a program of this sort, and variations in abilities to assemble appropriate resources as needed.

Some installations have had greater difficulty than others in being constructive and effective in these developments. Each command has been effected by the accidental presence or absence of senior officers who are capable of generating the sorts of new ideas which would enable us to use unusual features of technical developments for training purposes. Efforts are being made to exchange views and ideas. The current system does not provide much orderliness for such exchange. One commander indicated that the money he had spent to permit members of his staff to travel elsewhere to see what was going on had been very substantial. There is obviously a great need for technical assistance to the installations working on training problems.

We saw evidence that there is a tendency to invent the same thing at a number of places; yet no single installation can be viewed as the "lead" installation at this time. We have mixed views about how meritorious it is to let installations try to find solutions to a particular problem independently. It may well be that a certain amount of redundancy and duplication of effort is necessary in order to gain the support of the school staffs involved, and in order to compare major and minor variations in approaches in the problems of supporting training.

We have observed that the problem of simulating and training devices encompasses a wide range of efforts. There is need for simulation of large-scale maneuvers and engagements with emphasis on the training of those persons who have the responsibility for deployment of forces and for directing the

ombat activities of rather substantial sized units. There is need for training of combat teams so that they can work together effectively and so that they may practice the precise skills required. The tank crew that must learn to work as a unit, or an infantry squad that is training for a particular mission, or an artillery battery that needs to run through its particular battle drill is an illustration of this. There is a necessity to train individual combat soldiers in those skills that must be learned exceptionally well, under circumstances that are as true a reflection of combat conditions as possible. The forward observer for an artillery battery, the individual rifleman, and the helicopter pilot need some aids so that they may maintain their individual skills at little cost.

Our Ad Hoc Group has systematically reviewed the program of training in most of the school settings, and has had one member observing the effects of the uses of new training technologies in Europe. We believe the campaign to improve combat readiness was needed, that results are encouraging, and that schools are in general doing highly useful things. The emphases on self-paced instruction, on performance evaluation are good. The degree to which best principles of training and of management of learning and retention are used can be improved. Some errors have been made in the selection or design of hardware. Some advances in technology are not known to users or, at least, have not been used. Our specific recommendations about some of the matters appear in the following sections of the report.

Our examination of such a variety of programs within TRADOC led to a series of specific observations that we feel obliged to record. The following notes are included for whatever merit they may have.

1. We are concerned that the exercises that involve the training of field grade officers be realistic and that they be appropriately scored. There is a great hazard in any training program that teaches the wrong things. If the fire power of the enemy is understated so that the outcome of an engagement that is simulated is different from what it would be in combat that particular type of simulation may have produced disastrous results. By the same token, if it turns out that in the simulation there is an easy way of outscoring your opponent, by "beating the game" such as following a rule that you open fire at 3,000 meters, then it may be that everybody will soon learn only the easy solution and the simulation will not have its appropriate training effects.

We are very much impressed with the ingenuity that has gone into the simulation of some of the more complicated combat activities. But all of the sophisticated war gaming devices suffer from the fact that they are not sufficiently interactive. That is, a team fights against a school solution or computer solution or a controller and is scored accordingly. It is worth the cost and additional inventiveness required to translate these into more appropriately interactive games in which each side may develop and test new tactics and will get scored for their performance in a realistic way. We understand some of the hazards involved in this sort of interactive mode, but we believe that the benefits are greater than the hazards.

There is another problem when estimates of weapon effectivenesss are built into computers. What is required is a complete scoring technique that is as close as possible to reality. One that would continually test the weapons effectiveness and related data that are pumped into the war games. These games must use the best estimate of weapon performance available, even if this means classified games. One possibility is to redesign the computers so that one might be able to place the weapon effectiveness tables depending upon whether the games were being played in a classified or non-classified mode.

In addition to this comment about the computerized games, we would like to add in the observation that the outcomes of maneuvers would be much better if they were only partially simulated. There is a real realism possible if a game involving many battalions were tied in to a field exercise in which one battalion were operating. What is required is some sort of test on the appropriateness of the scoring and the realism involved in the computer games. A marriage of the MILES exercise to the war games would be highly valuable for that purpose. There still would be problems in such things as the simulation of indirect fire in such operations and there would undoubtedly be some other obvious problems. The objective is so worthy however that we would like to see some attention given to it. We are impressed that early studies in the test of weapons effectiveness (the WESS exercise) demonstrated the effects on troop behavior on a form of simulation that was convincing about casualties. This is an important part of all simulation of combat; it is critical for making combat training realistic, and for providing feedback about what one has done right and what one has done wrong. This is a problem that is joint between the simulation of combat maneuvers, and the training for team effectiveness.

2. All of the various school commands are examining the same fundamental question, whether to use the equipment which is provided for combat use as that equipment which is essential for training, or to develop devices which will make it unnecessary to use the actual equipment, thereby reducing costs, reducing hazards, and in some instances in making possible training which otherwise would be impossible. There are so many different weapon systems that require simulators and so many obvious ways in which simulation could be provided that the decision must be made separately for each and not in terms of some general principle. What we see as essential is a vigorous effort to analyze those features of the skill to be learned into its critical components, and then the development of training procedures that would assure the development of the component skills. This will mean in some instances the development of simulators and other instances not. There is a general tendency to replicate an entire system in order to use it as a simulator; there is also a general feeling that no simulation is adequate and the real equipment must be used.

The Army has an insufficient research and development capability for attacking this major task in its entirety. Certain things seem obvious. The best way to train in the operation and maintenance of signal equipment is with the signal equipment itself. The simulation of some environmental circumstances, and of such things as jamming may be required, and when provided should be as realistic as possible. But the notion of training on simulated communications gear seems foolish. On the other hand to train every tank crew to learn to act to acquire targets and to load and fire upon

as the only way of training would make it impossible to keep tank crews to a desired level of performance. Some form of simulation is required, if only to reduce ammunition costs. When firing ranges are inaccessible as they are in Germany, simulation may be even more essential. The training of helicopter pilots to engage in instrument flying at night might be delegated to simulators, for purposes of saving fuel and lives.

In general, our Ad Hoc Group resists the replication of an entire system in order to use it as a simulator. We have seen a couple of installations in which the simulator costs more than the initial item of equipment. When the initial item is a multimillion dollar item, it seems as though it would be possible to avoid some of the costs of building that item of equipment when it is to be used for simulation only. The occurrence of such major investments is necessary only in those instances in which there are no other ways to learn what the critical tasks in operation are and to discover whether or not the devices are appropriately engineered.

To illustrate what we were talking about recently, the features of a tank that make it a highly desirable weapon on the battlefield do not need to be replicated down to every detail of armor in order to help persons learn how to load, aim, and fire the main weapon. Likewise the unusual control mechanisms that make it possible for a helicopter to do all the things it does in the air probably need to be incorporated in a ground device, but that ground device does not need to respond precisely in every one of the aspects of motion in order for a large number of pilots to be trained to fly.

3. The development of simulators which would enable individuals to perfect their skills independent of other operators, is a highly attractive notion. The development of skill in the maintenance of a piece of communications gear is such an illustration. Skill in firing the M-16 rifle is another. The microprocessor that enables the forward observers to report in positions for a target for an artillery battery is an interesting illustration of a training device which has built into it the full sequences of operations that are expected of the forward observer. That particular development also illustrates the advantages of thinking in terms of minicomputers and microprocessors rather than in terms of large-scale general-purpose computers. While the use of large computers is appropriate for programs as CATTS, and may be reasonable for initial development of software for field exercise simulations, in the actual implementation, minicomputers and microprocessors should be included as intrinsic components, in order that every effort be made to provide for breaking out the particular components on which individuals need training. These new computer technologies will enhance portability, will have a lower software cost, and will allow more flexibility for changes in order to introduce new tactical situations and data. Attention to them will not only help in individualizing training to a point where persons can self-base themselves and effectively maintain skills, but will also operate to enhance the capabilities and flexibility of large-scale devices when they are employed in more global training problems.

4. TRADOC's emphasis on increasing the readability of its soldier manuals is to be applauded. We are dismayed at the low level of reading ability of the soldiers who are to use highly technical equipment. We are less alarmed at their ability to learn. What is required is as much movement

...s possible away from paper and pencil to technical methods of helping ...em to learn orally and in a hands-on mode. The variety of possibilities for development is enormous. A plan which decentralizes responsibilities to the school commands will be less effective than the Army is going to require. It seems to us that there needs to be an investment centrally in a developmental program of this sort.

5. Audio-Visual Aids (film, audio cassettes, video cassettes, audio-keyed projection, programmed texts): The Army schools are making good use of audio-visual aids for training and are paying attention to such aids for "exportable" training packages. Key factors in selection of particular aids should be production cost, production time, and ease of updating. The simplified programmed text accompanied by audio cassettes is particularly attractive as an exportable training aid. A long "approval chain" can defeat the objective of quick release and distribution of training packages, no matter how effective the media used.

6. Computers and Computer Software: Minicomputers and microcomputers are applicable to many training systems. Commercial minicomputers with manufacturer-supported system software should be incorporated in CAMMS and CATTS type systems. Minicomputers have sufficient capacity, are low in cost, and are readily transportable.

Programs for CATTS and CAMMS applications should be written in a standard higher level language (for example, FORTRAN, PL/1, COBOL) and should follow the rules of modern programming technique:

> Programs should be written as assemblies of small procedure modules which can be debugged individually.
>
> Programs and data should be cleanly separated--with all dynamic information (weapons capabilities, scenarios, etc.) incorporated as data to facilitate change.

7. Laser Technology: Pulsed lasers are receiving wide attention for simulation of direct fire weapons. Efforts are being made to incorporate eye-safe lasers in these applications. Extended ranges in fog and haze may be possible with longer wavelength laser devices.

8. Microwave technology: Microwave systems, operating at frequencies where there are windows in the water vapor absorption spectrum (example, 90 ghz), may be applicable to longer wave simulation of direct fire weapons. Relatively low cost transmitters and receivers can be built using Gunn oscillator techniques, which require only 12 volt power supplies. Cost will be significantly higher than that of laser devices.

A drawback to microwave technology is the size of the antennae required for sufficiently narrow beam width to adequately simulate a weapon. For example, at 90 ghz a 1.65 m (5½ft.) diameter antennae yields an effective beam width of 0.1 degrees -- a 5 meter spot at 3000 meter range. Multiple horn or multiple dish configurations might, at increased cost, be useful in narrowing the effective beam width.

9. Positioning Systems: Positioning systems being developed by the Army can have application to the location of units by umpires in large-scale war games. A small LORAN-D receiver, which can be interfaced with a standard

field radio was developed by Litton Industries under Army contract. Approximately 100 units have been delivered to ECOM, but the decision has been made not to field the LORAN-D system. The units may be available for the Ft. Irwin training range. A transmitter system to cover the total range could be installed at relatively low cost. The LORAN-D system is used by the Air Force, making it attractive for joint exercises.

The development of a standard Army positioning system is continuing with the PLRS (a line-of-sight relay system) and GPSS (a satellite system) the prime contenders. Either of these could be used in the war game application, but it is not possible to forecast when (or if) either of these systems will be fielded.

Positioning systems of these types (particularly the low frequency LORAN system) offer an interesting possibility for simulation of indirect fire weapons. A target area could be specified by artillery units causing a unique signal to be received by position locators in the target area.

10. The industrial community is not adequately informed as to the class of problems for which trainers need solutions, therefore the available state of art in technology is not fully utilized in solving training problems.

The degree to which the industrial community is involved in training and to which the state of art in technology is utilized varies from school to school, but in all cases is considered inadequate. Also, the industrial areas tapped are not generally those that are in the forefront of new technology development and high technology areas. Therefore, the technology applied to training appears to be limited to what the trainers can themselves visualize and the training simulations are accordingly developed by industry on this basis and to these "specifications". It was rare that we observed the training simulators and devices being developed by the industrial hardware developer, and yet he is the best source of understanding relative to the hardware for which the training is needed and is generally in the forefront of the developing technologies. Similarly, the low-level of coupling between the Army developer (laboratories) and the user (schools) further aggravates effective utilization of the state of art in technology.

The PM TRADE annual publication (Army Training Device Exploratory Development Studies Program--last issue March 1976) to industry is not working to solve this problem. The publication covers very broad categories in very general terms. The definition of need, description of desired effort, and discussion of schedule are so general that it is doubtful any qualified industrial firm would give it a second reading. Also, the studies discussed appear to be fractionated; there is no evidence that they fit together into any over-all effort to bring technology to bear in an efficient and cost-effective manner on the training problem. The bits and pieces, as presented, will not attract any segment of industry worth having. Each study covers one-third to one-half of a page and could have been written by a technical observer in probably fifteen minutes each. Our conclusion is that this PM TRADE effort to get industry involved in technology SOA solutions to training problems is totally ineffective.

The training input to the STOG (1977) was reviewed with regard to SOA technology utilization. While the training needs faced by the user are adequately described, again, the science and technology prioritized objectives are quite general and are lacking in specific discussion of quantitative goals. Further, it is not apparent who will implement these needed programs, who will provide the centralized direction and control required to make the results available to all schools, and who will assure co-ordination of PM TRADE, DARCOM laboratories, and industrial firms. Again, there appears to be a lack of centralized authority and control in the area of training. It is difficult to see the developer (the various developer laboratories) striking out with vigor on the specific programs described for training--at least not to the degree that he will pursue the weapons hardware research programs that fall under his responsibility. And PM TRADE is certainly not doing this. The training responsibility clearly falls under TRADOC, but the SOA technology developments required for effective training for use of various weapons are not authoritatively being handled by any army agency. The Soldier Support Systems Subgroup of the ASAP Norfolk summer study in 1976 prepared a critique of the STOG 1977 on training. PM TRADE provided a response and update against the ASAP comments. Their response was defensive, and attempted to justify that they were indeed employing current techniques and training device technology development. Under the circumstances they are doing their best, but the fact remains that PM TRADE is not structured to work this problem, does not have the staff, and certainly does not have the authority (and probably not even the responsibility) within the Army to provide the needed centralized thrust.

The SOA in technology is needed to provide realistic simulated operation of complex systems for training. The Army must tap into these advancements and provide implementation of derivative training systems as early as possible. The computer, as we know it, has given way to the core microprocessor--made possible by the integrated microelectronic circuit, or chip. A set of such chips (microprocessor) is capable of performing the functions of a computer central processor. This "microprocessor," when combined with memory and input/output capabilities, forms today's microcomputer. The greatest impact of this development and microelectronics in general is exhibited in the storing, accessing, processing, communication and display of information. This is simply one example of SOA technology today. The benefits to simulated operation of army systems and training in general are almost beyond measure. And currently, not only is the Army failing to make full utilization of the development in training applications, but there appears to be no viable management/organization structure within TRADOC/DARCOM to achieve this. And, it is believed that use of simulators employing these new technologies will contribute significantly both to direct training savings and to increased personnel performance. Greater utilization of the weapons hardware developer is highly desirable. And, the Army must provide for responsibility lines into the Army developer laboratories (DARCOM) if the SOA technologies are to be effectively utilized. Finally, there should be established a competent and qualified agency (probably within TRADOC) to provide the centralized guidance, control, and authority necessary to develop and utilize this SOA technology in such a manner that common training needs are met through the most feasible and efficient combination of simulation hardware and associated hardware. Modular hardware devices should be considered so that a variety

training needs can be met with simple changes in software. The technology is here and its utilization is possible at reasonable cost provided there is the necessary degree of centralized planning, development, control, and authority within the Army.

Additionally, there is no apparent effort within the Army today to test out training ideas or training simulations. Consideration should be given to relating training needs to possible R&D simulator(s) that could be used experimentally to test out and validate approaches for meeting these needs, or even to prove the needs are real.

11. Cost savings and increased effectiveness of training can be realized through a program to develop a "class of things" called modularity; i.e., develop off-the-shelf modules that can be hooked together through appropriate software to meet various simulation configurations for training.

This relates to the use of microprocessors, suitable memory devices, and appropriate input/output units to form a microcomputer. Such a computer can be utilized to solve a variety of training problems when coupled with appropriate sensors, and through the simple technique of individualized software and programming routines. To be effective, however, there must be a centralized organization within the Army (TRADOC probably) that is staffed and has the authority to relate the various training needs of the schools to the SOA technology and to the off-the-shelf available hardware. They must also have close ties with industry and must be able to attract the high technology segment of industry and the universities to participate in this effort. There is then a strong requirement to have DARCOM (their laboratories) involved as well as their hardware development contractors. This is not the current situation in the Army. Under present circumstances, the Army is not apt to take full advantage of industry developments, is not centralizing their training needs in a way that permits general classes of solutions, and is not cross-communicating effectively among Army schools and with the DOD services. Changes should be made to enable and to force this needed outside communication.

12. There is the question of what is the right mode of instruction or vehicle to match to the particular situations being simulated.

This would relate to when should you use verbal, when visual, what vocabularies should you use, etc. Again, this question should not be answered on a school-to-school basis. There are common elements to this question, and they should be the responsibility of a centralized organization that provides guidance and control to all schools.

Based on what we observed, there is a wide variation of technique in this area, and none of these appears to be based on any solid foundation of reasoning. In fact, the mode adopted generally appears to reflect the local trainer or training developer's state of learning.

A real problem here is that relating to the noted fifth-grade reading or comprehension level. There are possible solutions to this. One is to get the developer into the program earlier--this means forcing the PM to recognize the value of training to the success of his system in the field. The user could assign the "fifth-grade" level man to the developer <u>early</u> and the developer could put him into the systems contractor's plant where he can

rn how the system works and how he will use it. Then let this Army man write the operations manual. Can do the same with the technical maintenance manuals. This approach puts the "monkey" on the Army developer and the contractor and the PM should be required to comply, regardless of his funds status. A second approach (not necessarily mutually exclusive) is to develop an equipment system for instructors, instructor schools, contractors, etc. that throws out verbiage (specific words) above this fifth-grade level. Could use an optical reader to scan written material, a storage device for the 3000 or so words allowable, a word matcher or sorter (comparator), an overprint device (to strike the bad word) and suitable input/output equipment. This could be one of the "gates" the contractor must go through to get his technical manuals accepted.

13. Observations on the self-pacing approach to instruction.

Self-pacing instruction is being used in all of the schools in varying degrees. Self-pacing generally appears to improve the instruction content and effectiveness. But, in some instances it appears to be developing as a "cult" or a "religion". Self-paced instruction can shorten course lengths and can improve the level of training. But, self-pacing can be a disaster when the course level is such that the students cannot pass beyond level one because the course content--verbiage and visual--is beyond their level of comprehension. There appears to be more emphasis on the techniques of self-paced courses (the displays, the digitech, etc.) than on what the student can really handle and progress. A problem in self-pacing is that there is not enough peer involvement. There is a need for getting all students together to hear lectures, to talk, to exchange views, etc. And one must also make certain there is a meaningful and effective teacher who can insure student involvement so that it is not a totally hands-off operation.

Another problem is how to handle the so-called fifth-grade level soldier in a self-paced course. We observed such students, and they were not only bogged down in words, but they were, through repetition, trying to best the self-pacing course material by a trial-and-error learning process. That is, try this selection, and if it fails, try the next, until they eliminate all possibilities and pass. They may pass, but they haven't learned. This is not a solution.

Self-pacing is potentially an excellent training tool. But it must be based on sound foundations and the training exercise must be at a level that accommodates the involved students. It is not, in any sense, a solution to the problems of the student level involved, and should not be employed in that sense.

14. There is a question relating to nature and time of training relationships with manufacturers and Army developers.

The introduction of the training requirements for any major Army system first appears with the RFP to industry. The training requirements are usually spelled out clearly, and the industry responds accordingly. But, in the final negotiation, funding limitations and hardware development priorities frequently lead to compromise in handling the training requirements at the outset of a program. Therefore, once a program is started, the practice is to defer

-tions of the training systems and the associated costs. The result is that training requirements do not get the early attention required to assure that the system when fielded can be operated and maintained.

The developer (Army DARCOM) is concentrating on developing the weapon system, in qualifying it, and in delivering it to the Operation Command. The training commands have a supportive role not a decisive role, and they take whatever is offered. Thus, they get systems that are not properly maintainable, or even operable. They start their learning process for operation well beyond the point in development where they might be able to influence the basic system design. This again goes back to the fact that the user command is basically an observer, and he becomes an observer too late in the development to influence the design--even if he had the authority, which he does not.

The real need is to force an early involvement of the user with the developer and with the hardware contractor. This must be forced by higher command within the Army and it must be recognized as essential within the Army in Washington, the DOD, and the Congress. Today, training has limited "clout" within the Army, and is not adequately recognized as an important element within the DOD.

15. The role of the Computer Aided Instruction (CAI) needs examination

Use of Computer Aided Instruction varies widely from school to school. We have observed computers being utilized as bookkeeping systems for students progressing through the schools. This is an inefficient use of computers and doesn't qualify as aiding instruction. ABACUS is a system that would have great capability as a CAI system, but is being used as a record-keeping system only. This poor utilization reflects the lack of an over-all systems approach to the training problems and an understanding of how modern computers can be effectively brought into the solution of training problems.

There are many ways in which true Computer Aided Instruction can be brought to bear on the Army training problems. Currently, CAI is being utilized in a number of Army schools, but usually in different forms and contexts. There is a need to review the application of CAI to all of the Army training areas and to evaluate the effectiveness of projects and action to date and to give some central guidance to projects of the future. There is also the need to evaluate the effectiveness of applications to date.

16. How do you address the requirement for the hierarchy of training of individuals, crews, branches, and total Army?

There is a wide variance among the various schools relative to the importance of training the individual, the crew, or the branches. It is not clear as to what the training pattern should really be. But, it is disturbing to note that within one school--Ft. Knox--you can get a strong difference of opinion as to whether the emphasis should be placed on training the individual in the tank crew or training the total tank crew. This observation is not peculiar to Fort Knox.

Again, it appears that there is a lack of guidance and drive from the top of the Army to assure that the total U.S. Army is adequately trained and prepared to fight the next war. The differences from one branch to another are so great that one can only conclude that there are many armies to do many things and that they need not be co-ordinated. Within the schools, each does a good job; the degree of innovation is variable, but most appear to be addressing their own problems in an effective manner. But, in a war, it appears that our Army branches could be about as far apart as our NATO allied forces of today would be. And this is not good.

There needs to be a study from TRADOC--actively supported by DARCOM--to carefully evaluate the training needs relative to individuals, crews, branches, and total Army. The results of such a study could provide valuable inputs to how the Army should address this question of hierarchy of training.

17. Learning Curves, Forgetting Curves and Transfer of Training

The nature of learning curves and forgetting curves in various military settings and MOS's is reasonably well established and understood among many elements of TRADOC. The criticality of training outcomes being directly transferable to actual on-the-job performance is also understood. Critical task analysis preceding training developments is becoming a more consistent approach in the design and evaluation of various training programs. A definite switch has been made from instructor-centered to student-centered techniques and training hardware.

For combat readiness to be maintained, it must be continuously reinforced, exercised, and practiced. It cannot be maintained through very limited live fire and in-the-field maneuvers.

When new weapons and equipment are designed and developed, a training package for school and/or field training should be an integral part of the weapon or equipment development. Man-in-the-loop must be a greater part of design considerations with human factors being a key element in operability, maintainability and traning required.

Program Managers must be evaluated on their performance in having complete, usable, proven training systems in place when new equipment and weapons go into the field. Merely getting the gear in place on time without regard to having the man make it work in the field should no longer be acceptable performance. The Army should invest in an array of part task simulators for the individual crew members of combat teams, in full crew interactive simulators for armor, artillery and helicopter crew training, and in expanded command and control simulators to train field grade officers. Such simulators need to be placed in several locations within CONUS, Europe, and perhaps Korea. Research should be conducted on optimal mixes of real fire, field exercise and simulator time.

Learning curves and forgetting curves should be established for all critical tasks of combat arms MOS's. Training programs with the appropriate training devices should then be placed in units which will maintain the required levels of proficiency for individuals, crews, teams, units, etc. Self-pacing plus the various self-help, self-teaching methods available should be expanded in order to maximize student/teacher ratios and to permit students to progress through training programs at an individual rate.

The Army needs to quickly move away from word-bound technical and field soldiers manuals. The combat arms soldier is dealing with a complex weapon in a hostile environment without highly developed skills. Therefore, field repair must be made as simple as possible and avoid the written word as much as possible.

18. The current approach in TRADOC of forcing the centers to address their individual training problems using their own individual initiatives has produced excellent results in some areas, but less than desired results elsewhere. The results appear to depend on the quality of training development staffs, which in the main appear to consist of dedicated, energetic people, but in some cases give the impression of being more interested in justifying their efforts than in showing real results. There is a need for increased co-ordination among training developers in order that common technologies can be applied to different applications. Co-ordination in matters relating to common technologies would appear to be a function which should be (but appears not to be) performed by PM TRADE.

The current approach of placing responsibility for training development at the centers should continue, with an increase in co-ordination and communication among training developers. TRADOC Headquarters should be staffed to allow for a greater role in co-ordination (but not direction). PM TRADE should be tasked to provide engineering co-ordination to assist all training developers.

19. A career path for future promotability of the Directors of Training Development appears to be lacking in the Army. At most facilities visited by the Ad Hoc Group the DTD is a "terminal" colonel. This can have good results, if the incumbent has as his goal the doing of the best job possible in his last Army assignment (which impressed the group as being the fact at most centers), but it has the limitation that this excellent experience in training development is not transferred with the individual to operational commands.

In fact, the Ad Hoc Group questions whether the Army is really committed to excellence in training. Commanders and staff officers involved in training have an incentive to want the training results to appear excellent and have a natural reluctance to being a "bearer of bad tidings" by performing a critical evaluation of training results. The group has grave concerns as to whether the state of training of operational units is a specific measure of performance imposed on field commanders.

The Army should make, or reinforce, a commitment to excellence in training by creating career paths which make assignments to training development activities important as a step in the development of officers; providing for objective audits of the results of training at the schools; and by making the state of training of troop units a major factor in fitness evaluation of commanders at all levels.

20. The Ad Hoc Group is impressed that the most difficult training function and the one which imposes the greatest challenge on training developers is that of training for command of units from battalion up. CATTS and CAMMS are excellent steps toward improvement of command training and the TOS system offers significant potential in a command training role at division and higher echelons. These systems also offer great potential for interaction with doctrine development. The group is concerned, however, about two aspects of computer-aided command training: 1) The realism of results is crucially dependent on having accurate system capabilities and weapons effects parameters entered as data for computer programs. The nonlinearity of tactical games makes "scaling" of such parameters a source of significant error in results and can cause training toward erroneous objectives. 2) Man-against-machine (or "one-sided") games tend to train people toward the "school solution" to tactical problems. Games which pit teams of human commanders and staffs against each other, using the computer as an information processing aid would appear to have great benefit in command training. (The role of simulated command of Warsaw Pact forces using Pact doctrine should, in itself, be a useful command training tool.) We think there should be an exportable version of CATTS as an interim command trainer at battalion level. The development of CATTS - type systems should use commercially available minicomputers and flexible computer software to facilitate changes in scenarios and weapons, and should extend the CATTS system to permit two-sided games. Using the techniques developed in CATTS, the Army should develop expanded versions, applicable to one-sided and two-sided games for training of commanders and staffs above battalion level. In all command training of this type one should emphasize command under conditions of severely degraded communications capabilities. Indirect fire and tactical air support needs to be built into computer-aided command training systems.

21. Personnel turbulence of senior officers, junior officers, non-commissioned officers and men in TO&E units results in a critical loss of individual, crew and team skills, and combat readiness.

Gains made through utilizing improved training technologies at major combat arms schools is substantially lost as a result of such turbulence.

The Army needs to develop an alternative to its present manpower utilization and promotion system. Officers, non-commissioned officers and their men in crews and units must be kept together if combat proficiency is to be

maintained to win the first battle. No time will be available for buildup or training. Men and materiel in place throughout the world must provide the combat readiness.

An experimental system should be adopted for a division to test the feasibility and payoff of modifying current combat MOS's, their pay grades and promotion criteria so that crews and units can stay together rather than being broken up by rotation politices, filling replacements and/or promotion. Whole crews and units should be replaced and rotated, not individuals, in this experimental division.

If high turbulence is to continue to be a way of life, then the need for training devices that can be used on an individual basis and by total crew at the lowest organizational levels possible becomes absolutely critical.

22. Training and Readiness in TRADOC Installations and TO&E Units

When not in actual combat, the Army is in the training business. Therefore, training should be second in priority only to combat readiness.

Readiness to go into combat is, to a large extent, dependent upon the maintenance of high skill proficiency over long periods of time without field exercise, a live fire or maneuver over unfamiliar terrain.

Training, as second priority, stops when officers and troops graduate from TRADOC schools. Commanders, at all levels, must be held accountable and be periodically evaluated and rewarded or punished upon combat readiness of troops under their command.

FORSCOM needs to be held accountable for training TO&E units releasing TRADOC training technologists to pursue state-of-the-art technologies, assure quality control of training processes and outcomes, perform training research and development for the next generation of training approaches and systems, and operate the basic training installations within the TRADOC charter.

Top-level Army commanders must make a major commitment to the importance of training and insist that it be secondary only to actual combat. Each level of command should be expected to use currently fielded training devices and a system to monitor such usage and training set up. The best vehicle for this seems to be SQT's and ARTEP's.

The Army must make the maintenance of high skill proficiency a critical priority in the minds of all commanders at all levels. To make this happen, commanders must see to it that relevant training takes place in their command units. These same commanders must then be evaluated on how well their units perform over periodic, successive evaluations not at a singular point in time. Unless training is regularly inspected by each level's higher authority, it will not get the attention it absolutely must receive.

Exportability and transportability of simulators and training devices is a key consideration in their design, development and placement. Such devices must be highly flexible and movable so they can be used in the field

and in reserve unit armories in cities. Miniprocessing technology and satellite communications technology permit maximizing exportability of even highly exotic simulators. One crucial consideration in the use of such equipment is the need to have real numbers, not degraded numbers, for security purposes, in the simulators. To train otherwise is to invite severe problems, unpleasant surprises, and battlefield disaster.

23. There is no means currently to evaluate over-all what is feasible, what is cost-effective, what must be developed on a priority basis, etc. A greater analytical capability must be developed to assure that the right things are being accomplished. PM TRADE is not doing this, is not pictured within the organization to do this, and is not staffed to do this. The training institution (TRADOC) must accept this responsibility, and the schools must be given the help (leadership and guidance) to accomplish co-ordinated and cost-effective training, including training of the training developers.

There is an extremely high degree of fractionization in the training enterprise. Related to this, it is not clear who is responsible for systematically training the training developers.

The training in the Army schools varies in approach, techniques, depth, and utilization of technology by Program and Branch. While some variation is expected and is desirable, what we have observed goes well into the region of training ineffectiveness. There is no evidence of an effective central control within TRADOC to identify common elements, requirements, and techniques, and then to insure their uniform handling and to provide centralized control. It is difficult to identify what drives this fractionalization; however, one strong factor within each school is the idea that "no one else can do my training, I must do it myself." Another factor is that the coupling between the "developers" and "users" is very loose, and in some instances appears to be missing totally. In the present organizational situation, there appears to be no one organization having either the motivation or the authority to step up to this coupling problem. These observations also lead to the related conclusion that no one agency is responsible for or looking after the training of the training developers. That is, who trains the training developers? This is an important question when we recognize that the army exists to do only two things--to fight or to train. A related question is, who assesses the training developers, and who assesses the commanders in the field? ARTEPS does not achieve this. A further problem is that most trainers are light and full colonels who are on terminal assignments. There is little or no career motivation. The lack of a centralized activity for co-ordination, analysis, application and evaluation of techniques, etc. in order to insure continuity and uniformity within the schools, where such is effective, is considered to be a prime contributor to fractionization. There is no real regulation on the P.M. with regard to training. When funds are short, he can cut training, and his personal performance measurement is likely to suffer little, if at all. Therefore, you have wide variation in training among programs, and training effectiveness becomes, in part, a function of the disposition of the specific P.M. Similarly, among the various branches (field artillery, air defense, etc.) there is a wide variation in the training activities.

24. There is a great need for an instrumented test and training range of sufficient size and variation to exercise complete combined arms maneuvers. Such a sight could be Ft. Irwin in California. It is close to both Hunter-Ligget and Nellis Air Base. There is, further, a need for a duplicate sort of facility for the eastern one-half of the United States. Surely, such a facility would be most helpful in Europe as well.

An overview of all of the above suggests that the Army must find newer, better, more lasting training techniques in order to have cost-effective training that simultaneously assures combat readiness of regular and reserve individuals, crews, units and major commands. Much of the technology is available. There is a considerable array of equipment "on the shelf" ready for use without high development costs, and there is a partial data base established by research up to this point in time. Now we need to move forward.

A combined arms simulator is required which includes friendly and hostile indirect fire effects. Air cover and air assault should also be inserted into the combined arms simulator. Logistical support and problems need to be inserted into the combined arms simulator and perhaps into the various part task simulators as well. The whole arena of nuclear weapons effects needs to be added to the upper level simulators. DWEEPS and Jeremiah need to be integrated into existing upper level simulators and the next generation of simulators.

There is no question about the need to develop force-on-force simulator capability. This is true of each of the separate combat arms and certainly true for the combined arms simulator. Full-scale and miniscale ranges need moving targets rather than only stationary targets. Also, the configuration of the terrain, combatants, and locations must be changed to minimize participants memorizing the situation in which they find themselves--one that is a static situation in an armory or a static range in the field. Sub caliber, laser and minirange technologies all have great potential and already some proven utility. These should be expanded and enhanced in both active and reserve units.

There is a need to develop a system which will indicate the effects of indirect fire on units exercising in the field; this system would be used in conjunction with Realtrain, Miles and subsequent like systems.

It is abundantly clear that because of the large costs involved in using live regular ammunition, fuel, troop movement to exercise locations, limited space in which to maneuver and a host of increasing constraints that simulators and other training devices are absolutely essential for any semblance of combat readiness.

25. There is a strong need for triservice co-ordination in the training technology field. There is a like need for a central clearinghouse who really knows what is going on within the various agencies of the Army and also in the Navy and Air Force in research, development, and applications of training technology.

26. The R&D community needs a "blue streak" pathway to get through the usual administrative hangups for procurement of necessary gear for training

-s and simulators when such equipment is readily available "on the shelf" does not require new development and the like.

27. A logical model to be followed in investigating what is required to acquire and maintain skill and minimum proficiency would include:

analysis of critical job tasks
training requirements to develop skill in those tasks
forgetting curve analysis
required time and effort to return to minimum level of proficiency
training devices required
sequence of use of training devices
optimal mix of real time exercise and use of training devices including sub caliber, laser and other technologies

28. There is a need to catalog the research that has been completed and that in progress undertaken by the various Army laboratories, field units and training schools. The catalog should include: effectiveness of various teaching techniques (lecture, peer, manual self-paced, audio/visual self-paced, self-paced computer assisted, manual simulators, computer assisted simulators); transfer of training to on-the-job proficiency; decay of skills without reinforcement training; skill retention with reinforcement training; use of sub caliber, laser and like devices; and optics studies to avoid duplication or missing an opportunity to build on previous research in optics.

29. Armor has 2 per cent of manpower yet 36 per cent of firepower. Yet it also has a 144 per cent turnover in crews in both the U.S. and Europe. And 80 per cent of targets infantry shoot at are moving, yet there are no ranges in the U.S. that have moving targets for infantry training. Further, infantry soldiers, on the average, must be at 200 meters to hit their target.

Conclusions and Recommendations

The Ad Hoc Group on training technology was charged with reviewing the need for improving training and issues of cost effectiveness and optimal utilization of scientific knowledge and technology in combat simulations. Our group has examined the programs of TRADOC and its School Commands, and has found the programs for improvement of training both in schools and for export to T&O units quite impressive. We have been less impressed with the analytical and technical support being given the program, especially in the light of the emphasis that the Army must place at this time on training. TRADOC does not have the easy and ready access to the industrial and academic communities of scientists and engineers that comes naturally to DARCOM and its laboratories. TRADOC needs such laboratory and technical support. It needs consultation with the sort of persons who constitute the membership of ASAP. It needs much more of the sort of analytical capability that ARI can provide-- and does provide through its field units. We applaud the directions being taken under TRADOC policies, and make a series of recommendations to make the programs more effective per unit cost, and more likely to produce the desired training objectives.

The Army's programs for simulation of combat are innovative and useful. Their primary faults lie in their design, which neither use the best of technological developments available, nor the most accurate information about weapons effects and terrain characteristics. It would be possible to design more flexible systems that would be more readily modified, that could have both classified and unclassified scoring for weapons effects, and that would be more readily exported beyond the school setting for less than the current investment in current systems like CATTS and CAMMS. Most critically, such games need to be tied to actual field exercises carried out on well-instrumented battlefields. TRADOC's plans for such a program seem to us very wise.

The training programs of the Army have been substantially revised in an effort to make them more effective in teaching basic army skills and technical competencies, more readily useable in settings other than schools, and to increase the levels of abilities acquired and the permanence of the acquisition. Less emphasis has been placed on written texts, more on "hands-on" performance. Increased attention has been given to the "exportability" of training materials beyond the classroom and into the field.

Along with this effort has been an attempt to analyze the probable combat environment, and to attempt to provide training exercises that would increase the combat readiness at all levels. This program has required the development of varieties of technical equipment in order to simulate as nearly as possible all of the elements of the combat situation.

Our panel is impressed by this program, both in its scope, and in the outcomes already apparent. Leadership in TRADOC has effected a substantial number of improvements in training programs in a relatively short time. The degree of attainment of objectives varies quite a bit from school command to school command, but there is at no place a lack of understanding of the objectives, or a lack of effort. Shortfalls occur in the main from lack of technical support at a local level, because of the complexity of the problem, or because of factors beyond the scope of training programs alone. We propose some remedies in our recommendations below.

RECOMMENDATION No. 1. We recommend that TRADOC establish a major research and development laboratory to support its efforts in training. The laboratory would develop a capability in the human and hardware aspects of training, and would provide a central place where problems of the sort outlined below might be addressed.

a. Simulators (as for helicopters, tanks, missiles, etc.) tend to over-replicate the actual hardware, and thus to be more expensive than required. In the absence of adequate empirical research, no guidelines exist to suggest what dimensions may be neglected in building simulators, and what may not. A variety of such studies is needed.

b. Decentralized efforts at solving training problems by use of sophisticated technologies have produced very expensive installations that are one-time developments. A central resource could aid local developers, and propose modular features that would make modification and replication easier.

c. DARCOM laboratories have over the years developed close relations with industrial and academic counterparts. TRADOC has no natural way to develop such continuing relations. As a result its efforts to develop analytical and technological capabilities have been hampered.

RECOMMENDATION No. 2. We recommend that the Army Research Institute for the Behavioral and Social Sciences (ARI) be tasked to provide a greater technical base for the Army's training effort, especially with regard to R&D programs in the following areas:

a. Analysis of critical tasks for various Army specialties, especially to discover those tasks that are ill-performed in the field, and those that are easily lost without practice, those that are better taught in schools, and those that are better learned in field units;

b. Comparative evaluation of different modes of instruction both in schools and later, as an aid to the continuing improvement of training programs;

c. Development of basic guidelines, based on empirical research, to determine the components of military skills that can be developed with less than actual combat experience involving full combat equipment. Examples of problems in this area:

1) Do tank teams need to feel they are moving in order to train them properly?

2) Can helicopter pilots learn to fly nap-of-the-earth at night by "flying" simulators? What features of the "flying" need to be simulated?

3) What are the critical skills involved in air defense weaponry? Can simulators be developed that would exercise these skills?

4) Do electronics maintenance personnel need to know electronic theory?

priority to training requ[illegible]
with involvement of training personnel early in the
with particular attention to

a. problems of the man-machine interface;

b. issues related to training for maintenance and operations, especially those related to preparation of technical manuals that are useable by military, not engineering, personnel;

c. development of integrated, programs in training using the equipment as in combat.

RECOMMENDATION No. 4. We recommend that the Army take whatever steps are appropriate to

a. increase incentives for unit commanders to give high priority to training requirements;

b. increase incentives for school command to measure the effectiveness of their training immediately and over time; and

c. make careers for those persons who have outstanding ability as training developers more attractive.

RECOMMENDATION No. 5. We recommend relocation of PM TRADE either to an Army R&D facility or to a location nearer Ft. Monroe. We see little benefit accruing from the association with the U.S. Navy at Orlando save in routine matters of procurement.

RECOMMENDATION No. 6. We recommend consideration of an administrative move of ARI from DCSPER to TRADOC, in view of the great needs of TRADOC, and the relevance of ARI's capabilities to that need.

RECOMMENDATION No. 7. We recommend that a review be made at highest levels in the Army of policies relating to personnel rotation. A major portion of school and unit training is lost every year by virtue of excessive personnel turbulence. We see a need for major policy changes. The loss of capability in tank teams alone demands such a study.

RECOMMENDATION No. 8. We recommend the development of a simulator for helicopter flight to be dedicated to training research and development. Such a simulator might be a modification of one now extant, if it has been built with sufficient flexibility to permit adequate testing of each sensory and motor component of helicopter flight. Its ideal location would be either at Ft. Rucker or at a centralized laboratory of the type described in Recommendation 1a.

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APPENDIX A

Terms of Reference

Army Scientific Advisory Panel
Ad Hoc Group on Training Technology

1. Background

The U. S. Army must have an effective program to prepare combat units and related support units to the level of proficiency required for them to win the first battle in any future hostilities.

An effective use of current training technology would make it possible to provide substitutes for actual firing and for large-scale maneuvers. Such substitutes are not only less expensive and less hazardous, but also they can be made universally available to training centers and to combat units, so as to provide continuing opportunities for practice. Evidence of the decay of quality of performance in combat roles suggests the need to increase the length of training, and to reduce the interval between training periods. Certain questions about substitutes for combat require answers. When other than actual combat exercise with firing of weapons is involved, what variables still must be maintained in the training program in order for it to be effective? When combat is simulated, how can maximum transfer of training to actual combat be achieved? What methods can sustain the level of effectiveness attained during periods of intensive training?

These questions are sufficiently critical to require examination both by persons involved in training programs, and by individuals who are acquainted with the nature and potentialities of current training technologies.

2. Terms of Reference

a. What needs exist for improved methods for crew, group, unit training within the Army, particularly with regard to the ways in which new training technologies may improve such training?

b. How cost effective are various methods of simulating combat activity, particularly with regard to

1) the degree to which such simulation transfers to actual combat;

2) the degree to which such training improves the immediate readiness of combat forces, and

3) the degree to which specific components of training may be more important than others to simulate, in terms of their relative criticality in determining combat effectiveness?

c. What actions should the Army take with regard to specific programs that should be employed in combat simulation? What roles should relevant laboratories play in the development of those training programs? Should the Army invest in simulators? Of what sort? Where should such simulators be located?

d. How widespread throughout the Army should be the deployment of such simulators and training aids?

e. The Ad Hoc Group is expected to indicate to the Army the degree to which practices in the Army are utilizing the most advanced states of the art in training technology, and to recommend the appropriate nature and level of R&D support for the Army's training programs.

3. Termination

The Ad Hoc Group should attempt to complete its work at the earliest possible date. However, a final report should be submitted not later than 30 June 1977.

APPENDIX B

Membership

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d. How widespread throughout the Army should be the deployment of such simulators and training aids?

e. The Ad Hoc Group is expected to indicate to the Army the degree to which practices in the Army are utilizing the most advanced states of the art in training technology, and to recommend the appropriate nature and level of R&D support for the Army's training programs.

3. Termination

The Ad Hoc Group should attempt to complete its work at the earliest possible date. However, a final report should be submitted not later than 30 June 1977.

5) How much transfer of training to field exercises can be expected for each of the various war games?

6) How close to real life must simulations be in order for troops to be adequately motivated to use them?

RECOMMENDATION No. 3. We recommend that all Army components give higher priority to training requirements in the development of new weapon systems, with involvement of training personnel early in the developmental process with particular attention to

a. problems of the man-machine interface;

b. issues related to training for maintenance and operations, especially those related to preparation of technical manuals that are useable by military, not engineering, personnel;

c. development of integrated, programs in training using the equipment as in combat.

RECOMMENDATION No. 4. We recommend that the Army take whatever steps are appropriate to

a. increase incentives for unit commanders to give high priority to training requirements;

b. increase incentives for school command to measure the effectiveness of their training immediately and over time; and

c. make careers for those persons who have outstanding ability as training developers more attractive.

RECOMMENDATION No. 5. We recommend relocation of PM TRADE either to an Army R&D facility or to a location nearer Ft. Monroe. We see little benefit accruing from the association with the U.S. Navy at Orlando save in routine matters of procurement.

RECOMMENDATION No. 6. We recommend consideration of an administrative move of ARI from DCSPER to TRADOC, in view of the great needs of TRADOC, and the relevance of ARI's capabilities to that need.

RECOMMENDATION No. 7. We recommend that a review be made at highest levels in the Army of policies relating to personnel rotation. A major portion of school and unit training is lost every year by virtue of excessive personnel turbulence. We see a need for major policy changes. The loss of capability in tank teams alone demands such a study.

RECOMMENDATION No. 8. We recommend the development of a simulator for helicopter flight to be dedicated to training research and development. Such a simulator might be a modification of one now extant, if it has been built with sufficient flexibility to permit adequate testing of each sensory and motor component of helicopter flight. Its ideal location would be either at Ft. Rucker or at a centralized laboratory of the type described in Recommendation 1a.

MMENDATION No. 9. We recommend that TRADOC establish some form of ality review mechanism to bring the quality of instruction and the level of exploitation of available technology at all school commands up to the level of the best. Such a review would provide early identification of errors in instructional procedures, under-utilization of sophisticated equipment, and unsolved problems in developing simulators and training aids.