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Individual and Small-Unit Training for Combat Operations

Papers by

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Prefatory Note

Numerous research projects concerned with military training and training methods have been conducted by the Human Resources Research Office, other military-affiliated organizations, and, in the case of training technology, organizations without military orientation. Research in this area was reviewed and assessed for its relevance to modern combat operations and its efficiency, in a Human Factors Research and Development Symposium, part of the twelfth annual conference sponsored by the Chief of Research and Development, Department of the Army, held at Fort Benning, Georgia, October 1966.

In the symposium on training, particular training programs were described for the advanced individual soldier and for the development of teamwork in small units, and a method used to identify knowledges and skills for officer training was outlined. The need for individualization in individual training, within the Army, was discussed, and an example was presented of the successful achievement of this goal in an academic setting.

Dr. T.O. Jacobs, HumRRO Division No. 4 (Infantry), served as chairman of the symposium. Other participants were Dr. Clay E. George and Mr. Theodore R. Powers, also of HumRRO Division No. 4 (Infantry), Dr. Howard H. McFann and Dr. Joseph S. Ward, HumRRO Division No. 3 (Recruit Training), and Dr. Richard K. Wilson of Oakland Community College, Pontiac, Michigan, who presented a paper by Albert A. Canfield, Walter J. Fightmaster, and Alvin Ugelow.

Research projects reviewed by Dr. Jacobs were largely those conducted at the HumRRO Divisions over the past 15 years. The research reported by Dr. George was of Work Unit UNIFECT, Procedures for Increasing the Effectiveness of Small Infantry-Type Units; that described by Mr. Powers of Work Unit ROCOM, Development of Methods and Techniques for Improving the Output of ROTC. Dr. Ward's paper was based on Work Unit RIFLEMAN, Improvement of the Combat Proficiency of the Light Weapons Infantryman; comments by Dr. McFann were based both on educational writings and research and on HumRRO research in the area of individual training. The paper presented by Dr. Wilson described the application of the systems approach to an academic and technical education program at a new community college.

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SYMPOSIUM: Individual and Small-Unit Training for Combat Operations

TRAINING FOR MODERN COMBAT OPERATIONS

T. O. Jacobs

Before the turn of the century, Captain C. B. Mayne of the Royal Engineers wrote:

> "In the next war, the nation which has best educated its troops to the true character of modern fighting, by teaching them to do in peace what they will have to do in war, and by subordinating to that end the whole training of the soldier, will have placed itself in a position to have gone, at least, a long way on the road to gain success" (1).

Training for modern combat operations, then a problem, has since been enormously magnified with the progression of the technology of modern warfare, and the size of the military establishment that must be trained for combat operations.

The magnitude of the task was recently described in detail by Honorable Thomas D. Morris, Assistant Secretary of Defense for Manpower. The following are selected quotes from his presentation to the June 1966 Engineering Systems for Education and Training Conference:

> "There are over four million military and civilian personnel employed in the Department of Defense. Almost one out of every ten can be found in a formal training environment at any time during the year; and about four out of ten receive some period of formal training during each year....We have about one trainer or training support person assigned for every four people being trained--about 90,000 today....The annual training bill is $4 billion....These figures suggest, first, that even small improvements can produce very significant dividends to our military readiness" (2, p. 2).

There was a further breakdown of these costs:

> "Half of our training costs are devoted to enlisted personnel--over $2 billion annually....We averaged a recruit training input of close to 500,000 men annually between 1960-65, and had, of course, a much larger input this year. This basic program costs about $1 billion annually. It is, indeed, a mass production effort of the first order, with all the problems of mass production--planning, scheduling, logistics, and quality control" (2, p. 3).

Mr. Morris further described the resources allocated to skills training beyond Basic Combat Training (BCT) and Advanced Individual Training (AIT), and their counterparts in the other services. The cost of such training runs another $1 billion annually, and may require as much as a full year for completion. He continued:

> "...by the time our new soldier is ready to join a unit, we have made a sizeable investment in him--$1,200 for his basic training alone, plus another $2,000 to $12,000 for his skill training. While we must make this new soldier proficient for his task, we must, likewise, be sure we have not wasted time in teaching him facts that will prove of little or no value when he reaches the job. The challenge, therefore, is how to optimize the time spent in training, versus the time spent on the job, for the first term enlisted man" (2, p. 6).

The remaining $2 billion of the annual training bill is expended on officer training, pilot training (the cost of which approaches $1 billion per year), and other Defense training and education programs. If the cost of the training per annum is used as a criterion of the priority that should be allocated to the research supporting such training, the following is obtained:

(1) Enlisted training	$2 billion
(a) Basic training	$1 billion
(b) Skill training	$1 billion
(2) Pilot training	$1 billion
(3) Officer training	$400 million
(4) Other training and education programs	$600 million

If the scope of this paper is restricted to Army training, it is likely that the allocation for pilot training will drop sufficiently far that it will fall into the third category of importance, or perhaps the fourth; that is, its present position in the list is probably due to Air Force pilot training programs, in that these figures were service-wide.

My paper will be divided into two broad parts. The first will deal with training research that has had as an immediate objective a contribution to the effectiveness of specific training, usually through actual redesign of such training. Two broad criteria have been used to assess the success of such re-designed training: (a) relevance to the needs of modern combat operations; and (b) the efficiency of the training, measured in terms of decreased time, increased proficiency, or both.

The second part of the paper will deal with less applied research, that which has had as its immediate objective the acquisition of knowledge that contributes to training technology, and which has produced, among other things, the current enthusiasm about programed instruction, educational TV, and computer-based instruction.

APPLIED TRAINING RESEARCH

Basic Combat and Advanced Individual Training

A substantial amount of highly applied work has been done to improve basic and advanced individual training programs within the Army. Most of this work has had a specific orientation toward Infantry, although some has been oriented toward Armor. A great deal of work has also been done on training for technical Military Occupational Speciality (MOS) assignments, for example, for electronics maintenance. However, discussion of this will be excluded from the present paper in favor of more combat-related training for the soldier in the combat arms.

As will be seen shortly, training research efforts of this type have been engaged in one or a combination of three broad steps: (a) identification of the combat task facing the trainee, (b) development of training to produce skills on these combat tasks, and (c) evaluation of the training through the use of a proficiency test that reflects combat requirements.

Perhaps the best-known of these applied training research efforts was the series of studies under the name TRAINFIRE which led in 1955 to revision of the Army Marksmanship Training Program. The first step in the development of this training (3) involved a comprehensive analysis of the combat tasks of the infantry soldier. Characteristics of these combat tasks were identified and used as a basis for the design of training. Some of the factors dealt with by the analysis were:

(1) The nature of the combat target. It was found that it was not rare at all for a soldier to report having seen no targets at which to fire. The soldier who did see targets reported that they were fleeting targets, that is, they were typically moving and/or visible for only a short time. When taken under fire, the typical combat target logically sought to become less visible.

(2) Target ranges. Relatively few combat targets were found at extended ranges. This does not mean that the infantry soldier should not be able to hit a target at a farther range, but it does mean that the efficiency of his training is maximized when he is taught to hit typical targets effectively at the shorter ranges at which they are likely to occur before he is taught to hit targets at the longer ranges.

(3) Time pressures. If a target did present itself, it was usually available for only a very short time. Thus, the soldier needed to be able to fire quickly, before his target disappeared.

The training resulting from this analysis contained many innovations. First of all, the soldier was taught to fire at life-sized targets, which could "pop-up," simulating the sudden appearance of an enemy soldier. These targets were also close to the ground, another realistic condition that required the soldier to learn how to fire at targets so placed. Because most soldiers reported having seen extremely few targets in combat, training was also included on how to detect targets on the battlefield, and how to search suspected target locations by fire in order to hit enemy soldiers who might be concealed there.

It is worthwhile emphasizing that the objective of this new training program was not to produce a superior marksman, but rather, as Mr. Morris so aptly put it a decade later, to mass produce the most effective man-weapon assembly possible within the limitations imposed by existing resources.

However, the ability to use his weapon is not the only important skill area that must be mastered by the basic and advanced trainee. The ability to navigate over familiar and unfamiliar terrain under all conditions of visibility is also quite important. In a series of studies from 1955 through 1964, the important skills involved in land navigation were identified, and land navigation training programs were built into advanced individual training.

The strategy underlying this research effort was essentially the same as that of the earlier TRAINFIRE work. The objectives of the first study (4) were quite limited, specifically to find a more effective and economical method of instruction in map using for trainees. An experimental method was devised, but it did not increase map using proficiency in comparison with the methods then in use, although it did decrease training time. Nonetheless, there was a basic failure to increase skill in interpreting contour lines, and after their instruction, the trainees knew little about contour lines and marginal data on maps.

In a second study, Findlay (5) undertook to identify the skills that are important in field navigation, and to develop a valid, short, and convenient method of testing field navigation. Rosenquist (6), at about the same time, began working on a method for training soldiers to navigate over unfamiliar terrain under conditions of severely limited visibility employing only a map and a compass.

From these earlier studies, Follettie (7) was able to determine that it was feasible to teach trainees only two kinds of navigation techniques, dead reckoning (using compass and counting paces) and map-terrain association (using preselected terrain features that can be recognized and located on the map). Of these two, dead reckoning was identified as the more general technique; further, evaluation of the ability of trainees to utilize these navigational methods was tested under conditions of limited visibility, under the assumption that this was the more difficult test and thus the ultimate condition for which training should be developed. The training program developed from these assumptions enabled 75% of all pairs of trainees to pass the night land navigation proficiency test established as a criterion.

Continuing to build upon the basic data, Powers (8) developed a program of advanced land navigation instruction to be included in AIT, and increased the level of individual expertise beyond that produced by the BCT land navigation course. Again, the same strategy was used: Identify the performance requirement, develop training, and determine whether the performance requirement is met. Powers selected as his performance requirement the typical navigational requirement imposed by small unit patrols. Under daylight conditions, in three hours, it was required that a soldier be able to navigate over unfamiliar, difficult terrain for a distance of three kilometers and arrive at an objective that was 50 meters wide. By night, in two hours, it was required that a pair of soldiers navigate over difficult, unfamiliar terrain for two kilometers and arrive at an objective 50 meters wide. After training, 76% of the experimental group was able to complete the night requirements, as opposed to 5% of a group of subjects who had not had the training.

The objective of basic combat training is, in essence, to give the trainee the "basic polish" required to convert him from a civilian to a soldier. TRAINFIRE, and the first part of the land navigation work, were oriented toward assisting in this process. A third major developmental effort, RIFLEMAN, was oriented toward advanced individual training, the purpose of which is to complete the preparation of replacements for overseas movement (POR) qualification of the individual soldier, and to ready him for assignment to a fighting unit. However, since this work will be described in considerable detail in an individual paper later during this session, I shall not describe it further at this time. Nonetheless, it is worth noting that this effort also used the same basic strategy, identification of performance requirements (9), the development of training (10), and evaluation of the training to determine that the performance requirements are met. This, of course, does not constitute a comprehensive review of the training research that has had an impact on enlisted training, although the three research areas described probably constitute the most comprehensive of their type. Several other studies, important in their own right although they are more fragmentary, are worth describing.

Some of these studies are concerned with training the infantry soldier to deal with a night environment. One series was concerned solely with night rifle firing under conditions of severely limited visibility. (The importance of this skill has been amplified in recent years by the strong tendency for guerillas to operate under such conditions.) The ability of the individual soldier to hit targets under conditions of limited visibility was studied (11, 12, 13) and training methods were devised to enable him to use his weapon more effectively under such conditions. In the first of these studies, it was found, interestingly, that veterans of night combat firing in Korea were no more proficient than men who had just finished basic combat training. That is, under conditions of severely limited visibility, the veterans were virtually unproficient, despite their past experience. Fourteen hours of experimental training and the expenditure of 52 rounds during this training increased proficiency from 60% to 210%, depending upon the type of target.

However, the ability to use one's weapon, while important, is not enough. A further study by Neal (14) provided a more general analysis of infantry night operation problems. Eight skill areas were identified. Among these were land navigation; the ability to detect, locate and identify targets at night; the ability to avoid being detected by the enemy--a problem primarily of noise discipline; the ability to use effective communication techniques when operating as a member of a team; the ability to operate, identify, and install by touch the equipment that is used at night; and the ability to use appropriate techniques for engaging targets with rifle platoon weapons at night. Land navigation and the ability to use the rifle under conditions of limited visibility have been dealt with. However, training research is lacking in the other areas.

All the studies reviewed to this point have dealt with the content for basic and advanced training. There are three additional broad areas I will mention. One of these is a series of studies on noncommissioned officer leadership conducted by Paul Hood and his associates (15, 16, 17, 18, 19). (Since this work will be described in greater detail in an individual paper following this one, I will not describe it further except to note its presence.)

The two remaining areas will be dealt with at somewhat greater length. The first of these will be squad training and the second will be a series of research studies attempting to discriminate between fighters and non-fighters.

Training research interest in squads and platoons, as units, dates from Clark's (20) description of leadership in rifle squads on the Korean front line. These studies indicated, as might have been predicted from social psychological theory, that the effectiveness of a combat rifle squad is not simply the sum of the individual knowledges and skills of its members. There is a dynamic group process involved which must produce certain common goals and values among the group members if the squad is to be an effective unit. George (21) and his associates (22) have more recently initiated a series of studies to determine the feasibility of developing squad training which will produce the kind of squad member interdependence required for combat effectiveness. Preliminary indications are that such training can be developed and that it is effective, although more time is needed to be certain of the degree of effectiveness.

Research to differentiate between fighters and non-fighters began during World War II, with the studies on the combat effectiveness of the American soldier (23, 24), and was continued during the later stages of the Korean War by a research group from the Leadership Human Research Unit then located at Fort Ord, California. In two publications, Egbert and his associates (25, 26) reported the differential characteristics of fighters and non-fighters in units having recent combat experience. Later work by this team was devoted to attempts to build field situations that would simulate the stress of combat, in order to facilitate study of these stress processes under controlled conditions. Berkun et al. (27) described several successful situations, and the characteristics required by a situation that produces stress.

In broad summary, there has been a great deal of developmental training research to improve basic combat and advanced individual training. Most of the comprehensive engineering efforts have been oriented toward a single course or curriculum, to produce better assimilation of the knowledges and skills required for later successful performance. Those areas chosen thus far have probably been the most important areas that could have been chosen--the soldier's use of his individual weapon, his ability to move over unfamiliar terrain under any condition of visibility, his beginning ability to operate as a member of an infantry rifle squad, and, for those who are qualified, the ability to assume the beginning responsibilities of leadership within a rifle squad. However, there are obvious gaps that should be remedied. The individual soldier at the end of advanced individual training, for example, is probably far less adept at night operations than he should be. His ability to operate as a member of a unit is also limited; squad training and platoon training have been sorely neglected.

Whether there is a need for either of these two kinds of training cannot be determined except by opinion at this point. What does seem appropriate is a study of modern combat operations to identify the conditions under which the modern combat soldier operates, and the knowledges and skills required. The RIFLEMAN study, detailing the critical knowledges and skills required of the advanced individual soldier, which will be described by Dr. Ward, is sufficient for the AIT level. The question remains of whether more sophisticated training is needed by the soldier prior to entry into combat. Another gap in the research literature concerns the psychological conditioning of the basic combat trainee, and the advanced individual soldier. It seems reasonable to suppose that his training should condition him psychologically for combat, and should strive to develop a high degree of motivation to perform his soldierly skills effectively. Aside from a smattering of studies, there has been little work to develop effective training to accomplish these goals.

Developmental engineering research on officer training is even more scarce than in the area just reviewed. Perhaps the most comprehensive engineering effort in the officer training area was accomplished in a series of studies by Lange and his associates (28, 29, 30) under OFFTRAIN. The objective of this research was to identify the kinds of leader-follower interactions that underlie effective leadership, and then to design a program of leadership instruction that would teach an understanding of these processes to junior officers. In a first study (31), this group collected a large number of accounts of leader-follower interaction, which were content analyzed for behavioral variables that could be related to leader effectiveness. On the basis of these findings, Jacobs (32) developed a program of leadership instruction for junior officers which presently is in use in all Army ROTC units.

Roach and Baker (33) and Baker et al. (34) have developed training for the armor platoon leader. In the first of these two studies, the authors analyzed and described the combat job requirements for tank platoon leaders and tank platoon sergeants, and obtained information on the combat importance of each requirement. In the second study, they developed ten tactical training exercises that were employed under two kinds of conditions, one a miniature armor battlefield, and the other an armor combat decisions game. These two environments were calculated to improve the technical capabilities of armor platoon leaders in analysis and use of terrain, command and control, application of tactical principles, target selection and tank fire control, and coordination and reporting of combat information.

In more recent studies, Powers has conducted a study of performance requirements imposed by the initial duty assignment of ROTC graduates. This work will be described at greater length in a subsequent individual paper. Ammerman (35, 36, 37) has identified training objectives for the Nike Hercules fire control platoon leader and has developed procedures for developing task inventories and deriving and classifying training objectives. Olmstead has prepared a background volume1/ designed to provide an understanding of leadership processes at high organizational levels, specifically division and above, for the U.S. Army Command and General Staff College. Work is presently under way to identify the critical combat knowledges and skills of the infantry rifle platoon leader.

1/ Draft report, "Leadership at Senior Levels of Command," by J. A. Olmstead, HumRRO Division No. 4 (Infantry).

In summary, developmental training research for the officer is sparse in comparison with that for the enlisted man. This probably is as it should be, since the number of enlisted men receiving training on a yearly basis is quite massive in comparison with the number of officers receiving training. However, the importance of officer training research is probably substantially greater than would be indicated by the amount of such research that has been accomplished. For example, there is very little systematic knowledge about the performance requirements placed on officers above platoon leader level. Nor has there been any training of demonstrated success in developing such complex cognitive processes as decision making and maximally efficient utilization of a military organization to accomplish stated objectives. Probably one reason why such research has not been done is its obvious difficulty.

TRAINING METHODS RESEARCH

In this section, I will deal with a very limited selection of studies on training methodology, per se. The studies in the preceding section have, by and large, had as an objective the revision or engineering of specific training to qualify a student to accomplish the requirements of some particular duty. The studies in this section are not oriented toward a particular duty assignment, but rather toward a comparative analysis of methodology and training media. Thus, this research has more general application, and less specific utility. Three major developments in training methodology (training media) will be discussed: Programed instruction, educational TV, and computer-based instruction.

Programed Instruction

Most authors attribute the origin of programed instruction to S. L. Pressey (38), who in 1926 described a device that was intended to give tests and score them simultaneously. It was thought to teach at the same time. Most educators and psychologists would agree that this device did, in fact, teach because it remained locked for each item until the correct key was pressed. This provided a learning experience for the student.

For some reason, this device did not "catch on" among the academic community, nor was its potential for instruction utilized. However, in 1954, B. F. Skinner (39) described a teaching machine that permitted self-paced, reinforced practice. Perhaps because of the emphasis on the teaching function of the machine, as opposed to testing and scoring, programed instruction as a generalized approach to teaching began to "mushroom" at a fantastic rate. The programing technique advocated by Skinner involved small steps, required the student to respond actively to each step by filling in a blank, provided knowledge of results to act as a reinforcement for the student, and, in general, utilized many of the learning principles that had been derived from his studies of white rats and pigeons in the laboratory. For whatever reason, good principles or good instruction, his students learned and learned well.

During the period from 1954 until the present, the growth of programed instruction has been phenomenal. Melching (40), for example, cites six reviews of programed instruction literature:

(1) Carr, Self-instructional devices: A review of current concepts. August 1959, from Wright-Patterson AFB.
(2) Ekstrand, et al. Teaching machines in the modern military organization. December 1960, from Wright-Patterson AFB.
(3) Ugelow, Motivation and the automation of training: A literature review. March 1962, from Wright-Patterson AFB.
(4) Darby, An annotated bibliography on the automation of instruction. July 1959, from Air Defense Human Research Unit.
(5) Silverman, Automated teaching: A review of theory and research. June 1960, from Naval Training Device Center.
(6) (No author) Automatic teaching machine, devices; First interim report (Part I). July 1961, from Marine Corps Equipment Board, Quantico, Va. (40, p. 2).

Most of the early work on programed instruction led to the finding that students learned either better or faster from programed instruction material than from conventional material. Because of the remarkable efficiencies that seemed to be available through the use of programed instruction, the military establishment, and particularly the Air Force, began to invest heavily in the programing of instruction. For example, some of the results of the Air Training Command's implementation of programed instruction material were summarized by Ofiesh (41):

> "In comparison with conventional instruction the programed packages resulted in average mean reduction of 33% in training time and a gain of 11% in achievement. Of 46 packages that went through comparative testing with conventional procedures the median reduction in training time was 40% and median gain was 9%. This was accomplished with limited resources and experience" (41, abstract).

However, at the same time, storm clouds were gathering. Lumsdaine and Glaser (42), while editing a volume on teaching machines and programed learning, concluded cautiously that the papers collected in their volume represented only the beginning of the effort needed to develop the technology of instructional method which might be possible.

> "At this early stage it seems premature to predict the specific outcomes toward which sustained effort in this direction may lead. What does seem predictable is that the explicit identification of variables and functional relationships which influence the modification of behavior through instruction will continue to be the heart of effective attempts to improve education" (p. 563).

They predicted also the possibility that "teaching machines" and "programed learning" as terms might disappear, that the role of reinforcement and feedback might change or be differently conceived, and that the nature of programs themselves might change. They also feared that a major problem could arise from premature publication and sale of hastily conceived and untested programs. "This would pose a serious problem, since flooding the market with such programs could tend to discredit the whole concept of programed instruction" (p. 566). And of vital importance, they gave a clear call for re-emphasis of objectives as opposed to means. "It seems clear that standards for the adequacy of a program ought to be conceived primarily in terms of its effectiveness in obtaining defined educational objectives, rather than by specifying the format, sequencing, or other aspects of the means whereby these ends are achieved" (42, p. 556).

This cautious warning was well-taken. Not all programed instruction worked. For example, Melching, Christensen, and Kubala (43) reported an auto-instructional program in basic electronics in which performance on a criterion test was roughly the same for programed instruction and conventional groups, and in which only one-third of the programed instruction students completed the course in equal or less time than was required under conventional instruction.

Feldhusen (44) summarized the state of the research in programed instruction quite effectively as "Taps for Teaching Machines." While I do not wish to imply that programed instruction is a "flop," let me, with Feldhusen's article, summarize some of the earlier misconceptions in the light of recent findings.

(1) Active participation. One of the initial postulates of programed instruction was that learning required active participation. Feldhusen notes that a number of studies have shown that the blanks can be filled in without affecting performance. McCrystal and Jacobs (45) found this to be true. The major outcome from relieving the student of active participation is that there is a saving in time.

(2) Reward for correct performance. As Feldhusen notes, the finding that active responding is not required also marks the demise of the concept that feedback is necessary. A linear program that produces 90% to 95% correct responses seems to present the student with so little difficulty that he does not need the feedback. Stolurow (46) also comments on this point, noting that most linear programs seem to relieve the student of the need for feedback.

(3) Size of frame. There is no definitive evidence on this point, though in unpublished research, Follettie and McCrystal found that reduction of the programed instruction material back into narrative format did not decrease the effectiveness of the material for instructional purposes. If a narrative presentation can be equated with a large frame, then apparently a large frame will do as well as a small one. Feldhusen substantiates this finding by noting that when linear programs have their blanks filled in, and are then reassembled into paragraphs, they resemble narrative materials in texts. Not too surprisingly, they teach as well as the programs from which they were derived.

(4) Elimination of individual differences. Early advocates of programed instruction apparently believed that this medium would eliminate student ability differences. As Feldhusen puts it, this notion also has "hit the dust." As one example, McNeil and Keislar (47) reported correlations between mental age and achievement of .43 to .89. It is highly likely that programs which eliminate individual differences are channelled toward the lowest common denominator in the classroom, with the result that the brighter student is penalized.

Feldhusen concludes that the movement has gone too far and too fast. The enthusiastic application of the so-called principles of programing has not paid dividends. He calls for stepping back to see if there is anything in the movement that is of value, and, perhaps of greater importance, to proceed with caution in putting programed instruction into the schools.

Feldhusen's critique of programed instruction is harsh indeed. However, Stolurow (46) writes in essentially the same vein:

> "Most of the notions about programed instruction, as formulated in the age of the black-box and linear program, are now primarily of historical interest. Needless to say, they were important stimuli for a good deal of research and a good deal of verbal behavior. Black-box programed instruction also served as a catalyst for a second generation of concepts which are developing rapidly even before their predecessors have been laid to rest. However, if we had to sum up, the most optimistic of us would have to admit that the past decade has led to more psychological heat than light. In part, this can be traced to the use of more vigor than rigor in research, and to the greater emphasis upon inception that conception" (46, pp. 1-2).

Stolurow further caustically describes the old concept of individualized instruction:

> "Right or wrong they all go from frame to frame, some being shaped, others reshaped, and still others bored. This was not very much of a change from the conventional pre-planned instructional experience provided by the more efficient and conscientious classroom teacher. In short, instructional experience was not really individualized. What the student saw next was not dependent upon his responses and therefore not tailored to his needs. In this form of programed instruction the information presented to all students is the same in content and in sequence" (46, p. 2).

The question then is, whither away in programed instruction? Is it a brilliantly useful new technique, or a fad that is even now passing from the scene?

If we re-examine the technology of training, as applied in the earlier developmental training research reviews, it is instructive to find that the major emphasis is upon training objectives. Smith (48) summarized seven steps that are essential in the development of instruction:

(1) Analysis of the operational system and the training system.
(2) Analysis of the job.
(3) Analysis of the tasks to specify required knowledges and skills.
(4) Determination of training objectives.
(5) Construction of the training program.
(6) Development of measures of proficiency.
(7) Evaluation of the training program.

Perhaps the key elements are steps 2, 3, and 4. This emphasis on objectives, of course, is not new. Robert F. Mager (49) had written a program on describing objectives two years earlier. Crawford (50) had emphasized the same point in discussing the technology of curriculum development two years before that. And solid developmental training research had been using the objectives approach many years earlier.

The fact that programed instruction worked in some situations and not in others leads one to ask why it worked when it did. As a way of obtaining an answer, let us examine the typical manner in which a program is developed. If he works carefully, the program author will analyze the task to be performed, identify knowledges and skills essential in its performance, and establish training objectives. After writing the program, and receiving technical review of its content by a content expert, he submits it to an actual try-out with students. Carefully recording student responses, he obtains feedback for himself as to where the students have problems. Also, if at this point he has developed a criterion test keyed to the training objectives on which his program is based, he will have further knowledge about which training objectives are being achieved and which are not. (Indeed, Komoski1/ has noted that the teachers themselves are taught by this process.)

It is highly tempting, in summary, to view programed instruction not as a special and especially effective medium, but rather as merely another form that instruction can take. The form, however, is not critical. The content is. Once the content is engineered to produce student understanding, it can be presented in almost any form with roughly equivalent effectiveness. Again, the key is the careful analysis of tasks to identify training objectives, and the equally careful sequencing of material to produce understanding.

Thus, the question of whether programed instruction should be used as opposed to another medium should be answered on an individual basis by determining whether it results in more efficient instruction. Efficiency at this point would be defined in terms of cost per student hour. Under some circumstances, presentation by some means other than a programed book will prove more efficient or less costly, or both. As an example of the logistical nightmare that can occur, consider the description of the support requirements for a program cited by Klaus and Lumsdaine (51):

> "During the course of this study, some 500 students were furnished with auto-instructional materials consisting of about 3,000 frames in high school physics. These materials represented slightly less than 20% of the content of the corresponding physics course but, nevertheless, involved logistics of considerable magnitude. For instance, the materials furnished to these 500 students required over 3 1/2 tons of paper and 120 dozen loose-leaf notebooks. Had the entire course been prepared in the programed-text format used, it would have been necessary to furnish each student with the equivalent of twenty-two 300-page volumes at an estimated cost of $66 per student" (51, p. 198).

It is my suspicion that he refers only to the cost of the materials when he states $66 per student.

However, it probably is reasonable to predict, as did Stolurow (52), that programed instruction--or perhaps I should say well-engineered

1/P. Kenneth Komoski, "Current Development and Experimentation in the Field of Programed Instruction," unpublished article.

written content--is here to stay, on the basis of its generally greater efficiency in the teaching process. It will stay either in the form of written materials or materials presented by means of high-speed computers, which I will discuss shortly. In my own view, the reason for its greater efficiency is that a student will read, generally, at approximately 200 words per minute or better. He can "listen" only about two-thirds that fast. Thus, if the material is equally well-engineered, there is approximately a 30% to 40% saving when the visual modality is used in comparison with the auditory modality. It would appear that this greater efficiency, and the opportunity to use self-directed student study instead of classroom presentations by instructors--thereby conserving instructional resources--would be sufficient reasons to keep well-engineered written materials around for some time.

Educational TV

If the literature on programed instruction has blossomed in the past 10 years, the literature on educational TV cannot be said to have been stagnant. A partial bibliography prepared in October 1964 contained 114 references. A very large number of these consisted of books and technical reports describing the effectiveness of closed circuit television in various educational applications, without comparative evaluations. A large number of reports and articles, however, do provide comparative evaluation in a relatively rigorously controlled experiment between educational television and conventional classroom presentations.

A complete review of the literature on educational television is obviously impossible within the scope of this paper. In a joint publication by the Ford Foundation and the Fund for Advancement of Education (53), it was noted in 1959 that at the time of publication, in the United States, there were a total of 117 colleges and universities offering television courses for credit, 241 colleges and universities offering credit for Continental Classroom, and 569 school districts making regular use of televised instruction. The authors note that six years previously there probably would have been no more than a half-dozen such uses of educational television. Further, the growth of educational television as a medium has undoubtedly expanded subsequently at an even more rapid rate than during those six years.

One of the more interesting reports of comparative study of closed circuit television is reported by Carpenter and Greenhill (54). Their report covers the second and third academic years of The Pennsylvania State University television project. Among the courses taught were general psychology, general chemistry, elementary business law, introductory sociology, elementary meteorology, and music appreciation. In all these courses, there were no statistically significant differences between direct instruction and televised instruction with the same teachers teaching comparison groups.

Of perhaps more vital interest, this report contains a cost analysis for the courses taught during 1956-1957 (psychology, accounting, sociology, and air science). This analysis indicates a saving in favor of television of $7,545, $980, $2,747, and $27,443, respectively. Of course, in evaluating the savings, it should be noted that the cost per student credit unit varies as a function of the number of students taught. At Penn State, the break-even point occurred with a density of approximately 190 students. Further, Penn State apparently relied upon live instructors; if video film or tape had been used, it is likely that the cost per student might have decreased, especially over successive presentations of the course material.

It is instructive to inquire at this point, as was done with programed instruction, as to the advantages and disadvantages of closed circuit television. It is interesting to recall the work done during World War II on films for troop information. One excellent series of experiments is detailed by Hovland, Lumsdaine, and Sheffield (55). What is different about educational TV?

The answer appears to harken back to the general concept of efficiency. Educational television is merely another audio-visual medium, and does not differ in effectiveness from films, except insofar as it seems to have the ability to "capture" the student to a slightly greater extent (56). However, if the audio-visual presentation is on a television receiver, it apparently does not matter whether it is filmed or "live," so long as the student does not know which is the case. Thus, the merit of educational television stems from its relative cost, and the ability of administrators to present the student either (a) the best instruction available, over and over, or (b) demonstrations or views of demonstrations that could not ordinarily be arranged for the student. However, neither of these added capabilities is minor as a consideration. Indeed, Carpenter and Greenhill note that at Penn State, through the use of educational TV, the business administration department was able to meet increased student enrollment in the accounting class without an increase in staff, during a period when it might have been extremely difficult to add personnel.

Computer-Assisted Instruction

In contrast with the literature on programed instruction and that on educational TV, the literature on the use of computer-assisted instruction is only in its infancey. It appears very likely that the extreme cost of the computer facilities required to make advances beyond the stage already noted in the literature will prohibit studies except by relatively more sophisticated centers concerned with the learning process itself, instead of merely with the use of the computer as a medium. Even so, Hickey and Newton (57) noted in a review early in 1966 that their report covered approximately 100 documents abstracted prior to December 31, 1965, and that they had not covered all the literature available.

One of the most basic problems in instruction is the fact that the individual student is just that, an individual. Classical instructional systems have been unable to do more than offer token solutions to this problem. Admittedly, if the same treatment is given a class of students, most of them learn at least something. However, the conditions of learning are maximally effective and efficient for no more than an extremely small minority, and sometimes for none at all.

I regularly teach statistics, to rather small classes. For this subject, there are certain terminal performance objectives that are required, and certain others that are desirable. The content presented during class meetings is organized around these objectives. Occasionally, because of duty requirements, a student misses several consecutive hours of classroom work and needs individual tutoring to make up the work.

A typical finding is that a student can cover successfully in one hour of tutoring that which would have required three to four hours as a member of the class. In other words, given a clear knowledge of terminal performance objectives, I am 300% to 400% more effective and efficient as a teacher when interacting on a teacher-to-single-student basis. There are at least two reasons for this. One is that I can pitch the difficulty level of the material exactly to his level of ability to absorb it, and adjust that level with precision as necessary. Second, I can diagnose errors he makes in interacting with me, and thus correct his misconceptions and misunderstandings with much greater speed than would be possible in the classroom. In this setting, I am acting much like a computer will eventually act, providing highly individualized instruction for the individual student.

This problem of individual differences is staggering within the conventional instructional system. Rigney (58) describes its magnitude:

(1) Variation in intelligence and prior achievement at any given level. He notes that by grade 6, 2% of the students will have mental ages (MAs) lower than 8 years and 2% higher than 16 years, a range of more than 8 years. Most high school teachers will find a range in MA of 6 to 10 years. (Teachers have typically reacted to this problem in two ways, by segregating students according to ability, and by devoting a disproportionate amount of their time to students of lower ability, leaving the brighter students on their own.)

(2) Different learning abilities. Allison's factor analysis of learning abilities produced seven different underlying factors. Learning for any given student would be optimized if his instruction contained the balance of learning requirements that best matched his ability structure.

(3) Different kinds of learning curves. Not only are there differences from one person to another, but there also are differences from one session to another for a given student.

(4) Shifts in aptitude patterns. Finally, there is evidence that aptitude patterns change during the learning process. Students seemingly enlist different combinations of abilities at different learning stages.

Human instructors cannot deal effectively with the first of these sources of individual differences in the classroom setting. It is difficult to see how they could even be sensitive to the remaining three sources. However, a computer can. As Stolurow notes (59, 60), a computer provides the means for detection of individual differences, for the provision of differential feedback to students based on their individual differences, and for shifting from one criterion to another in order to determine what instructional rule holds at any given point in time, based on the student's needs.

There are two basic uses of the computer in the instructional process, one as a sequencer of content, and the other as an author. As a sequencer, the computer merely schedules content which has previously been "canned." Such a system might contain only three elements, the computer, an interface between the computer and the student, and the student himself. The interface might be some kind of audio-visual apparatus, such as a random-access slide projector. In such a system, the computer activates the interface mechanism to present material to the student, senses the student's response to the material, and then activates the mechanism to present a subsequent unit of material.

The principal advantage offered by such a system is that it is possible to instruct the computer to do a number of operations on the student's responses, such as counting the number of errors, classifying the types of errors, and so on. The outcomes of these operations, and other more complex operations that could be performed, constitute criteria on which decisions may be based as to subsequent material that should be presented the student.

Rigney (58) has described two kinds of content sequencing, "remedial sequencing" and "predicted sequencing." Remedial sequencing involves monitoring student responses so that when the quality of these responses drops below a certain limit, the computer either resequences the content, or switches to a remedial loop in the instruction to remedy the defect. The computer's capability, when used as a sequencer, does not go beyond remedial sequencing. While this is an obvious advance in instructional technology, it basically is not much different from the kind of thing that can be done with a good programed book, except in some special applications. Consequently, though it is a clear advance, it is not what might be described as a quantum jump.

The eventual promise of the computer probably will be achieved only when the computer is used as an author, taking instructional material from its memory and reconstituting it to provide intelligent communication of a Socratic nature with the student, giving the student material tailored to his own individual capabilities, and, indeed, perhaps eventually, to his interests and personality. Rigney describes this as "predicted sequencing," which, in contrast to remedial sequencing, involves analysis of student characteristics, and the subsequent prediction of the best sequence of material to produce optimum learning. At least theoretically, this will permit highly individualized instruction that not only will produce much more efficient student learning, but will also relieve the instructor of much of his instructional load, and thereby conserve scarce instructional resources.

However, there are hurdles to be crossed before this final goal is achieved. At present, the interface--the means by which the computer and the student communicate--is a weak link. Indeed, Estrin (61) believes it to be the weakest part of the system. While this is debatable, the fact that it constitutes a problem is not.

If a weakest part is to be identified, it is likely that content should be given the dubious prominence so afforded. Rigney (58) notes three requirements for predicted sequencing:

(1) Systematic classification of individual differences on which to base predictions.

(2) A systematic classification of ways of presenting subject matter.

(3) A body of information of interrelations between (1) and (2).

These three needs are a long way from being satisfied. As Estrin (61) notes succinctly, learning theory as it now exists, simply is not very useful in sequencing real-world subject matter. Rigney comments that the study of individual differences and the study of learning theory have taken separate roads, with the result that there is no mutual body of knowledge. Further, not very much is known about the logical ordering of subject matter, learning theorists having concerned themselves primarily with elimination of individual differences rather than their study, and control of subject matter through use of trivial content rather than its examination. Roderburg, et al. (62) concede that "The preparation of teaching material for programmed teaching machines is a complex task. Computer-directed teaching machines require that a structure be identified for each subject taught" (p. 1).

The expense involved in such detailed treatment of content is obvious. Informal information from the IBM Computer-Assisted Instruction Laboratory at Yorktown Heights, N. Y., on the cost of developing a one-year programed CAI course in algebra, a relatively straightforward subject, is quite instructive. Assuming 90 hours in a classroom setting, the estimated cost of the software for the computer, that is, content and instructions, runs to approximately $175,000, or almost $2,000 per classroom hour. The operating cost of the computer to administer the instruction is extra.

Nonetheless, research is being done to solve these problems. In their 1966 review, Hickey and Newton (57) identified 12 different laboratory facilities utilizing a complex computer within an instructional system. It appears that at least four of these either have the current capability of limited use of the computer as an author or verge upon this capability.

The Technology of Training

The preceding sections of this paper have presented reviews of several developmental training research efforts which produced a direct impact on training effectiveness, and selected reports of research on three educational media. In all of these, it was concluded that effectiveness depends upon content, rather than upon medium. In three separate publications, Smith (63, 64, 65) describes the development of training objectives on which to base instruction, the control of the quality of training through the use of training objectives, and the design of instructional systems based on training objectives. It is difficult to avoid the conclusion that the medium of instruction is relatively unimportant, compared to the content.

One selected set of studies on electronics maintenance will illustrate this point. In describing these studies, Shriver (66) details several years of training development. In the first research effort (67) data were obtained on activities of maintenance technicians in the field, including data on the frequency of different types of failures, and so forth. Training was changed to reflect the kinds of activities these technicians actually performed, with the result that individuals receiving the new training were equal in ability to men who had been in the field for a year. The rationale was simply that of learning what the man really does out there, and then tailoring the training to it. In a later effort (68, 69) following the same philosophy, experimental training was reduced from 37 weeks to 22 weeks, with no decrement in performance. Without detailing subsequent steps, the ultimate outcome of basing content on actual performance requirements and sequencing it approximately was that training time in one final electronics maintenance course was reduced by 60% (from 1,000 academic hours to 400 academic hours) and the performance level of the experimental and standard groups was essentially the same. A second test was performed, reducing time by only 50% and providing a special training device for troubleshooting practice, with the result that experimental students performed at a 40% higher level than the conventionally trained students. Of course, the findings in electronics maintenance are more dramatic than those obtained elsewhere, because the criterion of performance effectiveness is so readily available. However, the need to base training on terminal performance requirements is general to all training.

In summary, the effectiveness of a training system or a training medium is dependent not on the specific form of the medium, but rather on the extent to which the content transmitted to the student is oriented toward achieving training objectives which realistically reflect terminal performance requirements. Beyond this single requirement, the question of which medium to use for instructional purposes, at least at present, appears to depend entirely on the question of cost effectiveness. For military instruction, particularly in high-density courses, it appears that programed instruction, educational television, and computer-assisted instruction will provide massive gains, though only if they are utilized in a manner that conserves instructional resources. If this is not taken as a deliberate objective, these newer media are likely to increase costs to a greater extent than they increase the effectiveness of training. Of these three, computer-assisted instruction, although in its infancy, may offer the greatest promise, by virtue of its potential for providing individualized instruction, completely independent of human instructors.

* * *

The remainder of this session will consist of five individual papers, which will give more extensive coverage of some of the concepts introduced in my paper. In the first, Dr. Ward will describe the developmental engineering of a training program for the advanced individual soldier. He will describe the entire sequence of steps from development of objectives to completion of training. Mr. Powers will follow with a description of methodology used to identify very broadly stated knowledges and skills that can serve as a foundation for officer training. Dr. George will describe some pioneering work on the development of teamwork training for units of men, as opposed to individuals.

The final two papers fall into the realm of extrapolations. Dr. McFann will describe the need for individualization of individual training within the Army. This, as a goal, may not be within reach in the combat arms, or, if so, perhaps not for some time. However, McFann's thesis is that it probably could be achieved very soon for some or many of the technical specialties. Support for this thesis is contained in the final paper[1/] which will be presented by Dr. Richard K. Wilson, Dean of Instruction, Oakland Community College, Pontiac, Michigan, who will describe a junior college in which this goal has in large part been

1/ "An Application of the Systems Approach to Instruction," by Dr. Albert A. Canfield, Mr. Walter J. Fightmaster, and Dr. Alvin Ugelow.

achieved. The significance of this achievement cannot be overemphasized because it clearly indicates that the theoretical benefits of a systems approach to instruction can be realized in fact, and that individualization of instruction is both a practicable and desirable goal.

A CASE STUDY OF THE DEVELOPMENT OF AN INDIVIDUAL COMBAT TRAINING PROGRAM

Joseph S. Ward

In answer to a requirement from Headquarters, USCONARC, HumRRO initiated Work Unit RIFLEMAN, to develop training to improve the effectiveness of the individual soldier who bears the brunt of close combat--the Light Weapons Infantryman.

Before proceeding to the actual training development, however, I would like to spend a few moments discussing, in general, some of the problems that continually plague any such developmental program.

The first problem concerns the validation of the training program and a peripheral concern. I am not referring here to evaluation testing where the newly developed program is compared to one already in existence. This concern goes beyond evaluation as such and, essentially, asks the question: "Is this training program related to the needs of the actual job?"

We would probably all agree that the ideal method for determining the validity of a newly developed training program--in effect, a weapons system--would be to turn the products of this training over to users for performance testing, under actual operational conditions. The conditions of actual combat provide the ultimate testing ground for the products of military training, and set the conditions that must be met.

However, the conditions of actual combat are usually not available to the curriculum engineer, even when they exist. Most military commanders are less than overjoyed at the prospect of conducting military operations with new and untested products, whether personnel or materiel. They are more than aghast at the mere thought of a scientist following individual members of a rifle squad in combat with pad and pencil in hand.

Curriculum engineers must necessarily resort to some approximation of the actual combat conditions when designing improved training in individual combat skills. Such an approximation must be developed through the use of trusted experts whose knowledge, information, and experience constitute an assurance that the approximation developed is a meaningful one.

It would be possible to use a single military expert for this if we could be assured that our choice of this expert was correct. However, since all of the necessary background data for determining the choice of a single expert are rarely available, the most satisfactory method we have found involves the use of a number of experts, with each functioning as a check on the other.

Another problem faced by the curriculum designer is that of dealing with traditional subjects which are difficult to relate to an actual performance requirement. Some subjects are designed to teach performance skills that are no longer necessary in the jobs for which students are being trained. The "operational" conditions exist only in the training program and have no real relation to the real world. As a consequence, there is no real application for the knowledges and skills learned. A related problem is occasioned by classroom training. While the primary purpose of classroom training is to create behavior in the real world, classrooms seldom mirror the real world faithfully, but rather are tolerated under the pressure to mass produce a minimum necessary skill level with a minimum expenditure of training resources.

A second problem, and a much more insidious one, encountered by the curriculum engineer is concerned with the differentiation between "training realism" and "realistic training." Training realism may be defined as the maximizing of realistic combat conditions in a training program, while realistic training is concerned with the maximizing of conditions conducive to learning in a training program. In other words, it is more concerned with training conditions than with job conditions.

These concepts are not necessarily opposed to each other, but the haphazard design of training programs may make them appear to be. Many changes have been made in training programs in the interest of "training realism" which actually detract from "realistic training" in individual skills. This occurs, for example, when, in the interest of maintaining training realism, exercises are not interrupted to make immediate corrections of individual errors or improperly applied skills, or to explain to confused trainees what is happening. It also occurs when exercises are conducted on a "real time" basis to conform to combat conditions, with the resultant utilization of training time for essentially unproductive purposes. In patrolling, this might take the form of long, unproductive walks through woods instead of long, hard drilling on necessary individual skills.

The early stages of training should be concerned primarily with the establishment of well-drilled fundamental skills. Those conditions that contribute to realistic training should be emphasized. Too often, the superficially most logical progression in training throws the man into situations requiring proficient use of skills before the fundamentals of these skills have been mastered. Time and resources are wasted whenever there is an attempt to advance before the fundamentals have been completely learned. However, once the fundamentals are mastered and tactical training which makes frequent demands upon these fundamentals is instituted, the complexity of tactical training can be increased and practice continued profitably. More and more of the conditions contributing to training realism can be added to training exercises until they become quite similar to actual combat.

I have chosen Work Unit RIFLEMAN for my presentation because it represents a complete job of curriculum engineering of an individual training program. Except for our method of arriving at the Critical Combat Skills, Knowledges, and Performances, which had to be adapted to the problems of analyzing a man-ascendant1/ system, we believe that our methodology might be applicable to any curriculum engineering requirement, be it military or otherwise.

Our research fell into 10 progressive steps:

(1) Study of doctrine and literature.
(2) Determination of essential combat subjects and levels of proficiency.
(3) Determination of essential skills, knowledges and performances.
(4) Selection of performances most related to combat and those most in need of additional training.
(5) Development and administration of test to Advanced Individual Training (AIT) Graduates.
(6) Observation and analysis of pertinent training at Army and Marine Training Centers.
(7) Analysis of shortcomings of AIT graduates and ongoing training.
(8) Determination of possible improvements in training.
(9) Construction of the training program.
(10) Development and testing of lesson outlines, instructor's guides, and detailed lesson plans.

Step 1: Study of Doctrine and Literature

The literature search included study of (a) pertinent Army doctrinal publications, field manuals, training circulars, Army training programs, etc., (b) military periodicals, (c) military books on small-unit actions, (d) monographs of student officers at USAIS, and (e) duty assignment of AIT graduates.

Step 2: Determination of Essential Combat Subjects and Levels of Proficiency

Utilizing the experience of combat veterans, subjects essential to AIT and levels of proficiency necessary in each subject were determined. Veterans were asked to relate each subject to need for effectiveness in combat, duty assignment upon graduation from AIT, weapons to be used (projected), and average terrain and climatic conditions.

Nonessential subjects were eliminated. Those needed through the projected date were included or added, and levels of proficiency for each subject were determined. Concurrence of the U.S. Army Infantry School (USAIS) was obtained.

1/ This is in contrast with much more easily analyzed machine-ascendant systems, in which the machine provides structure to the tasks performed by the man and makes the task analysis far easier to perform.

Step 3: Determination of Essential Skills, Knowledges, and Performances

It would have been desirable to determine essential skills, knowledges, and performances directly from the job performed as in an industrial job analysis. Because any sampling of the combat infantryman's performance in combat would be difficult to get and might be distorted by local conditions, an indirect approach was followed. Military personnel with infantry combat experience ranging from World War I through the Korean conflict studied and recorded, under our supervision, their conceptions of the combat job, in the projected time frame of the LWI--making their analyses for each of the subjects in Step 2. These analyses were based on (a) previous research memoranda, (b) a conceptualization of the projected battlefield, (c) the anticipated use of specific weapons, (d) current field manuals, Army subject schedules, Army training programs, training circulars, and so forth, and (e) their own combat experiences.

After the performances, knowledges, and skills were formulated, selected combat-experienced Infantry officers and noncommissioned officers were questioned to obtain supplementary information and suggestions for modification of the existing material. Where significant modifications were suggested, the papers were revised to reflect such additions or deletions. After several stages of review, "murder," and revision, the papers on all combat subjects were submitted to USAIS for review and comment. Differences reflected in USAIS comments on the papers were reconciled.

The outcome of this step was a set of 41 subjects judged essential to the training of the Light Weapons Infantryman. Essential combat skills, knowledges, and performances for each of these subjects were then recorded for these subjects. In all, there were 102 performances, each having its own underlying skills and knowledges, which then constituted the basis for a test of currently trained Light Weapons Infantrymen, as well as a basis for the content of the improved training to follow.

Step 4: Selection of Performances Most Related to Combat and Those Most in Need of Additional Training

Combat veterans then were asked to choose 60 of the performances they thought were the most directly related to combat missions, and then to arrange these performances in order of their essentiality for entry into combat. Additionally, 50 members of a STRAC division, users of LWI graduates, were asked to arrange the same 60 performances to reflect the greatest need for additional or better training, if the graduates they were receiving were to be sent immediately to combat. We selected the 13 performances judged to be most in need of improved training and most combat-essential for inclusion in a test of the LWIs then currently graduating.

Step 5: Development and Administration of Test to AIT Graduates

We then developed a field test incorporating the 13 selected performances, on which 51 men (25 M1 subjects and 26 BAR subjects) were tested immediately after graduation from AIT. During each administration of the exercise, four men were evaluated individually as they participated in a series of actions which included a night engagement of infiltrators; an advance to, and reduction of, an outpost; an advance to, and assault of, an enemy position; a consolidation and defense of that position; and an engagement of a moving tank.

Generally, the results of this study identified shortcomings in the AIT graduate in performing duties of LWI in combat. These aspects of performance, which received special attention in designing new training, included:

For Weapons Training

(1) Firing from a fox hole at moving targets for both M1 and BAR.
(2) Firing during an advance from standing and kneeling positions.
(3) Accuracy for single and multiple stationary personnel target, especially with increase in range.
(4) Direction and distribution of fire at point targets and suspected enemy locations while advancing from 100 to 35 meters in position.
(5) Accuracy in tossing hand grenades and also, in a weapon-choice situation, recognizing when grenades should be used.

Performance of rifle grenades and launchers was comparable to that of other weapons.

For Tactical Training

(1) In response to effective small arms fire, taking cover and immediate return of fire.
(2) Distribution of fire both vertically and laterally while firing from fox holes at a range of 140 meters and upon verbal order.
(3) Shifting to "surprise targets" in a timely fashion.
(4) Surveillance of the area for enemy targets, including observing for enemy activities, while reloading weapons.
(5) Taking and using available cover and concealment, and minimizing exposure to enemy fire while firing from ground positions or fox holes.

Step 6: Observation and Analysis of Pertinent Training at Army and Marine Training Centers

Armed with knowledge of deficiencies uncovered in Step 5, Work Unit personnel made detailed observations of all pertinent ongoing training at three Army Training Centers and one Marine Training Regiment. These observations reinforced the test results (Step 5) and gave positive indications of where methods of instruction and content fell short of effectiveness. Questionnaires, administered to training center personnel, further indicated areas for improvement. There was confirmation, generally, of the skills, knowledges, and performances developed in Step 3.

Step 7: Analysis of Shortcomings of AIT Graduates and Ongoing Training

Deficiencies uncovered in Step 5 were related to observations made at training centers. Sources of strength and weakness were determined, recorded and categorized. Possible corrective measures such as improved instructional methods, improved content or better allocation of hours were recorded.

Step 8: Determination of Possible Improvements in Training

Instructional methods applicable to military training of this nature were studied in detail. Observations (Step 6) at training centers, and questionnaires administered at training centers, contributed to instructional methods. Skills, knowledges, and performances developed in Step 3 determined content. All possible improvements were recorded.

Step 9: Construction of the Training Program

By this time, in fact somewhat earlier, it was apparent that instruction based on the selected 13 performances would parallel or supplement current training in Patrolling Technique of Fire and Rifle Squad Tactics. Accordingly, it was decided that our efforts would be confined to improving these two courses. Our studies so far indicated that the experimental course should be built around the following concepts:

First Concept. Tactics and Technique of Fire are primarily "doing" subjects, and training time should be devoted to practical work in fundamental skills and the integration of mutually related combat skills.

Second Concept. The practice of skills and knowledges should emphasize principles of "functional context" training; that is to say, practical work should occur in situations which provide as many of the relevant factors of real combat as possible.

Third Concept. Content should be oriented exclusively to the needs of the Light Weapons Infantryman.

Fourth Concept. Knowledge of results is a necessary condition to improvement in trainee performance.

Fifth Concept. Training in complex skills should employ the following steps:

(1) Statement to the trainee of what is to be learned.
(2) Learning of the particular task through deliberate practical work.
(3) Practicing and integrating particular tasks into the larger job.

Studies indicated that the following improvements could and should be incorporated into the training program:

(1) The lesson plans must be in sufficient detail to insure not only uniform instruction, but a reasonably uniform product.

(2) Content must conform to the Critical Combat Skills, Knowledges, and Performances contained in Step 3.

(3) Lectures should be virtually eliminated.

(4) Virtually all of the training time should be devoted to "doing," interspersed with appropriate small segments of explanation by instructors.

(5) Instructors who have been trained in what to look for should be utilized as squad leaders throughout the program.

(6) Provision must be made for retaining the same trainees in a squad throughout the program.

(7) Emphasis must be on instructors correcting individual mistakes as they occur. Trainees also should observe and point out each other's mistakes.

(8) Provision should be made for repetition until satisfactory performance is obtained from all men.

(9) Man-against-man, team-against-team, and squad-against-squad exercises should be utilized wherever applicable.

(10) Instruction should progress from a review of individual skills and knowledges through the integration of these skills into tactical performances.

(11) Emphasis should be placed on execution of team and squad leaders' orders, conforming to leader controls, and coordination of individuals' actions with those of fellow squad members.

(12) Weapons and positions should be interchanged so that all men occupy all team positions armed with all team weapons.

(13) Usually the target should be a man realistically portraying the role of an enemy.

(14) Blanks should be fired where they serve the purpose of portraying to an opponent that he has exposed himself to fire.

(15) Where applicable, the AI should put trainees through set staked-out courses which are self-correcting. Individual trainees become actively involved in correcting their own mistakes.

(16) Bottlenecks and programing conducive to wasting time must be eliminated. Each trainee's entire time should be gainfully employed in learning--for a full 50 minutes of each hour. Scheduled training, covered by detailed lesson plans, must be substituted for "concurrent training."

(17) Where rehearsals are appropriate, full rehearsal instructions must be included.

(18) Fire coordination and simulated fire support within the squad must be emphasized.

(19) Material presented must be so scheduled and oriented that it dovetails into, and complements, portions of the current program that are to be retained.

(20) All instruction must be re-examined by the Infantry School for its suitability and compatibility with current USAIS doctrine.

Step 10: Development and Testing of Lesson Outlines, Instructor's Guides, and Detailed Lesson Plans

Within the framework of the concepts and possible improvements in Step 8 and 9 we developed successively--(1) Lesson Outlines, (2) Instructor's Guides, (3) Detailed Lesson Plans.

Material was arranged to progress from individual training in fundamentals to combinations of actions, to actions in combination with other LWIs, to combined actions, to responses to squad leader's directions. Throughout this development, the functional concept was followed--having actions occur in the same sequence, and as nearly like combat as possible.

The completed Lesson Outlines, Instructor's Guides, and Lesson Plans were then tested on two companies in cycle at a Training Center. Instructors whose regular duties included presentation of the standard course in Patrolling and Technique of Fire and Tactics of the Rifle Squad were assigned by the Training Center for sufficient time to learn the HumRRO-developed program and to present it.

Instructors and observers, comparing the regular Army training with the experimental program on nearly 30 items under the categories of Skills and Knowledges, Training Time, Realism, Conduct of Instruction, and Motivation, judged the experimental program to be more, or much more, effective than the current program in almost every respect.

Trainee responses to questions concerning such matters as the quality of training, the use of training time, the amount of attention received from instructors, motivation, and the effect of training upon their opinion of the Army, indicated that the experimental program was more, or much more, effective than other training they had received in all categories.

At the present time, our 32-hour patrolling program has been accepted, and both this program and the two tactical training films sponsored by the Work Unit are in Army-wide use. The remainder of the tactics portion is still under consideration by Hq USCONARC and USAIS.

A major training principle of the Army is, "training should be applicatory." Research such as this supports this principle in an area where it is easy to mistake "training realism" for "realistic training."

THE FOUNDATIONS FOR LEADER TRAINING

Theodore R. Powers

In his address to the Eighth Annual Army Human Factors Engineering Conference held in 1962, the last Research and Development Conference to be held at Fort Benning, Major General Ben Harrell, Commanding General of the Infantry Center and Commandant of the Infantry School, stated,

> "...the overriding reason we failed to realize our full combat potential was not due to the quality of our manpower, nor the lack of equipment, nor even the type of equipment but rather was due to our failure to control men and equipment properly.... Effective control--especially control of combat units on the battlefield--is not something which occurs automatically simply because we have good equipment and good men. It is, rather, the product of superior leadership, workable communications, sound organization, and effective training." 1/

We know that these factors are as important today as they were four years ago, and Work Unit ROCOM has been concerned with two of the factors which General Harrell identified--leadership and training--because the knowledges and skills of the ROTC graduate are directly related to each of these factors. The purpose of my presentation, therefore, is to describe to you some of the work we have done on the Army ROTC program that is meant to serve as a foundation for curriculum design and improvement.

The Army ROTC program as it exists today is a massive training system that enrolls over 150,000 students annually in 247 different institutions of higher learning. There are currently two types of curricula within the ROTC system. The General Military Science (GMS) curriculum is taught in about 85% of all the schools--graduates of this program may be assigned to any one of 14 different branches of the Army. In about 15% of the schools a specific branch program is presented--graduates of these schools are assigned to the particular branch for which they received training.

As a beginning in a long-range program of research on the Army ROTC system, it was determined that the development of detailed duty-oriented training objectives applicable to the GMS curriculum should comprise the initial research effort. These objectives would give basic guidance to the curriculum planner and would also lay a firm foundation for any subsequent research that might be conducted on specific facets of the ROTC program.

1/ Report of Eighth Annual Army Human Factors Engineering Conference, USAIC, 16-19 October 1962, p. 17.

Since current theory indicates that the development of training objectives should be based on job requirements, as the first research step, representatives of U. S. Continental Army Command and Department of the Army were asked if they kept records of initial duty assignments of ROTC graduates. We were advised that, although complete individual data existed, there were no summary data showing the pattern of initial duty assignments, along with their relative frequency of occurrence. Accordingly, we designed an officer job survey to identify the desired information.

Branch schools were asked to supply rosters of their FY 1963 Officer Basic Course (C-20) graduates. Using a random sampling technique involving the last digit of the service number, a representative number of ROTC graduates was selected from each branch. The actual number drawn was based both on the relative size of the branch as a whole (column 1 Figure 1) and the proportion of ROTC input into each of these branches (column 2). Examination of these two columns shows that the two sets of figures are very similar, and thus we made our subsamples (columns 3 and 4) match the distributions of columns 1 and 2 as closely as possible.

PERCENTAGE, BY BRANCH, OF THE TOTAL ACTIVE OFFICER CORPS, ROTC INPUT FY 1963, AND ROCOM SAMPLE

Branch	Total Active Officers	ROTC	ROCOM	Sample *N*
Infantry	23	25	24	460
Artillery	21	12-Ad 7	13-Ad 8	248 - 158
Armor	8	10	12	233
Engineer Corps	8	9	9	189
Signal Corps	7	9	9	184
Ordnance	6	7	7	135
Transportation Corps	5	6	6	125
Quartermaster Corps	4	4	5	96
Adjutant General	3	5	4	88
Military Police Corps	2	2	2	41

Figure 1

The total survey covered about 2,000 officers. The number of branches was restricted to those shown in Figure 1 since they are the ones to which the majority of ROTC graduates are assigned.

For each officer in the survey, we obtained at the Personnel Records Section, DA, the first Officer Efficiency Report (DA Form 67-5) from which we photocopied Sections 1 through 14. These sections do not contain any evaluative information about an officer but do give the particulars of his duty assignment.

We found that junior officers receive a large number of different initial duty assignments (Figure 2). In fact, if you sum across branches

NUMBER OF DIFFERENT JUNIOR OFFICER ASSIGNMENTS BY BRANCH	
Branch	Assignments
Artillery	82
Infantry	69
Signal Corps	69
Ordnance	60
Quartermaster Corps	53
Adjutant General	47
Engineer Corps	46
Transportation Corps	43
Armor	39
Military Police Corps	12

Figure 3

the survey identified 520 principal duties. As would be expected, there is some variability between branches in the number of different assignments and this, of course, reflects the organization and mission of a particular branch.

Even though the survey determined that the range of duties assigned to junior officers was rather extensive, the frequency of occurrence was of equal interest and importance. That is, if, for example, in the Infantry, 99% of the junior officers received one assignment and the other one % received 68 different assignments, then training problems are minimized and the development of training objectives is simplified.

Unfortunately, in subsequent analysis, we found that ideal distributions of the previously mentioned type did not exist, although there is some variability across branches. The branches on the left half of Figure 3 typically assign a large proportion of their basic course graduates to a single initial duty assignment, while the ones on the right do not. This problem is compounded when it is remembered that the GMS curriculum makes input into all of these branches; when we combined all job data, we found that no one job appeared in the total sample more than 12% of the time. Thus, the small number of graduates assigned to the most frequently occurring of these initial duty assignments precludes the possibility of training the GMS ROTC student for a specific duty assignment.

These results presented us with a significant problem as they demonstrated that any training objectives that were developed could not focus exclusively on any one job or even a group of closely related jobs, but must instead evolve from an approach that would identify branch immaterial knowledges and skills appropriate for the widest possible range of job incumbents.

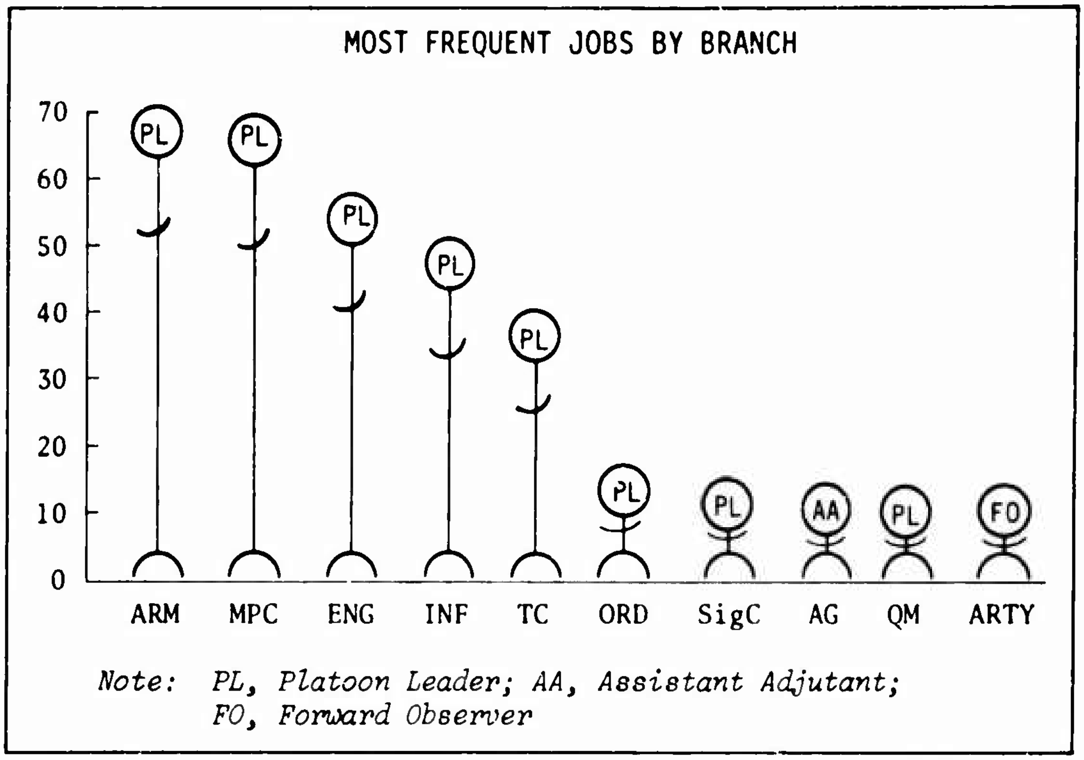

Figure 3

As a starting point in the development of such an approach, the total range of duties was assessed to see if there were any general groupings that could be accomplished. This strategy seemed to be productive in that it quickly appeared that some jobs had "key words" (e.g., supply, communications) included in their titles, which were also duplicated in many other assignments. Some rather informal gatherings of jobs were tried and these tentative groupings were further refined by considering the primary objective or purpose of specific duties as a determining characteristic of a group of duties. From this analysis, seven descriptive categories or, as they will be called, essential training dimensions, were identified (Figure 4).

ESSENTIAL TRAINING DIMENSIONS

Tactical Unit Command

Nontactical Unit Command

Operations, Training, and Training Center

Supply

Administrative and Personnel

Motor and Maintenance

Communications

Figure 4

This method of job classification had several major advantages. First, jobs with similar titles but found in different branches could be grouped under the same dimension, and thus the common attributes of similar jobs could be identified. Second, this technique made it possible to isolate under any one dimension the common skill and knowledge components of a wide variety of jobs, while the branch specific aspects (which are more properly taught at the branch schools rather than in ROTC instruction) did not need to be considered during this phase of the research. Lastly, and perhaps most important for our purposes, even though the range of duties was quite extensive, jobs performed by over 83% of the entire sample could be considered in this system, and thus the subsequent development of training objectives would yield appropriate instruction for a vast majority of ROTC graduates.

Although the development of descriptive categories solved the immediate problem of job classification, the major problem of specific knowledge and skill determination still remained. Because resource expenditures precluded the possibility of directly examining job incumbents for the purpose of job analysis, it was decided to employ a short-cut method of job assessment that involved using existing written material relating to these jobs. To maximize the reliability of a set of specific knowledge and skill areas identified for any one duty, as many references as possible were gathered for a particular job analysis (Figure 5).

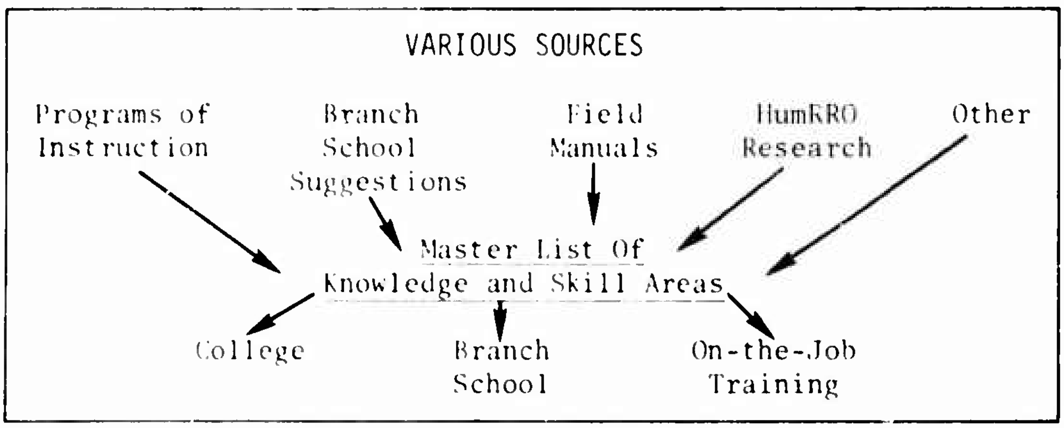

Figure 5

The type of background literature surveyed ranged from official Army publications such as field manuals, training directives, and similar material, to previous analyses conducted by HumRRO and other research organizations on specific jobs or groups of similar jobs. Although no two sources described a given job in exactly the same manner, it was hypothesized that the most important knowledge and skill areas for a particular job would be the most frequently mentioned in the various types of reports.

At this point I should state that what I mean by a knowledge and skill area is a generalized set of homogeneous performances. Examples of knowledge and skill areas, as we used the term, are Land Navigation and Use of Camouflage.

Although the previously mentioned job references identified the types of knowledges and skills involved, they usually did not judge either the importance to job performance of individual knowledge and skill areas or the consideration that some jobs are more important than others in that they are more frequently assigned ROTC graduates.

The problem was solved by using a complex statistical frequency count system which considered both the frequency of appearance of specific knowledge and skill areas within the job analysis literature and the relationship of these frequencies to the distribution of jobs that had been identified in our survey of initial duty assignments (Figure 6).

CRITERIA FOR ASSESSING IMPORTANCE OF SKILL AREA

Number of Mentions

Number of Duty Assignments Requiring

Number of Graduates Assigned

Figure 6

This procedure resulted in a list of ranked common knowledge and skill areas within each dimension, weighted on importance to training by an index reflecting relative frequency of appearance in the training literature, relative frequency of occurrence in the jobs within a dimension, and relative frequency of assignment of ROTC graduates to these jobs in their initial tours of duty.

This kind of information can be quite important to the curriculum designer (Figure 7). Given a limited number of hours around which to build a program of instruction, it would be desirable to allot the most

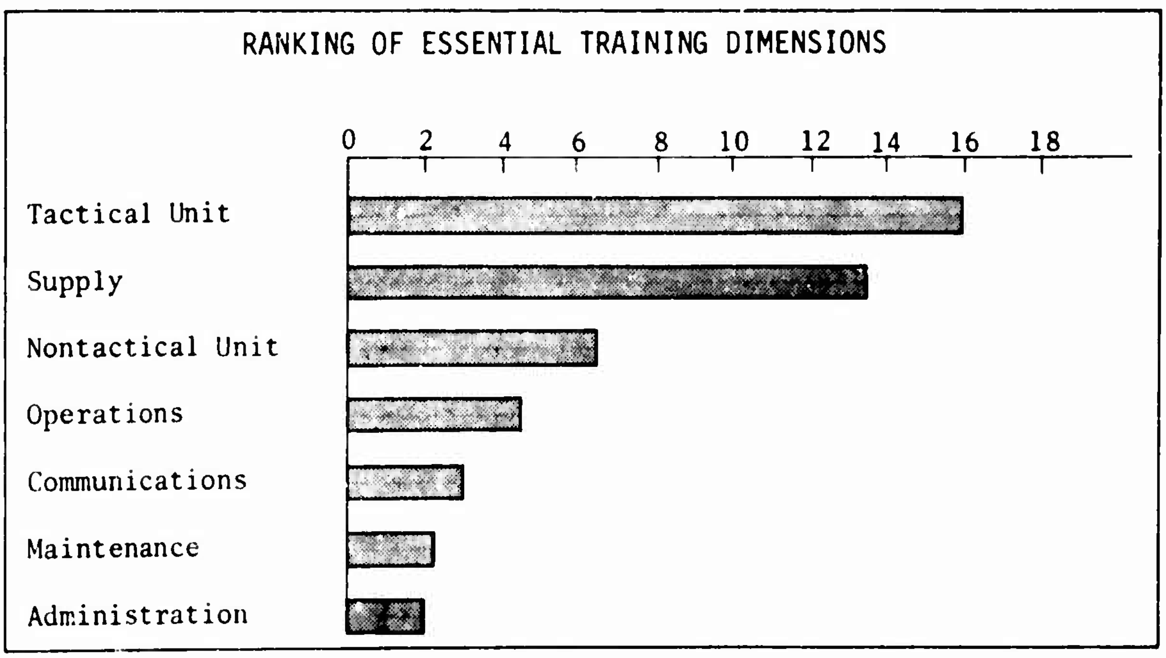

Figure 7

hours to those subjects that will be most useful and on a ratio proportional to their relative importance standings. Using the importance factors generated by ROCOM, it would be possible to define the specific subjects that should be taught and also the relative number of hours each should be assigned within a curriculum. This method of subject identification and assignment would optimize the impact of a training program.

Once the common knowledge and skill areas were identified, the next step involved determining which of these were appropriate for inclusion in the ROTC program (Figure 8). First, the various areas were assessed

CRITERIA FOR INCLUSION IN PROGRAM
Support Requirements
Long-term Retention

Figure 8

to determine whether the teaching of them required large expenditures of troops, terrain, or equipment. Since most colleges and universities do not have the requisite support items, it seemed obvious that certain things could not be taught at the college if their teaching were dependent on large amounts of these resources.

The other major criterion for consideration was the general area of psychological factors. That is, it was judged that one of the most important considerations in ROTC instruction was that the material taught be available for recall at some subsequent date that might be several years in the future. Since many of the variables that influence a high retention rate have been identified, several of these were selected and used in an assessment of the previously identified knowledge and skill areas.

As a result of this analysis, those common knowledge and skill areas thought appropriate for inclusion in the ROTC program were identified. These have been further broken down as to those areas appropriate for classroom instruction and those areas appropriate for an ROTC summer camp.

The terminal step in the research process was the expansion and development of the previously identified knowledge and skill areas into training objective terminology. In Figure 9, you see a part of a typical training objective. This particular one is included in the essential training dimension of Tactical Unit Command and deals with the areas of Map Reading and Land Navigation. The stem of the training objective (e.g., The student will know...) identifies a specific knowledge and skill area, while the breakdown under the stem (e.g., Grid Coordinates) identifies the basic ingredients involved. With the aid of objectives of this type, the curriculum planner could select

TRAINING OBJECTIVE

The student will know these basic principles of Map Reading to include:

1. Grid Coordinates
2. Topographic Symbols
3. Military Symbols
4. Distance Measurement
5. Orientation
6. Azimuths
7. Contour Interpretation

Figure 9

which knowledge and skill areas should be included in a program of instruction, as well as the major topics that should be covered for each of the selected areas.

Let me summarize what we have done. We were given the job of improving the Army ROTC program, and as the first step in this direction it was decided to generate a set of detailed duty-oriented training objectives applicable to the General Military Science curriculum. To base these objectives on hard data, a junior officer job survey was accomplished which determined that a large number and variety of different initial active duty assignments are available to graduates of the Army ROTC system. Since the available research resources were not adequate to accomplish a formal job analysis on the over 500 different duties identified, a unique method of job assessment was developed. We analyzed the pattern of the initial duty assignments, identified the total number of knowledge and skill areas required for job training, isolated the common or branch immaterial knowledge and skill areas, and, finally, developed the areas into training objectives. In this way, a valid basis was laid for curriculum design and improvement, and a firm foundation has been developed for further research in this area.

TRAINING FOR COORDINATION WITHIN RIFLE SQUADS

Clay E. George

Rifle squad evolution over the past century has been influenced by numerous developments that have tended to make coordination among its members increasingly difficult. The most obvious development has been the increased firepower brought against infantrymen, which forced them to disperse, thereby rendering leader control more difficult. A second development has been the increase in the probability that squads will be required to operate in jungle environments where leader control is rendered still more difficult. The third development, also related to changes in weaponry, is the increased degree of role specialization within squads. The present-day squad has grenadiers and automatic riflemen in addition to the riflemen and leaders of old. Finally, American infantry are, with increasing frequency, operating under conditions such as those in Korea and Vietnam where numbers are not great enough to establish front lines in the classic sense.

These developments are, of course, interrelated, but they do add up to a real problem in troop control and an increased requirement for light weapons infantrymen who will take the initiative to coordinate their responses to one another when leader control is not available. Squad reorganization into fire teams represents one attempt to meet the problem of troop control. A related approach is the current attempt to develop a practical intrasquad communication system.

Earlier HumRRO research, under Work Units TRAINFIRE and RIFLEMAN, introduced into individual training a number of elements designed to prepare soldiers to rapidly develop coordination once they became members of rifle squads. The research reported here, under Work Unit UNIFECT, was done to find a systematic way to train squads as squads for greater efficiency through improved coordination.

A semibasic research stage was carried out to study some of the ways coordination can be facilitated, even in the absence of a formal leader, through the manipulation of group task variables. A survey of the literature convinced us that attention to task variables was of paramount importance. The major task variable of interest was the degree of interdependence the task required of the men working on it.

Figure 1 illustrates a task equiring a zero level of interdependence. Shooters 1 through 5 are each responsible for the single target down range from their own positions. The men are operating in parallel with one another; they are not working jointly to reduce a common battery of targets.

In Figure 2 we have a situation where conditions of joint responsibility do prevail to a degree. Each man is primarily responsible for the target to his immediate front, but a target will not reappear after it has been shot down until every target in the battery has been shot down. Hence, a man's ability to fire again on his primary target is

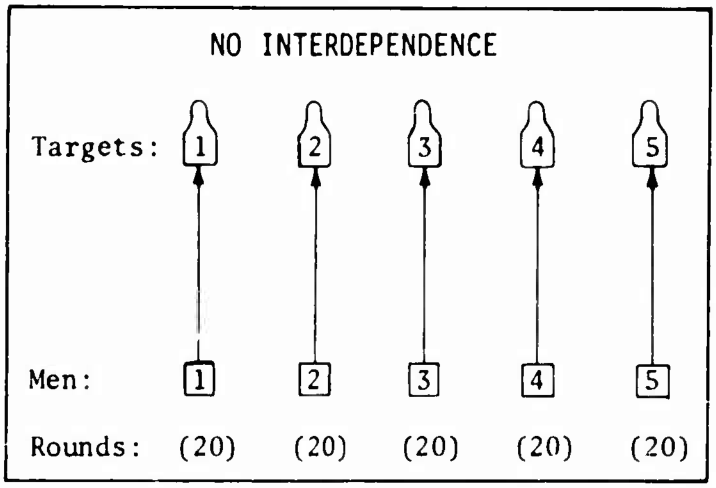

Figure 1

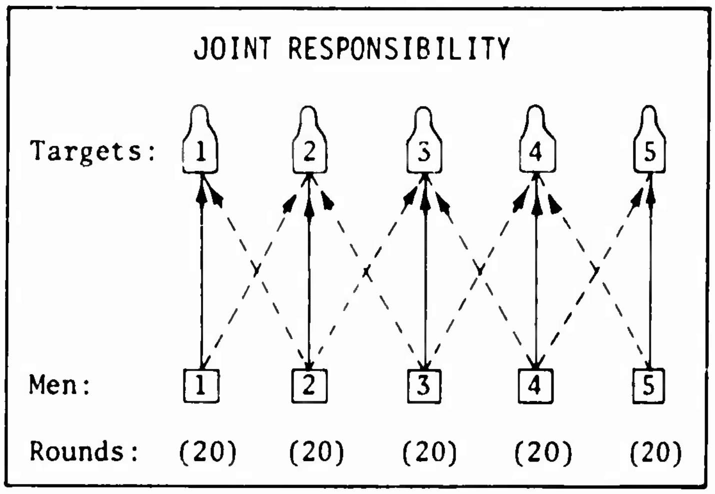

Figure 2

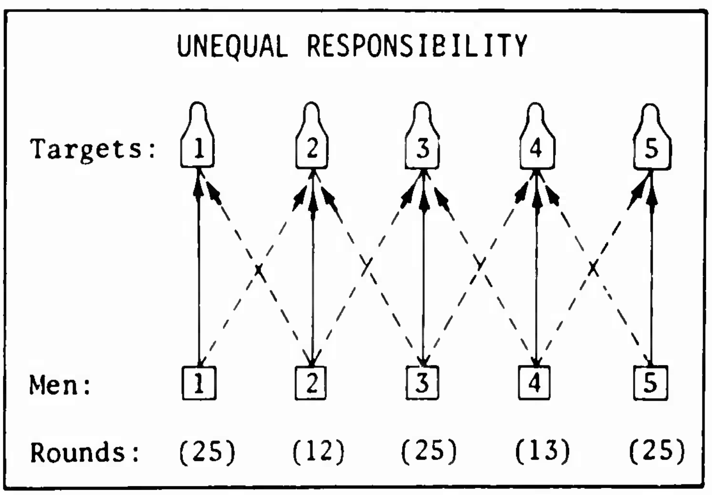

Figure 3

contingent upon all targets having been hit previously. A man may thus be required, under some circumstances, to hit a target for which another man is primarily responsible.

In the situation shown in Figure 3, mutual responsibility obtains, as before, but with an unequal allotment of ammunition among the men. The unequal allotment feature insures that men 1, 3, and 5 will be required to fire on targets 2 and 4 before the problem is concluded. They will, in effect, be able to conclude the trial only by compensating for the incapacities of those who have no more ammunition.

During early experiments with problems of the kind just described, it was noted that men scoring low on a measure of motivation for coordination would fire on the targets of other men when this was not necessary, and was even undesirable in that it wasted ammunition. To study this effect, an experiment was carried out in which 24 four-man teams fired a problem requiring coordination, but were not allowed to see or converse with one another. They were then exposed to instruction in how and when to coordinate their actions while working as group members in general and were given an opportunity to practice this in a simple two-man situation. Finally, they refired the original problem with no restrictions on communication so that they could coordinate their fire as they had been trained to do on the essentially different preceding problem.

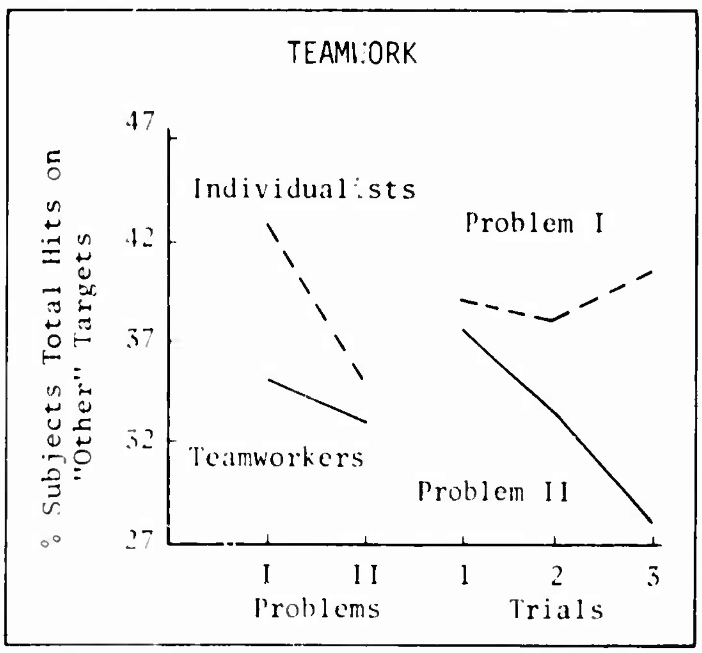

Figure 4

As shown in Figure 4, those low on motivation for coordination (the individualists) were hitting targets for which they had only secondary responsibility much more often than were the other men on Problem I. On Problem II, however, both types of men were hitting targets of secondary responsibility at about the same rate. The individualists had, presumably, learned to be teamworkers; a presumption supported by independent evidence from other experiments. While the problem required men to hit targets of secondary responsibility on some occasions, the truly coordinative behavior was to do so only when the man primarily responsible for the target could not hit it. It will also be noted that most of the change in the probability of hitting targets of secondary responsibility occurred over trials during Problem II. The experience gained on Problem II trials, including the between-trials critiques, seems to have been more important than that gained in the training between the two problems.

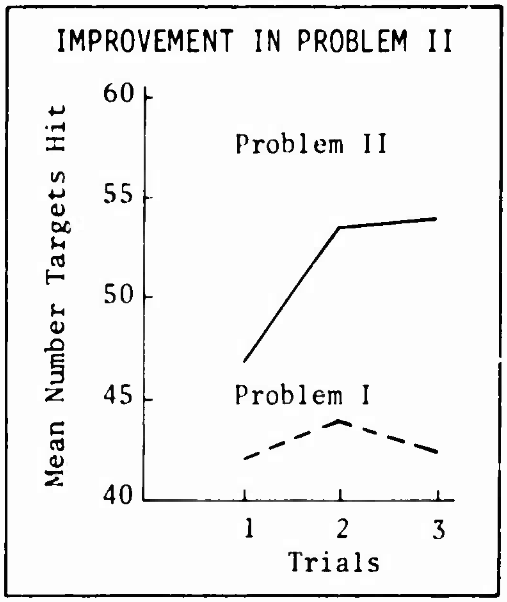

Figure 5

Figure 5 shows that improvement over trials in hitting targets, the real criterion on these problems, occurred only on Problem II, and that this parallels the finding that only on Problem II was there a decrement in the probability of hitting targets of secondary responsibility over trials.

Another experiment in this series was carried out over a two-day period, with 20 four-man groups. The ten control groups worked as individualists for three half-days while the ten experimental groups worked as teamworkers on similar problems. On the last half-day, all 20 groups worked as teams on a criterion firing problem. This problem had distributive leadership but it did not have an unequal ammunition distribution feature. The men were in defensive positions and could be faced with pop-up target arrays at ranges of 25-175 meters to their front. The terrain was such that a man could not always see a target in his primary zone of responsibility; a condition which necessitated intrateam communication and coordination. The men were first presented with a three-target array at ranges of between 125-175 meters. If no one hit the key target in this array within the time limit, the next array appeared in the 75-125 meter zone. If the key target was not hit within a lesser time limit, further target arrays appeared at increasingly closer ranges and for shorter time periods. Weighted scores were calculated on the basis of number of target arrays successfully reduced as a function of range.

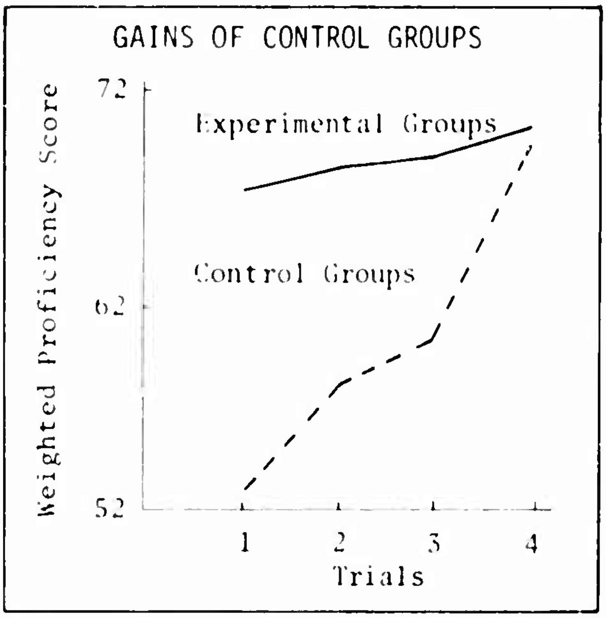

Figure 6

As shown in Figure 6, overall problem proficiency was significantly better for the experimental than for the control groups, but most interesting is the speed with which the control groups approached and, finally, virtually equaled the performance of experimental groups. The experience during the trials, and the between-trials critiques, evidently served as an efficient training device.

Peer ratings of acceptability as members of the same squad in combat were also made of each group member by his fellow members on several occasions. Ratings were made before any experimental work was done, at the end of laboratory problem solutions, just before the criterion problem described above, and finally at the end of the criterion problem. Results (Figure 7) tend to reflect those from the performance data.

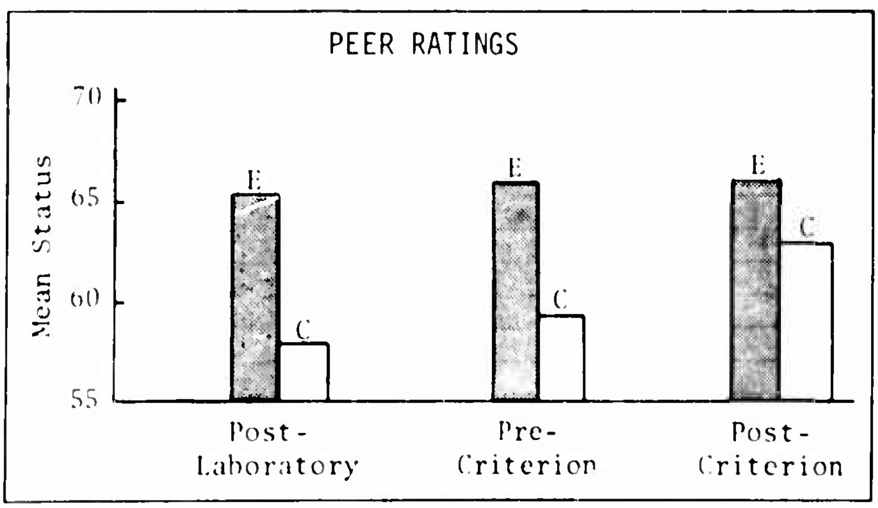

Figure 7

The experimental conditions produced a substantially greater increase in mutual esteem among team members than did the control conditions, but experience on the criterion problem tended to cancel out the differences.

The next series of experiments was more developmental in nature. Emergency events, such as simulated casualties and weapon failures, were used to create requirements for coordination. A fire team was told to advance until brought under simulated machinegun fire. They were then to go to the ground and provide a base of fire while another (simulated) team moved against the target area. The men were to expend the 840 rounds they had been issued into an objective area defined by fleeting targets. In a preliminary conference, the men had been instructed in fire distribution and in intrateam coordination. Once the firing was started, weapons began to malfunction according to a prearranged schedule and a casualty was assessed. The specific set of emergencies was counterbalanced over trials so that a given event never happened to the same man twice. Three observers rated the volume of fire, degree of coordination in reaction to the emergencies, and individual performances. Critiques between trials were keyed to the original conference and covered both objective measures of fire effectiveness and the rated performances.

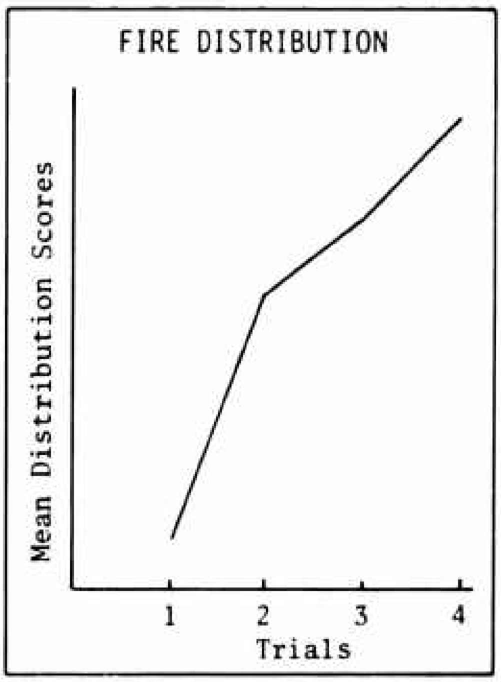

Figure 8

As shown in Figure 8, learning did occur in terms of objective measures of improved fire distribution over the four trials and (not shown) in terms of number of rounds placed in the objective area and time per trial.

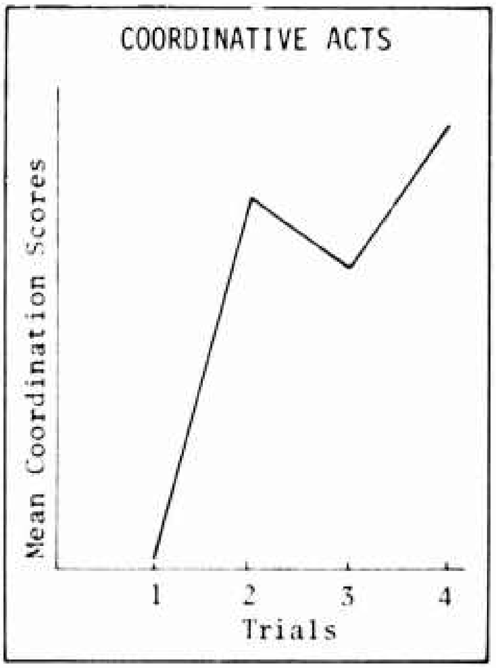

Figure 9

There was a concomitant increase in observed coordinative acts over trials as shown in Figure 9. These acts included such behaviors as alternating attention between cues from the objective area and conditions going on within the team, passing the word about conditions that might affect the team's mission, or taking over a key role such as AR (Automatic Rifle) man or team leader when casualties were assessed.

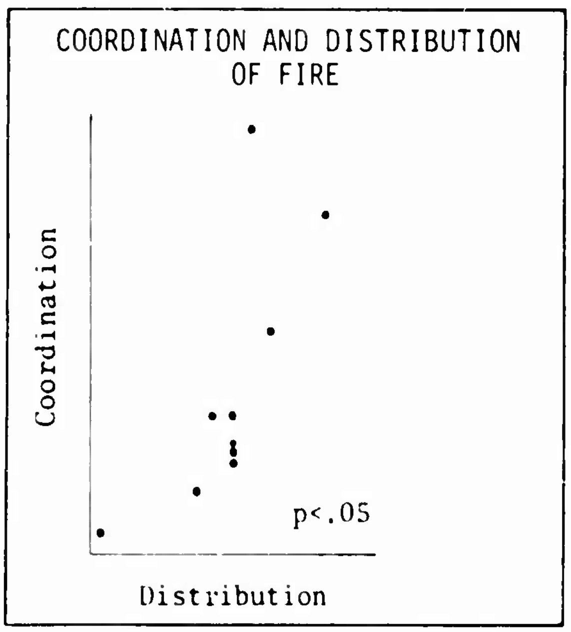

Figure 10

Summing rated coordination and distribution scores over trials, a relationship between the two variables was established as shown in Figure 10. Each point on the figure represents one fire team. Teams scoring low on coordination tended to score low on hit distribution and vice versa. How well the men coordinated their responses to emergencies did affect the adequacy with which their fire was distributed over the objective area.

A final experiment was conducted with eight full-strength squads, each studied for one day. Control squads participated in a conference on rifle squad in the attack, and ran one dry-fire and one blank-fire problem in the morning. Experimental squads received the same training with the following exceptions: (a) Some of the time spent on typical military content during the conference was used to instruct the men in coordination requirements; (b) the dry- and blank-fire exercises included some minor emergencies; and (c) the critiques of the exercises emphasized intrateam coordination.

In the afternoon of the experimental day, the squads were taken to a densely wooded attack range they had not seen. Control squads ran a live fire attack problem without emergency events and were not critiqued on coordination beyond that ordered by leaders. Then they ran the same problem with emergency events. Experimental squads ran two problems, each with a different set of emergency events and with a critique emphasizing coordination, including initiative and the coordinating responsibilities of every man. Approximately a one-fifth sample of the lateral area fired into was screened with screen wire in order to obtain an estimate of fire effectiveness.

As shown in Figure 11, experimental and control squads did differ significantly on the final problem. It is apparently the case that, if you want men to coordinate under the pressure of emergency events, you should train them to respond appropriately to such events.

In order to obtain the great degree of intrasquad coordination required by the conditions of modern warfare as described earlier, training should include emergency events and be conducted over rugged terrain. Such conditions force squad members to coordinate in much the same way that they will be required to do in combat. It is better to make errors in training, be critiqued on them, and then correct them in further training, than to meet rigorous demands for coordination for the first time in combat where errors may be disastrous.

In summary, there is the basic fact that small-unit effectiveness on the battlefield requires coordinated action by unit members. Coordination, in turn, is achieved in two ways, through leader control (direction) and through prior training that, in effect, rehearses unit members on their actions. Within infantry units, the latter means is limited because of the enormous variety of situations the unit is likely to confront; similarly, leader control has become more difficult because of requirements for increased unit dispersion, for combat in exceedingly dense terrain, and so on, that reduce his ability to communicate with unit members.

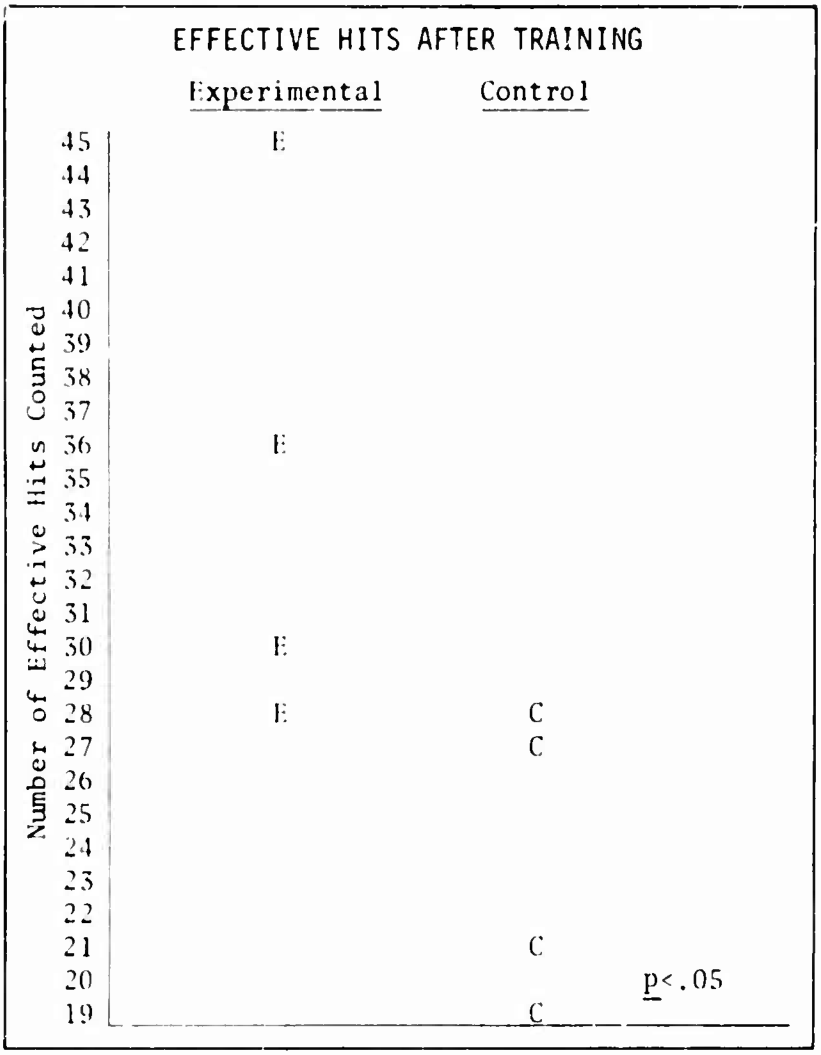

Figure 11

The present research was designed to provide a basis for the design of training that will facilitate coordination of the actions of unit members by shifting some of the responsibility for coordination from leaders to the unit members themselves.

The experiments reported here support the conclusion that such training has at least three essential aspects: (a) communication of coordination requirements to unit members, particularly information as to how coordination facilitates the accomplishment of unit goals; (b) practice on achieving typical unit goals despite unanticipated events that place unusually heavy requirements for coordination on unit members; and (c) feedback as to adequacy of performance, together with opportunity for further practice to correct errors, but with different events. The results of these experiments indicate that such training strongly tends to produce many of the coordinative responses that heretofore were learned primarily in combat where the cost of learning from one's errors is considerably greater than in training.

INDIVIDUALIZATION OF INSTRUCTION

Howard H. McFann

Although these meetings deal with individual combat training, I believe my comments on individualized instruction are generally as applicable to individual training and education as they are to combat training. This is not surprising since many of my thoughts derive from educational writings and research. First, I will attempt to state what I mean by individualized instruction or training. By individualized training I mean the providing of a training program that is geared to the individual learner. Such instruction implies (a) a series of explicit, measurable, and hierarchical objectives; (b) a method of assessment and diagnosis of progress and problems; and (c) a variety of instructional approaches, methods, and media. Individualized instruction would allow for a trainee's existing level of comprehension or skill development, his style of learning, and his rate of learning.

Since experimental evidence exists to show "...that individualization of school programs can save time, will reduce retardation of students, and is a motivating factor" (1), I doubt that many would seriously disagree with the desirability of having individualized instruction in the Army; the problem is practicability. During this presentation I will try to express some of my thoughts on why this desirable state does not exist, and to point some directions that should be considered to achieve an approximation, if not the state itself.

Quite interestingly, early Army individual training came close to individualized instruction. Formal instruction was pretty much on a one-to-one basis, diversity and complexity of material was not great, and ample time was available for learning to occur. The instructor-student ratio was low, and a form of tutorial or apprentice program was common. The instructor usually designed and administered the training as well as establishing standards of excellence. The trainee was well known, often assessed, and instruction was uniquely designed for him.

As the military demands became greater as to both quantity and diversity, the training of large masses became necessary and individualized instruction went by the board. Formal selection procedures were instituted to allow for a kind of grouping as to who might be most successful during training. The strategy of training was to give the same instruction to all of the group, or, in educational jargon, a one-track system or fixed educational treatment was used. To the extent that individual differences were handled during training, it was by a "weeding out" process or a "recycling" process whereby the trainee stayed in the system until he finally mastered the material or was "passed" along.

In reviewing some of the early HumRRO training research, it appears this was quite typical of our curriculum development. The approach was pretty much one of developing or engineering a single program, treatment, or package, to be given to the total group with the view of moving the whole group along. Such an approach was intentional and necessary since the programs were designed to be utilized, and only programs that could be inserted into the existing training system were acceptable. Interestingly, in looking over our published reports on research done in the mid 1950s, we find that the results generally emphasized average gain with not much attention to individual differences. Seemingly, what we were doing was designing instruction that was "pitched" for the middle or lower trainees with the general view that the higher aptitude trainees would get the training anyway. Let me cite some data which helps make my point.

Figure 1 summarizes performance (proficiency) scores for experimental and control groups obtained in HumRRO Task SHOCKACTION V (2), which was concerned with training of individual tank crewmen (loader, driver, and gunner). Figure 2 presents comparative results for hits for the combat marksmanship program developed as part of HumRRO Task TRAINFIRE I (3). In both cases, the general spread of scores is the same for experimental and control or conventionally trained groups. The difference is in the shape of the distribution, with the middle group showing the gain in proficiency.

HumRRO research in more technical areas such as electronics or maintenance and radio repair shows average improvement with a considerable spread on proficiency scores for the experimentally trained group. Also, they show some greater gain for the lower aptitude group (4, 5, 6, 7, 8). The research approach appears basically consistent with the strategy of fixed time and fixed program. In this research, to a fair extent, one finds the introduction of some form of remedial instruction for the slower trainee rather than just "weeding out" or "recycling."

Present Army training reflects this latter trend to some degree with special remedial sessions held after normal school or training hours. Sometimes the trainee is removed from the "normal" training, receives remedial instruction, and then is placed back in the "normal" training group. One sees also where specially designed materials are provided for self-study. For the most part, however, Army training, particularly BCT, reflects fixed treatment and fixed time, with emphasis on the less capable trainee.

The Army training strategy for handling individual differences is quite comparable to educational practices in most of our public schools, with the exception that the schools have a tendency to place more emphasis on education for the higher aptitude student at the expense of the lower aptitude student. Clearly, the strategy of fixed time and a single instructional system has been found wanting.

The continuing increased complexity and proliferation of military job requirements resulted in the need for more manpower and created new jobs calling for more talent. The Army, faced with using the manpower provided, found limitations on the amount of "weeding out" or "recycling" permissible or reasonable. They attempted to alleviate the problems by raising entrance standards or requirements, increasing

Distribution of Total Scores on Armor Mastery Test Battery

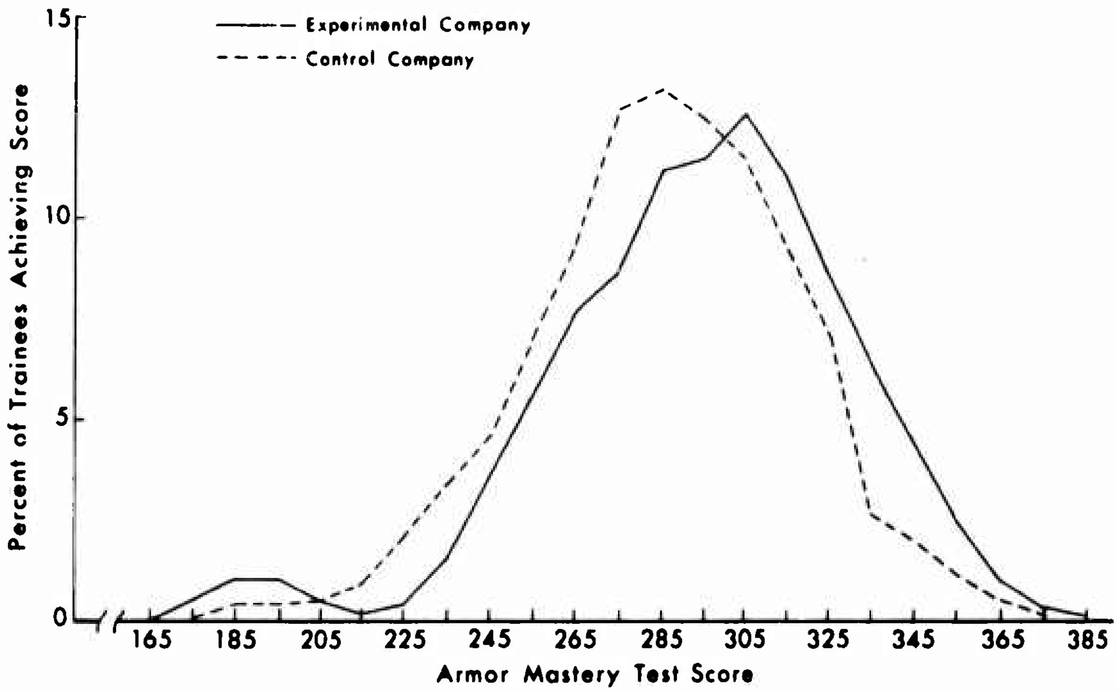

Figure 1

Distribution of Total Hit Scores on TRAINFIRE Record Range

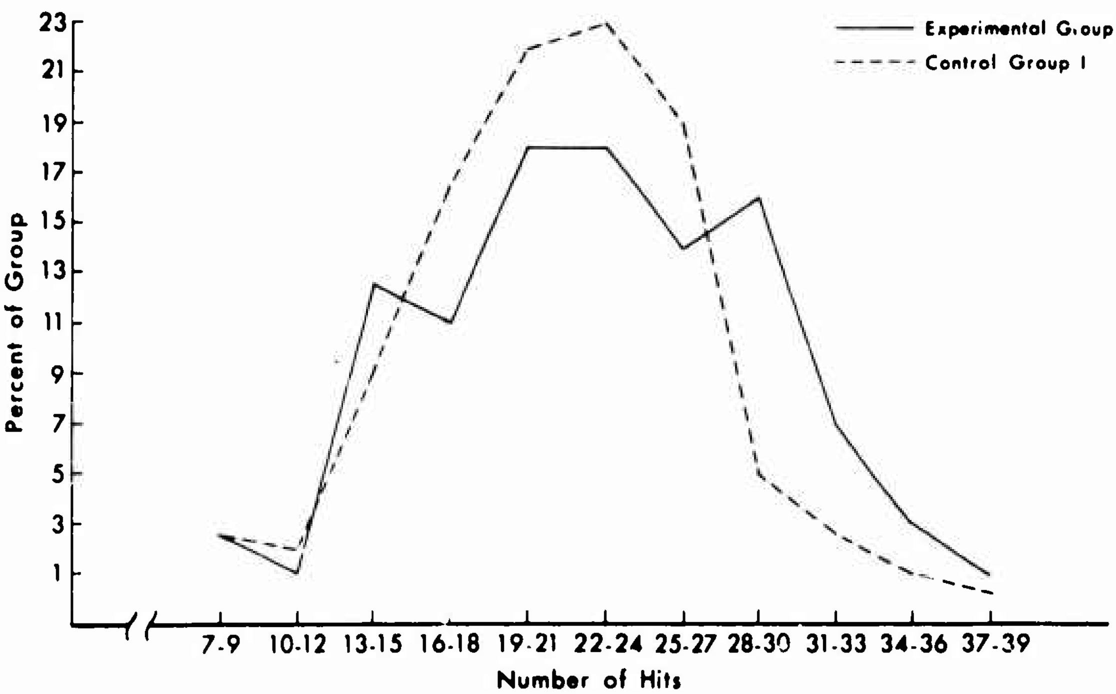

Figure 2

training time, and increasing the number and quality of instructors. Again, the analogy to educational practices is notable. In education, the channeling of students into special programs such as academic or vocational programs, and the ability grouping with specialized course material (e.g., English, mathematics) closely parallels the strategy of increasing entrance requirements. The increased time wanted for teaching, the fight for a low student-teacher ratio, and the clamor for better teachers, are most apparent in education. All of these approaches make good sense and help; unfortunately, they also create problems in that conflicts arise.

From the assignment person's perspective, there seems to be an endless chain of new training programs which continuously call for more training time and personnel, and curtail job utilization. The desired solution from the assignment view appears to be to train men in fundamentals and let them learn their job while working at it. Why waste time in over-specialized training when many men won't be used in the MOS for which they were trained?

The second view is that of the trainer who wants more training time, more cadre, and an opportunity for assuring that the individual has the proper knowledge and skills. The trainer often views his problem as having not enough time, too many things to teach, not enough staff. Even though selection has occurred, there still exists a wide variation in aptitude and ability of trainees so it is difficult to decide at what level to teach. A favorite solution preferred by the trainer is to teach fundamentals and let the man gain experience and proficiency during his assignment.

Understandably, most Unit Commanders view the world quite differently since they are the ones who will be responsible for designing and administering the training, along with other duties, which include using the trainee in an operational unit. Most Commanders' attitudes are, "Give me a man well trained in individual skills and knowledge, and I will weld him into my Unit."

The dilemma I have sketched is well known, real, and all indications are that it will get worse. Let me state where I think we now stand on meeting the conditions for individualized instruction and suggest actions that might be taken.

(1) Training Objectives Specification. Research and practice have demonstrated the feasibility and utility of defining training objectives in behavioral terms. Procedures have been written on how to do so (e.g., 9, 10, 11, 12). Army recognition has resulted in the development of many courses employing this research. Hopefully, developers of future courses of instruction will be required to determine and use training objectives.

(2) Assessment. I see three kinds of assessment required: (a) entering level of the trainee, (b) progression through the course, and (c) quality control or final proficiency. For all three the greatest lack is that of performance assessment procedures. With the emphasis on skill development and direct application of knowledge acquired, I firmly believe we must develop and use performance tests much more than now is done. I recognize that performance data are expensive and difficult to devise and administer, and that we have much to learn about them as test instruments. Where they have been

employed and tied to training objectives, considerable gains have resulted. If we could assess the performance capability of trainees as they enter a training program and move them along as quickly as they demonstrate mastery of material, much could be done to increase efficiency.

(3) Instructional Approaches, Methods, and Media. Much research has been done in these areas. Dr.Joseph S. Ward's presentation on the development of an individual combat training program summarizes some of this work and points directions that can be taken to ensure emphasis of performance-based instruction (13). The research on and use of programed instruction has proven worthwhile and is clearly a direction worth pursuing. The research now under way in computer-based instruction holds much promise and deserves careful attention.

I assert that all of these approaches will be of only limited value and their potential severly curtailed until we find ways of breaking away from the fixed-time, single-treatment training program. Ample research data exist to show that trainees, when given the opportunity, acquire skills and knowledge at vastly different rates (14, and 15), and that a single-treatment, fixed-time approach can have adverse effects. 1/

As I see it, two major problems face us in individualized instruction. On the one hand, there are tremendous administrative problems associated with this approach. They run the gamut from the very highest level in the Army dealing with such matters as flow and assignment, to the lowest level on such factors as scheduling, training facilities, and transportation.

On the other hand, we have the problem of developing and testing various schemes of individualizing instruction. One such possible scheme is the designing of special instructional systems for various trainee subgroups who have been grouped on the basis of their initial performance. Another scheme is the designing of a procedure by which individuals can progress as they demonstrate mastery of each segment of the training.

With the growing technology of training and use of automation within the Army, it appears that the time is appropriate for attempting and testing such solutions. Clearly, these endeavors will require not only mutual understanding, but close cooperation between the managers of training and training researchers. If one views solely the problems and difficulties inherent in the development and testing of such schemes, the effort appears to be too much. If, however, one focuses on the training problems and the potential gains realizable, clearly the job can and must be done.

1/Work done in 1963 by John S. Caylor and Richard Snyder concerning the improvement of recruit training (Work Unit TRANSITION).

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