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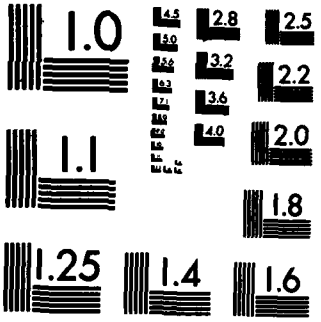
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AIR FORCE HUMAN RESOURCES LABORATORY

PRACTICE MAKES PERFECT

By

Elizabeth L. Martin

OPERATIONS TRAINING DIVISION
Williams Air Force Base, Arizona 85224-5000

October 1984
Interim Technical Paper for Period January 1982 – July 1983

AIR FORCE SYSTEMS COMMAND
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This paper has been reviewed and is approved for publication.

MILTON E. WOOD, Technical Advisor
Operations Training Division

CARL D. ELIASON, Colonel, USAF
Chief, Operations Training Division

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Training technology has unfortunately come to be equated with training equipment. Those aspects of training technology that actually concentrate on the performance and the processes underlying the performance seem to get neglected in research and development (R&D) and, more importantly, in the operational environment. Such fundamental factors as skill development, practice, feedback, and motivation receive relatively little attention. This paper presents the athletic training model as an example of an area in which a premium is placed on training technology, systematic applications of scientific principles to training, and ultimately, resulting performance levels. Various aspects of the athletic training model deserve close attention by those doing flying training system design. Emphasis is placed on practice which is carefully structured and arranged so as to facilitate maximum performance and transfer of training from one step to the next. The position is taken that many Air Force flying training programs lack the frequency of practice, careful arrangement of sequences, and a true commitment to performance excellence. The need for performance measurement is cited, as well as the need for more careful attention to the opportunities to practice high-level skills under simulated combat conditions. A two-fold increase in performance could be attainable via application of sound training principles at far less cost than designing and producing a piece of hardware which could result in the same increase. The role of training equipment and R&D in the development of training equipment should be changed to reflect a foundation built on need and potential for results rather than the simple desire to apply another field's technology.

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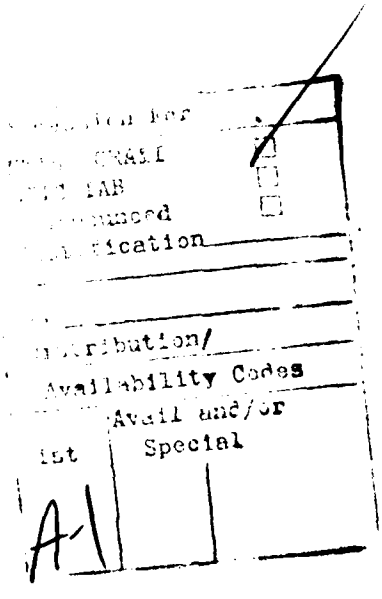


Reviewed and submitted for publication by

Lynn C. Thompson
Chief, Aircrew Training Branch

SUMMARY

This paper is an outgrowth of research and development in the application of flight simulation to training air-to-ground combat missions. Numerous discussions with subject-matter experts led to the opinion expressed in this paper that today's pilots do not get the amount of practice at each skill level that would be required for them to achieve their full potential. Unfortunately, task flying frequency requirements are driven by logistics and finances more than training requirements. This paper offers the notion that if pilots were trained in the same way as athletes are trained, substantial improvements in mission effectiveness would result. In the end, everyone stands to lose if pilots are not given the very best training that technology has to offer.

PREFACE

This effort represents a portion of the research and development (R&D) program of the Air Force Human Resources Laboratory for Technical Planning Objective 3, the thrust of which is Air Combat Tactics and Training. The general objective of this thrust is to identify and demonstrate cost-effectiveness of the Air Force aircrew members. More specifically, the effort was part of the R&D program conducted under the Air Combat Training Research subthrust, which has as its goal to provide a technology base for training high level and quickly perishable skills in simulated combat environments. Work Unit 11230367, F-16 Combat Scenario Development and Evaluation, addressed a portion of this subthrust, namely, the use of flight simulation to present a tactical combat training environment for F-16 applications. This paper is an interim report for this work unit.

PRACTICE MAKES PERFECT

It seems that the term training technology has become almost synonomous with training equipment. It must be remembered that equipment does not train; it simply provides a training medium. A corollary is that better training equipment does not guarantee a better-trained individual. Equipment advances will never replace the requirement to practice and in fact, may actually increase the practice requirements. At the risk of being out of step with the rest of the training research and development (R&D) community, this paper advocates the position that many of today's training problems (performance deficiencies) can be attributed to lack of sufficient practice; simply adding a new piece of training gear will not solve the problem. However, effective practice does not occur in a vacuum, and simply increasing frequency without regard for content will not guarantee success.

There are many professions that require a great deal of formal structured training to reach and maintain a working level of proficiency. To a certain extent, the training technology that underlies these programs relies on a set of common principles for skill acquisition and retention. Each specialty places its own particular demands on this technology, forcing the evolution of adjustments and adaptations specific to that profession. Often, the changes instituted in one profession will also benefit another profession. It makes sense to examine periodically the training programs of other disciplines in search of solutions to similar problems. The purpose of this paper is to examine a generic athletic training model and its relevance to the fighter pilot training programs. In this paper "athletic training" refers to the entire skill development sequence, not just the conditioning and exercise physiology domain.

Athletics was chosen because (a) this is a field that routinely obtains maximal or near-maximal performance from the participants, (b) the training technology is systematic and well documented, (c) the skeletal outline of the "assembly line" is similar to pilot training programs, and (d) the competitive nature of athletics may be analogous to fighter piloting tasks.

At the outset, similarities between athletic completion and aerial combat seem obvious: competition, aggression, discipline, physical and mental stresses, strategies, tactics, and teamwork. As the brief description of the athletic training model unfolds, more analogies to the fighter pilot training model should be obvious and will not be belabored. Some readers will say that This is nothing new or that we already do this. The position taken in this paper is that while the structures of the training programs are similar, the actual contents bear little resemblance, and only lip service is paid to many of the training principles (i.e., we don't really do it at all). The intent is to offer suggestions for ways to improve the fighter pilot's abilities, not just to criticize the present systems. It will be argued that the quality of today's fighter pilot may be improved considerably if a few tenets of athletic training were to be adopted and implemented by the Air Force.

The following basic elements function in the athletic training model: (a) the game structure, (b) the athletes, (c) the coach, (d) a sponsor, and (e) the opposition. Each of these elements has its counterpart in the pilot training routine. The intent of this paper is to focus on the athletes and coach; however, it should be recognized that the other elements exert strong influences on the overall program. For example, the ultimate sponsor is the taxpayer, with the Government and Air Force functioning as would a board of directors for a professional athletic team. Indeed, it may be worthwhile to examine closely these roles and interactions as they impact performance in both domains, but that topic is beyond the scope of this paper.

Unlike the scant knowledge data base supporting flying training programs, there is a considerable technical data base regarding skilled athletic performance. This information has resulted from years of research and years of documented trial and error. However, it is all structured around a fundamental understanding of what the performance requirements are. This means a dedication to a continually updated front-end analysis. This amounts to more than paying someone (the Air Force approach) to do a front-end analysis that sits on the shelf gathering dust. It is a philosophical commitment to the proposition that understanding structure, form, and function will further enhance the level of performance that can be attained.

As is the case for almost all activities leading to skilled performance, a building block approach is used. As the result of a front-end analysis, individual skill elements are identified and rank-ordered in terms of a most desirable skill acquisition sequence. This hierarchy is not necessarily perfectly consistent with a difficulty/complexity dimension and there may not be a great deal of skill overlap between many of the early successive levels.

The first level of the hierarchy requires mastery of the "fundamentals." The degree of emphasis placed on the fundamentals cannot be overstated. Fundamentals are practiced, practiced, and practiced. These fundamentals must be periodically and systematically reviewed, even after extremely high levels of proficiency have been attained. It is a truism in athletic training that the coach who slights the fundamentals will not have a consistently successful program. Virtually every practice session includes some practice of the fundamentals. They are practiced within the context of drills specifically designed to require a given skill element or combination of skill elements.

Drills are an entire topic in and of themselves. There is a wide variety of drills designed to ensure practice of the same skill element. There are, indeed, volumes entirely devoted to drills, for each aspect of all sports. Varying drills during and across practices maintains motivation levels and facilitates generalization of the basic skill elements across a variety of situations. As skill levels increase, the relative amount of time devoted to drilling fundamentals decreases and the level of sophistication (in complexity and approximations to game-like conditions) increases. The goal is both to overlearn and then to sustain that level of performance.

The next step in the model is the inclusion of drills requiring combinations of fundamentals. Typically, these drills are replicas of an isolated and simplified canned game situation. At this level, the drills begin to involve basic teamwork. The emphasis given to the fundamentals of teamwork seems to vary as a function of the game structure and the coach's personal philosophy. The drills become more and more game-like and more formally competitive in nature. (Drills at earlier levels were not formally competitive although implicit competition usually was present.) Progress toward closer approximations of the game conditions is made fairly rapidly.

The next major step involves the introduction and practice of formal strategies and tactics: offensive-defensive and transitions. At this level there is a decided slowdown in pace. The plays must be thoroughly understood. The level of understanding demanded by the coach can vary from simple mechanical reproduction of a given role to understanding the functional and purposive role of the entire play pattern. Thus, the cognitive demands may vary considerably. Plays are rehearsed verbally, then at walk-through pace, then at medium pace with frequent interruptions for corrections and instructions, and finally at full speed with real-time instruction.

After the coach is satisfied that the players have at least a fair understanding of the plays, the first formal simulation of game conditions can be introduced. If a scrimmage is allowed before this point, the quality of play degenerates, bad habits develop, and extra time must be spent to correct undesirable behaviors. The scrimmages usually are conducted under controlled conditions in the sense that the coach will instruct and interrupt the game at his discretion. Teams are constructed to be as close to equal in total team ability as possible.

From this point on, the scrimmages become more frequent, less controlled, more competitive, and longer. The coach begins to select those players who will constitute the first team by grouping them together during scrimmages. Scrimmages may then be followed by informal practice games with other teams and finally, by formally structured practice games.

All of the training that has transpired to this point is in preparation for the "real" game or competition. Each competition is followed by more practice sessions. These practice sessions do not differ in principle from the ones preceding the first game. The coach structures these between-game practices to work on those fundamentals which were poorly executed in the previous game and to practice specific adjustments needed for the next game. To be most effective over the course of many competitions, strategies sometimes require revision to prevent easy prediction by the opposition. However, the basic approach to practice and game preparation stays the same. The foundation was laid early with emphasis on the fundamentals; the basic outline of the "game plan" was also introduced early, with considerable attention to execution of plays. Specific game plans are usually variations of elements already well rehearsed. Not many totally new tasks are introduced once a season of competition is underway. New plays do not usually win games. What may appear to be a new play to a spectator is usually something that was introduced in practice before the season started but was not yet

perfected. Its use in a game could wait until the moment the coach felt it was needed.

The training regimen outlined above is fundamentally the same across the various levels of skill (e.g., high school, college, professional) and is repeated systematically. It is as if skill progression is achieved by climbing a spiral staircase. Twelve or more years of training may be behind an athlete at the peak performance level. The length of time that this level of performance can be maintained varies considerably, but in some fields it may be another 12 years before significant skill deterioration occurs. At a very gross level, the same training philosophy and program that engendered the skilled performance will be what maintains it.

In addition to the emphasis on carefully constructed and graduated practices, the athletic training model relies heavily on performance measurement. Athletes and teams are measured on almost every aspect of their performance during both practices and games. The measures usually are objective but subjective ratings and evaluations are also included (especially with respect to attitudinal and motivational factors). An important point to make about the measures is that they are useful. They have been well researched in both experimental and applied settings. They have been shown to be valid and reliable assessors and predictors of performance. There are staff members within most clubs and teams whose only responsibility is collecting and summarizing performance measures. These summary measures are valuable in that, first, the coaches use it to make player evaluations and training management decisions and, second, the players use it as feedback and for motivational purposes.

Initially, the coach uses the measures to ascertain a player's capabilities. The coach compares these numbers with normative data to make an estimate of each player's potential and then monitors the numbers for signs of progress. Deviations from a normal progression are usually taken as indications of important personal characteristics such as learning aptitude, desire, or "coachability." The coach also combines the measures of all his players to ascertain team strengths and weaknesses. The coach uses this information to determine what specific skills are emphasized during practices and to formulate a strategic system which maximizes strengths and minimizes weaknesses. Many coaches retain their records of practice sessions and game statistics for many years.

The same measures that are used by the coaches are also used by the athlete for many of the same purposes. The athlete can see an objective performance record, can monitor progress, and can compare the level of performance to that of others. Typically, a measurement system provides a strong motivational tool for the coach. Players strive to improve and are rewarded to see tangible evidence of that improvement. The coach must be able to discriminate differences in performance among players and needs measures that are sensitive to these differences. The players want to know where they stand and want to be treated as individuals and not lumped indiscriminately into a group. Thus, the players also need measures that are sensitive. In professional athletics, performance measures are often used as the basis of

salary bargaining, and differences in opinions regarding the relative worth of the measures often result in prolonged contract negotiations. The point is that performance measurement is an integral part of the athletic world; it is accepted and used by coaches and athletes alike.

Contrast what has just been described to performance measurement in the fighter training programs. The 0 to 3 rating scale, as everyone who uses it knows, is really a 2-point scale, since the extremes are rarely used. It has the appearance of an objective scale, since the definitions of each category refer to criterion-referenced objectives (CROs) for each task. However, the CROs have never been worked out for many tasks and are not used for many others. The end result of this type of measurement is that it is useless. It cannot be used to discriminate between differences in skill levels except at the low-end extreme. It cannot be used to track progress. It does not function as a motivational tool since everybody gets the same mark. It cannot be used to assess the effects of changes in the flying program. This lack of sensitivity may have indirectly resulted in the loss of many flying hours in the mid to late 1970s.

The prevailing pilot attitude toward measurement is distinctly negative unless, of course, it can be disguised as something else, as in the case of the Air Combat Maneuvering Instrumentation Range System. The negative attitude toward performance measurement even prevails at some combat training exercises. Since they are regarded as "training" exercises, there is a perceived need to avoid the appearance of "assessment" (i.e., measurement); somehow training and assessment are pitted against each other. (One might reasonably inquire whether the exercises really are effective or how much pilot improvement is a result of the experience.) Attitudes improve somewhat when it comes to scoring bomb deliveries or air-to-air kills. In these instances, the measures do serve many of the listed functions. Unfortunately, they are, by themselves, inadequate. (For example, they are totally nondiagnostic.) If one can judge by the successful function of measurement in the athletic training model, the pilot cadre is not doing anyone a service by eschewing performance measurement; rather, they should be encouraging the necessary R&D to develop effective measures.

The position taken in this paper is that current flight training programs are inadequate. The talent is there and the equipment is there, but the training program is not. Many articles and books on coaching contain the lead-in cliche, "You will play like you practice," or "Practice the way you want to play." The pilot will recognize these lines immediately. Herein lies the crux of the problem: "We don't really train the way we want to fight. Will we fight the way we trained?"

The highest level of normally scheduled training for an attack-type pilot is participation in a tactical field exercise, which perhaps lasts for 2 weeks and occurs for a pilot maybe once or twice a year. Such a training exercise is roughly equivalent to a preseason, controlled intra-squad scrimmage. One can imagine what would happen to the quality of an athlete's and team's performance if their training regimen never proceeded beyond an intra-squad scrimmage.

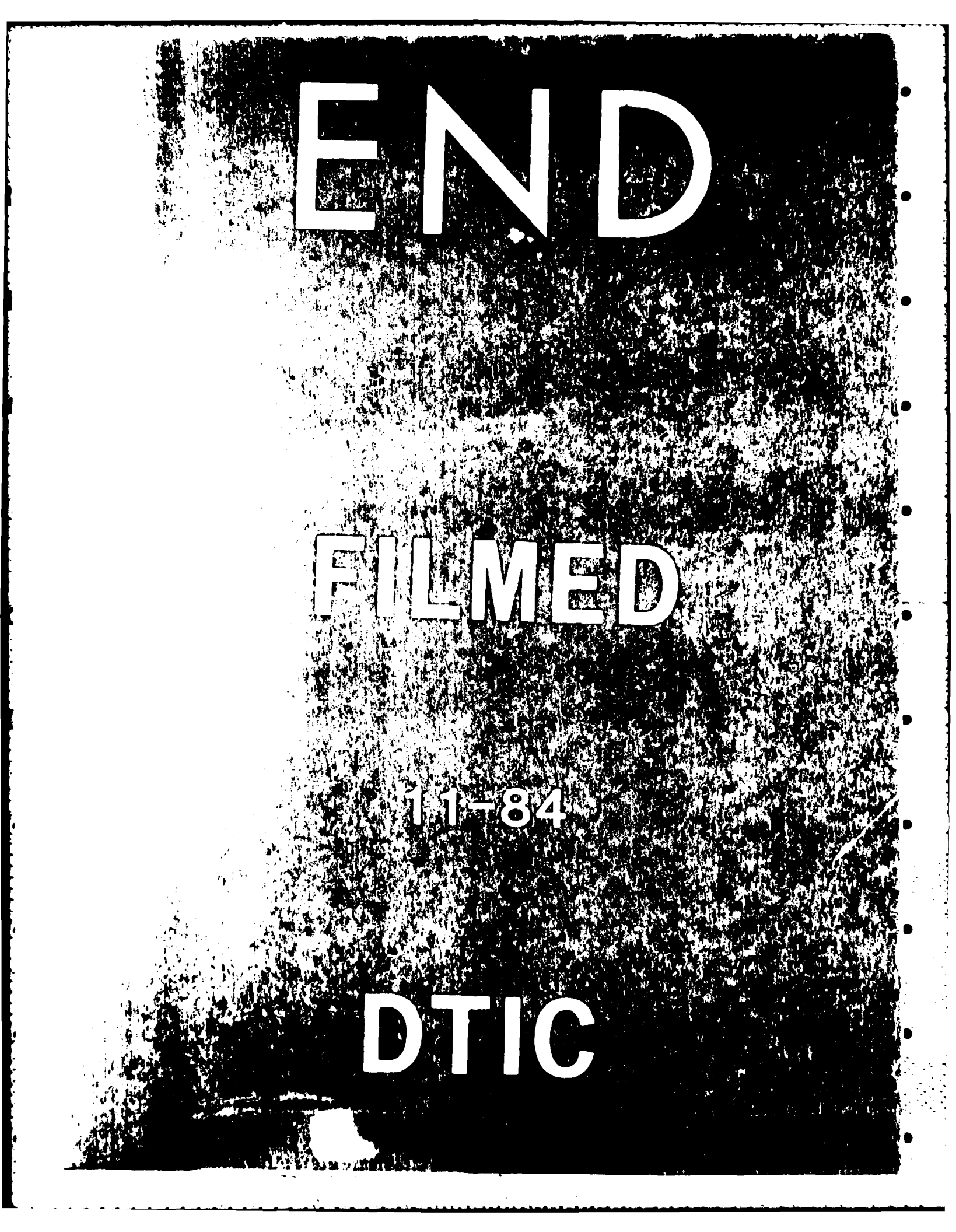
To make matters worse, there does not seem to be adequate background training in the prerequisite component skills/tasks (i.e., the fundamentals) to make the most of the experience. For example, one recent observer at the fighter lead-in training program noted that of the time allocated to surface attack only about one-quarter of the period was actually spent practicing the tasks. The remainder was spent getting to and from the range and in holding patterns. Things are somewhat better in the air-to-air combat training arena where a better build-up of training experiences can be arranged and practiced. However, even in the air-to-air domain, combat-required experiences in dissimilar combat training, mixed force training, missile firings (real or simulated), full-mission scenarios, and lower altitude engagements are extremely limited in scope and frequency.

Skill development/refinement is one of the functions of practicing under progressively more game-like conditions. Another function is to establish habit patterns which are resistant to degradation under the stress and anxiety experienced in a game. Here the complex interaction of task difficulty, baseline performance levels, stress and anxiety all interrelate to determine level of performance. Many are familiar with stories of athletes who seemed to excel in the "big game" or conversely, with those who seemed to "choke." Most coaches aim for consistency in practice and to create the level of competitiveness in scrimmages that approximates the game, such that the game is not a novel situation and subject to uncontrolled motivational effects. Learning to deal with stress and anxiety has become a very important area of R&D and application in sports psychology. It should also become an R&D area for aviation psychology.

Another area of athletic training that has relevance to pilot training is the relative ease with which new ideas, techniques, and equipment transition from the R&D world into the training environment. That is not to say that every gimmick, gadget, or idea is accepted without resistance. There is, though, always a desire to find a better way of doing things. Most new ideas are tested and replicated in experimental programs prior to widespread advocacy and adoption. However, once something has demonstrated potential, the transition is quick and welcomed. One method used to spread the word is through clinics and seminars where coaches exchange information on programs, tactics, techniques, and philosophies. The competitive nature of athletics facilitates the transaction process, since everyone is trying to attain an edge on the next guy. The inertia of any bureaucracy is well known and the Air Force training world is no exception. One of the biggest problems is a well-entrenched parochialism of the "if it wasn't invented here . . ." attitude. Additionally, many changes need to be implemented through the operations side of the house. Changes are often difficult to implement and flexibility is not the word of the day. Substantial thought needs to be given to these problems before any real innovations will make their way to the field.

CONCLUSION

Today's fighter force is not benefiting from optimized training programs. As a result, individual and unit mission readiness suffer. The author feels that the main problem with the Air Force's approach to training is reliance on equipment. Since equipment does not train, this approach is bound to fail and fail at a substantial cost. As an alternative, the athletic training model is offered as a guide. The emphasis in this model is on the individual and that person's performance; equipment is incorporated only as needed and not as an end of itself. The athletic training model is based on systematic application of training principles derived from a multi-disciplinary approach, much as would have to be the case in flying training. Additionally, the athletic training model emphasizes many areas that seem to be weak in existing flying training programs (frequency of practice, emphasis on fundamental skills, use of performance measurement, graduated realism in training, etc.). It is conceivable that a two-fold increase in mission effectiveness could be achieved with no additional training support equipment, and that the proper balance between training and training equipment can bring additional increases in performance.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