USER ACCEPTANCE OF R&D IN NAVY TRAINING: THE PROBLEM, MAJOR CONSTRAINTS, AND AN INITIAL MODEL OF THE ACCEPTANCE PROCESS*

Dr. Gerald R. Stoffer, Dr. Arthur S. Blaiwes,
Naval Training Equipment Center

and

Dr. Clyde A. Brictson
Dunlap and Associates, Inc.

ABSTRACT

The problem of operational user acceptance of naval training R&D studies and training devices is presented. A number of constraints on acceptance are described, including deficiencies in motivational conditions, deficiencies in social role assignments, deficiencies in official organizational policy and structure, inadequate defense R&D contracting methods, lack of integration of the user into the trainer system acquisition process, other-than-rational user responses to R&D studies in training, and deficiencies in training device design. A preliminary model of the acceptance process is presented. Finally, the degree of physical fidelity necessary for operational acceptance and training effectiveness is discussed. It is concluded that this paper and related recent work form a basis for the development of alternative approaches to solving the user acceptance problem.

INTRODUCTION

Scientific research and development (R&D) is a major institutionalized means for creating improvements in military technology. The R&D community creates these improvements not only by constantly advancing the technological data base, but also by introducing that technology into fleet operations. In fact, the force for change from "technology push" (12) by R&D agencies has been traditionally stronger in generating operational requirements than that from "requirements pull" by the operational fleet who formally establish Navy requirements (28). Training technology has also advanced rapidly in the last decade. However, there is considerable evidence that training organizations are reluctant to accept the introduction of R&D studies. In addition, acceptance of specific training devices is a major problem. There has been very little investigation of the factors influencing the acceptance of new training methods introduced by R&D studies. R&D has generally fulfilled its role in creating the potential for useful changes in operational training, but has not developed an adequate model to assist in how change should be managed. Basic organizational and human resistance to change has remained stable, whereas the rate of change itself has greatly increased. A major task of training R&D, therefore, is to develop managerial methods for the successful planning and implementing of changes in training technology.

Importance of the User Acceptance Problem.

Improved acceptance is especially critical now for several reasons:

1. Significant advances in effective training technology remain to be incorporated into the Fleet. Computer training technology (3) and maintenance training (23) advancements are two major areas of "gaps" between available technology and its applied use. In addition, further R&D studies need to be performed to evaluate and improve currently implemented training systems.

2. A variety of low-cost, low-fidelity approaches to training system design are now under development. The degree of physical fidelity (realism) has been shown to be the single most important variable in gaining user acceptance (7). However, the current practice of "buying" user acceptance of simulation training at the (high) cost of increased physical fidelity is being questioned. Thus, the loss of acceptance from fidelity sources requires improved acceptance conditions from areas other than fidelity. This issue will be discussed in a subsequent section.

3. There is an increasing need to introduce and to have accepted training improvements as early as possible. Over the past decade the time to acquire a major weapon system (and related training materials) has steadily increased (11). In the current environment of international tension, it is imperative that the user be in a position to move the acquisition process along and to incorporate training improvements as rapidly as feasible.

4. Training technology will be increasingly integrated into ongoing fleet operational systems. With the advent of portable, rugged, and compact training systems has come the possibility of training aboard ship (called onboard training or OBT) -- either in the form of original or refresher training (e.g., landing refresher trainers in the pilot ready room as currently envisioned by NAVTRAEQUIPCEN - see 25). Recent shipboard weapon system design with new class destroyers includes provisions for embedded training devices used to support team training. The success of the OBT concept will depend critically on acceptance of this concept by fleet personnel.

5. An especially critical problem of accepting flight simulators as flight hour

substitution devices now exists. In a document (8) issued by the Chief of Naval Operations (CNO), authorization and plans for achieving a 25% reduction in Navy flight hours (and huge fuel savings) by the end of FY 81 were stated. The flight simulator was viewed as a potential flight substitution device by higher command echelons of the Navy. Local training commands, however, have continued to view the simulator as a means for augmenting rather than replacing aircraft training. This discrepancy between perceptions of the purpose of the device is a major reason for the documented underutilization of aviation training devices and the consequent failure to demonstrate cost savings through flight hour reductions (Navy Audit Review, 24).

6. Operational tasks and equipment are becoming increasingly complex (14) and human error correspondingly probable and costly. Thus, greater reliance of training substitutes for operational environments will be necessary, for a variety of both high-cost and low-cost forms of training.

Focus of this Report. The focus here is on acceptability of new training methods by training system users. Acceptance of training, however, is regarded as a tri-service problem and a conceptual model of the acceptance process needs to be developed for tri-service use (see below).

A second major focus is on the factors supporting the introduction of R&D studies into training organizations, in contrast to subsequent testing, installation and institutionalization of the change into ongoing fleet training cycles. Obviously, successful acceptance at the beginning will make subsequent implementation much more likely. Although this report will often illustrate the process of acceptance in terms of an R&D study with a training device, the successful introduction of R&D studies in all operational training areas is of prime concern. Where devices are mentioned, they will be aviation training devices (ATDs) due to the authors' experience in this area and the high cost of these trainers. Underutilization and even non-utilization of ATDs has been documented for both Air Force (7) and Navy (20) devices. These two sources are the only studies that have systematically reviewed the effects of different user attitudes and device features on utilization of ATDs. Many of the observations made by these earlier reports regarding ATDs were supported herein as also being relevant to the acceptance of R&D studies. Additional observations have been provided in the present paper regarding acceptance of R&D, many of which would seem to apply as well to ATD acceptance. Further, a model for user acceptance of R&D has been developed which represents a beginning effort to integrate theoretical literature from the general area of organizational change with the earlier and present observations from ATD and R&D field implementations.

Perspectives on Acceptance and Change.

1. Who has the acceptance problem? There is a natural tendency to focus on the operational user when thinking about acceptance of R&D. If R&D studies or results are not accepted, the user may be labeled as resistant to change. The view here is that the user can take neither credit for acceptance nor blame for the rejection of R&D efforts. Instead, acceptance depends on a large number of factors influencing training at the individual, group, organizational, and CNO levels. Acceptance is a training system output and therefore the system should be the target for change.

A major purpose of this report is to identify a number of general constraints on acceptance, only some of which exist at the operational user level.

2. Is high user acceptance the goal of R&D efforts? User acceptance is a continuous variable ranging between the extremes of complete rejection of an innovation to complete acceptance. It is apparent that even the most effective and economical training program or device can have no value if it is rejected (unused). However, complete acceptance of a training method is not necessarily desirable either, since acceptance also may be based on reasons other than effectiveness and economy. Caro, Shellnutt, and Spears (7), e.g., have made an important distinction between acceptance of a device as used and acceptance of a device as it was designed to be used. In flight training, there is considerable evidence that even when devices are well accepted, their capabilities are often underutilized (29). Operational Flight Trainers (OFTs), e.g., are often highly accepted only as Cockpit Procedures Trainers (CPT). The primary goal of R&D efforts is not on maximizing user acceptance, but on maximizing organizational effectiveness and economy of the training organization.

3. Is the proposed change always desirable? The perspective taken here is that, in specific R&D studies planned with a particular user group, change introduced by the R&D should only be considered after careful diagnosis of the existing training program. Thus, R&D scientists are not to be labeled only as "change agents" but also as "interventionists", a term used by Argyris (2) to characterize a person who intervenes to diagnose an organization's effectiveness, but who does not necessarily follow through as a change agent.

Some R&D studies are ill-conceived; appropriate diagnosis may reveal that there is no training problem as originally conceived, or that the proposed R&D effort is irrelevant to correcting the identified problem, or that the original R&D problem is not significant. Or there may exist a variety of constraints on acceptance which make the study infeasible. These constraints on acceptance are the most compelling reasons for deciding not to introduce change, since almost all training programs could stand some improvement and almost all R&D studies can be (and usually are) adapted to become more relevant to the needs of the local operational group. The rational approach to R&D planning includes the option of not doing R&D studies where a variety of constraints on acceptance of change makes the study exceptionally risky or infeasible. These constraints which exist at all levels of the Navy training command structure, will be described in detail below.

4. To increase acceptance, should the man or the machine be changed? In traditional human

factors engineering, there is a focus on how man *interacts with machines* (e.g., training devices). To "perfect" the interaction, a scientist can attempt to change either the man or the machine. One approach emphasizes changing the man through "attitude engineering" to increase acceptance of device features existing in current trainers. An apparently more common approach is to focus on the design characteristics of the training machine, especially in terms of physical fidelity or realism. Both approaches need to be included in any comprehensive framework of the acceptance process. In addition, the framework must include "man-man" interactions among users, sponsers, and R&D personnel throughout the entire training system acquisition process, from introduction of initial R&D studies, through design reviews, initial device evaluations, and subsequent training support. *Grace (15), in her 1979 presidential* address before the Human Factors Society, has pointed out that human factors specialists' have traditionally overemphasized machines, devices, and systems, relative to human interaction problems in the design, development, and use of these machines.

5. Is a scientific approach to the problem of user acceptance possible? Some may resist *the idea that science can be used to analyze and* actually influence something so apparently nebulous and subjective as "acceptance". Although the state of science is not well developed in the acceptance area, there are some theoretical and empirical bases for influencing levels of acceptance. An initial step in the scientific approach would be to document the extent of variation of acceptance found in various aspects of naval training. Factors that influence acceptance would subsequently be identified, described, and prioritized for different applications. Then improved metrics for these factors would be generated. A conceptual framework consisting of these factors and their relationships to one another would be developed to understand the process of acceptance and to use as a basis for predicting acceptance levels in particular situations. Some of these factors have predictable, but uncontrollable consequences on acceptance levels; other factors are controllable by those with influence in the training command structure. The R&D community can become more proficient at managing the introduction of training innovations by applying those factors that can be controlled to influence acceptance.

Organization of this Report. The remainder of this paper is organized into four major sections:

1. Terminology of user acceptance
2. Major constraints on acceptance
3. Conceptual framework for acceptance
4. Issues in user acceptance

TERMINOLOGY OF USER ACCEPTANCE

Definition of the User. The usual focus on acceptance is on the operational user -- the level at which a training device or system is operated or maintained. However, in terms of the successful introduction of an R&D study, acceptance must exist on at least two additional levels -- the sponsor or funding level, and the technical or scientific level responsible for immediate management of the R&D study. If acceptance depends upon several levels of users, an overall metric of acceptance would include input from each of these primary users. The role of each user would reflect his major expertise and needs at each level. Thus, acceptance would be maximal when the R&D work was seen as: (1) credible by the operational user who uses his operational expertise to judge the training value of the R&D work; (2) affordable by the sponsor user who uses his cost-benefit analytic expertise to judge the value of the proposed work in terms of funding requirements of competing programs; and (3) researchable by the scientist user who uses his technical expertise to judge the scientific value of the work. Unless the subsequent text refers *specifically to the sponsor or the scientific user,* it should be assumed that the user is the operational one.

Definition of Acceptance. At the scientific user level, there are well developed rules or validity factors for accepting as worthwhile a proposed R&D study (cf., 6). At the sponsor user level, there also exist established procedures, federal regulations as well as statutory proscriptions *to judge the acceptability of a study in terms* of funding limits, appropriate funding appropriations, service priorities within funding categories, fiscal year time constraints on obligation, expenditure of funds, etc. At the operational user level, however, the criteria for acceptability typically are not based on scientific, regulatory, or statutory grounds. The criteria for acceptance are based mainly on a tradition which requires the user to make primar*ily subjective determinations of training value.* Subjective opinion will undoubtedly continue as a primary measure of acceptance. Although high subjective acceptance of training methods does not guarantee optimal training value, it is certainly true that an absence of subjective support will reduce the use of methods that may be highly acceptable to both scientific and sponsor level users.

A complete operational definition of acceptance will include all three user levels. In addition, within each user level, there may be several levels of acceptance of change (as modified from Hersey & Blanchard, 16) that can take place:

1. Individual knowledge of an alternative training method.
2. Individual attitudinal commitment to the alternative.
3. Individual behavioral commitment to the alternative.
4. Group behavioral commitment to the procedures called for by the alternative.
5. Organizational/Institutional policy commitment to the alternative.

This expanded definition of acceptance adds two important perspectives to the attempts of R&D to introduce behavioral changes in training practices: (1) failure to obtain behavioral change, at either the individual or group level does not *necessarily* mean that no change in knowledge or attitude has taken place. These "lower level" changes in knowledge and attitude can provide an important basis for subsequent attempts to obtain behavioral commitments; (2) even change in the form of behavioral commitment may fail to have longer term impact if the innovation does not become institutionalized into the organization's training policies.

Finally, each of these levels of acceptance are continuous variables. Thus, the R&D scientist should not expect to obtain, nor the user feel compelled to provide, unqualified acceptance. It is essential that the user understand that his "acceptance" of an R&D study does not necessarily constitute complete agreement with the proposed change. He should accept, however, the responsibility to honestly attempt to evaluate the training consequences of the implemented change.

CONSTRAINTS ON OPERATIONAL USER ACCEPTANCE

An analysis of the acceptance problem from a systems point of view reveals several kinds of constraints that mitigate or even prevent acceptance of an R&D study or of an ATD. These constraints exist at all levels of human behavior, including the personal, social, and organizational levels of the Navy. Listed below are several major kinds of constraints on acceptance. Although there is some overlap between these various constraints, they do appear to circumscribe the classes of limitations that would need to be considered (and further developed) in any comprehensive treatment of the acceptance process.

1. Deficiencies in User Motivational Conditions.
2. Deficiencies in User Role Assignments.
3. Deficiencies in Official Navy Policy and Structure.
4. Inadequate Defense R&D Contracting Methods.
5. Inadequate Integration of the User into the Weapon Systems Acquisition Process through Participative Management (PM).
6. Other-than-Rational User Responses to R&D Studies and to ATDs.
7. Deficiencies in Training Device Design.

<u>Deficiencies in User Motivational Conditions</u>. It is axiomatic that there must be some personal motivational basis for the acceptance of an R&D study or a new ATD. Adams (1) has recently stated that one of the five major learning principles on which ATDs are (or at least should be) designed and used is *trainee motivation to perform the task*. He refers to this principle as "customer acceptance". While it is true that the trainee's motivation to practice is important, the more crucial training element for both the acceptance of R&D studies and the use of an ATD itself appears to be the instructor. If the instructor fails to accept the innovation, it will not reach the trainee. Moreover, the instructor's attitudes and role modeling play crucial roles in motivating the trainee to use an ATD (cf., 7). It is also the instructor who is in a position to commit himself to implementing the training methods proposed by the R&D.

An analysis of the motivational conditions commonly found when instructors participate in R&D projects reveals serious deficiencies. These include:

1. *Little or no official recognition* (via, e.g., fitness reports, acheivement awards) is given for instructor contributions to R&D. As a result, the R&D is perceived as a low organizational priority and unrelated to their position in the Navy.

2. Incentives other than official recognition are also deficient. Although the instructors are essential to implement the study, they receive little credit for successful outcomes.

3. Participation in R&D often increases the total workload of users such that: (a) abnormally long and/or time-stressed periods are required to accomplish the job; (b) participation in R&D threatens performance on other tasks (often more critical in terms of fitness reports, advancements, etc.) due to time taken from these tasks for R&D assignments. Thus, R&D may be viewed by users as a work overload as well as a threat to their position in the Navy.

4. R&D studies are sometimes perceived by instructors as an assault to their professional status. First, there are ways to significantly improve training which users feel they should *have implemented but did not. Thus, R&D can* threaten the users' status as training designers. Secondly, some training operations (e.g., evaluating and diagnosing student performance, providing remedial practice) that the instructors feel pride and security in being uniquely qualified to perform can be proceduralized, automated and/or made more objective. In these ways, R&D can threaten the status of user as instructors (i.e., instructional technology might replace them or at least diminish their importance -- the "John Henry effect").

5. The use of low-cost, low-fidelity trainers, although able to provide effective training, can be interpreted by instructors as another sign that they are "less elite" than other occupational specialties in that their group has to "make do" with "inferior supplies".

6. Instructor time spent in a trainer can decrease instructor time with operational training equipment (e.g., aircraft). However, career advancement, as well as personal enjoyment, often seems to depend on use of operational (vs. simulated) equipment. Thus, R&D that seeks to reduce the inefficiencies of training with operational equipment can threaten both the enjoyment and career advancement of the user.

7. Although the principle of feedback is central to both motivational and learning theory, R&D personnel in training have been criticized for not providing knowledge of R&D results to the participating training organization. In a recent example, an operational squadron was less than

enthusiastic about starting a new study partly because they hadn't received even the final report of a study completed two years earlier.

8. There are predictable psychological responses to change which lead instructors (and others) to resist innovation. Such resistance is well documented (33) under a variety of conditions, including innovations in training and educational methods:

a. Basic security needs will be compromised in the face of uncertainty induced by the changes. For example, the instructor can feel unqualified to implement new procedures.

b. A second natural response to the innovation is that more effort will be necessary to implement the change than that required to continue older procedures.

c. It is also frequent for the implementing organizational unit to feel criticized in the face of the change. No amount of logical persuasion and discussions regarding the value of change can completely counteract the instructor's conclusion that *current performance may not be adequate*. Since there are few absolute standards of the value of his work, the work of the implementing instructor personnel is judged largely on the basis of relative standards, including R&D evaluations.

d. Finally, the members of the implementing organization will likely experience some degree of loss of freedom (or even perceived manipulation) by an outside agent. In discussing the personal response to managerial control systems, Cleland and King (9, pp. 330-331) have identified several common yet unintended consequences of control systems (as paraphrased from McGregor, 21). Managerial control and related restrictions on freedom initiated by R&D may yield: (1) failure to comply with the full requirements of the control system; (2) antagonism to the controls and to those who administer them; (3) unreliable performance information due to erroneous and/or misleading reporting; (4) necessity for close surveillance by managerial staff; and (5) high administrative costs due to the expense of surveillance.

Deficiencies in User Role Assignments. Inadequate liaison between R&D personnel and users also exists because of a lack of proper definition, acceptance and performance of social roles for various members of an R&D project. The social role literature, usually defines two kinds of role "stresses" -- role ambiguity and role conflict. Role ambiguity refers to a lack of clear definition of one's appropriate role behaviors; role conflict refers to two or more clearly defined roles in which simultaneous performance prevents either role holder from successfully fulfilling his responsibilities. A prevalent example of role conflict is between the R&D scientific role responsibility and the instructor's primary role to rapidly provide trained pilots, which very often requires training command resources completely devoted to the "urgency" of meeting the squadron training needs. To further aggravate the situation, many R&D efforts can provide only partial answers to training problems, which are not solved until several such answers are pieced together. The cooperation of users can become severely strained when it becomes clear that the slow, cautious, methodical, self-critical approach of the R&D project is not going to provide answers fast and sure enough to satisfy their current operational needs. Operational restrictions on experimental control can slow the R&D process by necessitating further R&D to answer questions about possible influences of uncontrolled variables.

A deficiency more serious than that of role conflict is role ambiguity. There is no basic conflict between users and R&D personnel in terms of their basic responsibilities for enhancing training effectiveness. There is a problem, and resultant stress for both parties, however, when roles are ambiguous, as currently exist for users working with R&D personnel. Clear roles defining expected liaison behaviors are absent.

There are at least two predominant kinds of response to role ambiguity. One may become "irresponsible" and give up trying to play any role at all. Or, an individual may try to assume all the behaviors that might fall under the jurisdiction of his usual organizational responsibilities. This latter response is fairly typical of pilot training in which instructors usually approach their job with a high sense of responsibility. However, role assignments are inappropriate when users attempt to evaluate technical research aspects of R&D efforts, such as research design and statistical analysis. When users begin taking on the role of R&D personnel, a third kind of role stress, which could be called "role overlap", develops. With role overlap, neither party in the relationship can feel responsible for successful role performance since there are multiple claims on "ownership" of the role behaviors. Like role ambiguity, role overlap can also lead to irresponsibility. If skilled R&D personnel are not given the opportunity by users to deal with the technical research issues, they are not "response-able"; if highly influential users do not have the necessary research expertise, they are not "able-to-respond".

There are several areas in which inappropriate role overlap currently exists:

1. Replication of a previous study (whereby the experimental conditions of an earlier experiment are essentially reproduced) often is viewed by users as "duplication of effort". Duplication of effort occurs and should be avoided, according to many users, where two or more R&D projects address the same general goals (e.g., optimization of the same training device). However, when the R&D objectives have critical implications for human lives, money, and mission success, multiple approaches to the same R&D objectives can be quite desirable and even imperative. Equally important, replication plays a critical scientific role in the R&D process in terms of defining the external validity or generalizability of previous findings across time, subjects, assumed irrelevant variations in experimental procedures, etc. In the case of truly independent replications, R&D findings be-

come extremely credible where similar conclusions are reached. Behavioral research is replete with experimental findings that cannot be replicated even under the best of conditions. Thus, replication needs to play a much greater role, especially in operational settings of minimal experimental control.

2. A relatively large sample size is considered by the user to be essential in order for any objective of the R&D project to be met. However, the size of an adequate experimental sample is a complex matter involving consideration of a number of design and statistical issues (e.g., the use of repeated measures, the error variance of the sample population, the extent to which experimental controls can be implemented), and the nature of the study objectives.

3. Operational users often want to consider the cost of the R&D as part of their evaluation of the project. This practice is inappropriate because R&D costs should be evaluated in a context of its contribution to technological information bases, as well as to the development of specific new products. Since, at best, users only have information related to the value of potential new products for their particular situation, user efforts to evaluate the general costs and benefits of the R&D are not completely meaningful.

4. The need for R&D is diminished in the view of users to the extent that they perceive their current training program as already successful. However, a major role activity of R&D scientists is to provide an independent assessment of organizational effectiveness. In addition, their responsbility is to help assure that a successful program is preserved over time through documentation and standardization of training procedures. Further, it is important to determine as precisely and accurately as possible what the criteria for training program success are, how well the training is in fact working, and what specific aspects of the training are contributing to or detracting from the level of success observed.

5. It is often expected by users that details of the research design for solving the R&D problem will be discussed very early in the project and often in the first kick-off meeting with users. This view conflicts with R&D requirements to delay specification of such details until appropriate rationale for such details can be obtained, which often involves the cooperation of the users who are requesting the details. It often happens that the R&D team is pressured into becoming too detailed too soon, with the result that the R&D design is quickly criticized as being inappropriate for the particular operational situation in question. Such criticisms are usually valid since a major contribution of users to R&D is to help determine an R&D design that is well suited to their particular situation. Thus, discussions at initial meetings between R&D personnel and users should include only the level of detail needed to evaluate the general R&D approach in terms of specific operational constraints such as current training schedule, instructor personnel and student throughput.

R&D managers have often been deficient in the application of participative management (PM) to capitalize on the user's expertise. PM could assist to more clearly define appropriate user roles (see below).

Deficiencies in Official Navy Organizational Policy and Structure. There are a number of constraints on acceptance which have little or nothing to do with individual motivation of the user or his social role interactions with R&D personnel. Direction from official policy at the training organization or even regional or national level of influence can restrict the successful introduction of R&D. An understanding of some of these policies can be extremely valuable because policy changes can help to overcome "Navy Policy" obstacles. Less directly, policy modifications also can aid in resolving the constraints discussed throughout this paper.

1. There is a prevalent and generally supported view in the Navy that R&D should be conducted with no interference with ongoing operational training. Semple (29), e.g., has specifically advocated a guest-host relationship in conducting training effectiveness evaluations with operational user hosts. A policy statement from the Chief of Naval Education and Training (CNET) subsequently formalized Semple's not-to-interfere-with-training concept. However, since most important R&D conducted in operational settings requires some such "interference", this conception often is counter-productive. Lacking a generally accepted definition of what interference means and how it applies to various R&D situations, this view can be taken literally and enforced by the user in cases where it should not be. A policy of non-interference also contributes to the impression that R&D is a low priority activity which is to be tolerated, if necessary, but is not to be given serious consideration by the user organization.

2. Current Navy policy requires frequent instructor rotation and training support personnel turnover. Thus, in the process of introducing an R&D project, one or more key personnel are almost always about to leave the organization. For these individuals there is no incentive to make a commitment to the project since any benefits resulting from the project probably will not occur until long after their rotation date. In addition, all the risks and uncertainty of change common to the initiation of any R&D project will be experienced if a commitment is made. Furthermore, frequent personnel rotations create problems when new users come to the project subsequent to its initiation. Efforts to indoctrinate users to the project need to be repeated each time a new member arrives. The new project members do not have the benefit of feeling that their efforts have influenced the determination of project goals or the methods used to achieve them. The issue of turnover is a crucial one in gaining initial acceptance as well as continuity of acceptance throughout the project.

3. The typical aviation training organization does not provide guidance for adequate instructor pilot (IP) training. Current instructor training policy is almost entirely on the job training (OJT) conducted very informally and sporadically as primary training schedules and other commitments permit. The training provided

to prospective instructors is not a basic but a collateral duty of the "qualified" instructor. As a consequence of inadequate instructor training to operate ATDs, R&D with ATDs is less likely to be accepted for at least three major reasons:

a. The new instructor is forced to develop his own unique training techniques used with the ATD. The emotional commitment to methods that one has developed himself is generally much stronger than those recommended or required by other people, such as R&D personnel (cf., 32). Thus, there is likely to be much greater resistance to a proposed change in training techniques than if the techniques were relatively standardized across instructors.

b. The lack of standardized instructor training and consequent diversity of opinion about what is important in training make it very difficult to achieve a cohesive user position in support of certain proposed changes in ATD training. In addition, the integration of new standardized procedures with instructors who previously have used highly heterogeneous training procedures is a problem because the relationship of the new procedures to existing ones needs to be examined on an individual instructor basis.

c. As device utilization methods pass informally from older to newer instructors, much of the original information is lost due to limitations in recall, oversimplification, etc. The natural oversimplification of the capabilities of ATDs over time helps explain the well documented fact of underutilization (e.g., using an OFT as a CPT) of a wide variety of Air Force and Navy ATDs. Thus, research projects which attempt to foster the use of the full capabilities of an ATD which has been passed on by several generations of instructors may meet with considerable resistance from current instructors.

4. With certain exceptions, such as the presence of Fleet Project Teams (FPTs), local training commands often do not have policy support for the personnel and resources required to accommodate an R&D effort. Some organizations are genuinely overloaded with existing operational training responsibilities.

<u>Inadequate Defense R&D Contracting Methods.</u> Government contracts involving operational training organizations tend to ignore the reality of the user acceptance problem until the contract work has begun. Scientific officers monitoring these contracts seldom require the contractor to develop a methodology for gaining acceptance. Nor is there a contractual requirement to document successful and unsuccessful acceptance methods. Consequently, there are no contractual provisions for the necessary time in the early part of the schedule to achieve acceptance milestones nor are there funds allowed to achieve and to document these milestones. Thus, each new R&D study is forced to "rush through" the acceptance problems by placing further pressure on the user. This pressure is applied without benefit of the lessons learned from previous studies that have experienced similar difficulties.

<u>Inadequate Integration of the User Into The Trainer System Acquisition Process: A Lack of Participative Management.</u> The formal structure of the Weapon System Acquisition Process, including training system development, requires user input and participation at several points in the process of ATD acquisition. Caro et al. (7) have found that participation of Air Force users during ATD design as well as during initial ATD effectiveness evaluation in the training environment, significantly improves attitudes toward the ATD. Mecherikoff and Mackie (22) found that a lack of such participation among Navy personnel created a strong negative attitude of "not invented here." There generally has been little systematic application of participative management (PM) techniques to the entire process of trainer acquisition and subsequent evaluation, including initial effectiveness evaluations and later ATD training optimization studies. PM has not been applied due largely to the three limitations indicated below:

1. Lack of recognition of the value of PM as a general tool for gaining acceptance of change.

2. Lack of operational definitions as to <u>how</u> PM should be implemented during a specific proposed change in training methods.

3. Lack of formal documentation of successful applications of PM to specific military training organizations.

A successful introduction of an R&D study will be more likely if it is made clear to users as soon as possible that a participative approach is desired. There is considerable empirical support for the value of PM as a general tool for introducing organizational change (16). In addition to the empirical basis for using PM, there are a number of more "intuitive/logical" reasons for using PM:

1. PM makes use of subject matter experts (SMEs) from the training command to provide necessary information to R&D personnel. Information regarding current training system practices and resources as well as suggestions for alternative R&D approaches and methods are especially critical in the complex system in which aerospace training takes place.

2. PM allows the SME to learn that he is valuable. A natural response to change, described earlier, is a feeling that one is being criticized for inadequacies. With PM used to introduce change, the SME learns that he is not being replaced. Certain behavioral practices of training may be replaced, however. To the extent that SMEs feel that they are being evaluated, PM encourages them to participate in determining the basis on which their efforts can be judged (16).

3. PM reduces the natural resistance due to uncertainty of an unknown change and its consequences.

4. PM reduces the natural resistance due

to the perceived loss of freedom initially attributed to presence of R&D personnel. The PM approach encourages full expression of dissenting opinions and is consistent with the democratic decision-making ideals generally held by this country.

5. PM allows the user to understand the likely level of complexity of the proposed change. If the user does not grasp how everything ties together in the R&D plan, he is likely to make changes (especially an upgrading of requirements) during the study without evaluation of the probable impact of changes on technical performance, schedule, or cost risks (10).

6. PM provides a context for group activity which can satisfy certain social needs such as affiliation.

7. PM identifies personal sources of necessary support for the change who were not initially part of the group participation.

8. PM informs "outsiders" of the informal rules of the organization which can complement the formal support of change.

9. As a result of a number of the foregoing advantages of PM, PM increases the organizational members' commitment to the change goals and objectives established. This consequence of PM is the single most valuable benefit of PM and also has been empirically documented (16). Participating in the development of a change effort gives one the experience of "owning" the change and responsibility for supporting its implementation. Thus, the implemented change is much more likely to be long-lasting, perhaps even eventually institutionalized into the training organization.

The value of PM as a general tool for gaining acceptance of change is becoming more widely acknowledged. However, there are few operational definitions of how to implement PM into operational military systems. However, there is at least one significant, but preliminary attempt to proceduralize PM into the evaluation of complex aviation systems throughout the weapon acquisition process. Butterbaugh, Moss, Sexton, and Kearns (5) have developed an acquisition process model for the Air Force that focuses extensively on user input evaluations throughout the process.

It should not be assumed that PM is a panacea for all organizational change goals. The success of PM over the alternative change strategy of directive management (DM) depends on the results of organizational diagnosis by the change advocates. This overall diagnosis would not only tell the R&D personnel whether change should be attempted at all, but also which change strategy would be more likely to be successful with the particular organization involved. The prime factor determining the relative efficacy of PM and DM, according to research in situational leadership theory (16), is the level of "task-relevant maturity" diagnosed in the group members. People with high task maturity are "achievement-oriented, seek responsibility, and have a degree of knowledge and experience that may be useful in developing new ways of operating ... A directive change style is inconsistent with their perceptions of themselves as mature, responsible, self-motivated people who should be consulted throughout the change process". (p. 283). This description of high maturity seems to fit very closely the operational users of primary interest in this report - namely pilots. An earlier section of this report pointed out that the typical instructor pilot has an intense responsibility to his operational tasks. Such responsibility, combined with the usual high degree of task-relevant expertise among pilots, is an extremely valuable asset in improving training systems.

<u>Other-Then-Rational User Responses to R&D Studies In Training</u>. Different methods of introducing R&D into operational military training organizations can be used. At a heuristic level, there are three general methods used to gain acceptance of R&D. The user may be told that he: (1) <u>shall do it</u> (power of higher authority); or that he (2) <u>can do it</u> (power of persuasion based on rational/logical arguments supporting the technical feasibility of a proposed change); or that he (3) <u>wants to do it</u> (power based on the user's own emotional/motivational/value system which is consistent with or satisfied by the proposed R&D study). Ideally, all three reasons exist to support acceptance. Seldom, however, is there clear and powerful "shall do" authority for initiating specific R&D studies; R&D personnel are normally staff officers without command authority.

The typically used method involves rational/logical appeals to the operational users' intellect based on the training value of the proposed R&D effort. This "rationalistic bias" of R&D specialists is also found in non-military organizational change efforts (33) and assumes that change requires no more than an exchange of technical knowledge. One of the major constraints on gaining user acceptance, however, is that acceptance of change is naturally influenced by emotional factors that are not strictly "rational" in nature. In the Navy maintenance training area, e.g., there exist severe acceptance problems of training devices although these devices were designed and validated according to principles of modularity, self-pacing, criterion-referencing, etc. Even where technical arguments are clearly made, they are not always sufficient. It is argued, therefore, that the successful R&D scientist must have skills which allow him to anticipate and deal with these "other-than-rational" user responses which can lead to lack of acceptance of a proposed study.

These responses to the introduction of an R&D study occur in many forms, but they can be classified in at least three basic ways. Some examples from naval aviation, as observed by various scientific officers and contractors working with the Naval Training Equipment Center is provided for each of these classifications. (A follow-on paper will attempt to describe these same kinds of responses by scientific officers, as observed by operational users).

1. <u>Emotional resistance based on the particular operational organization's situation.</u> Commonly heard statements by users include:

a. "Our situation is unique - training results found elsewhere don't apply to us".

b. "Our situation is too complex to study".

c. "Even if your proposed study could improve our training for now, our situation will change".

2. Emotional resistance based on the lack of credibility of the R&D specialist.

a. "You can't evaluate the flight simulator if you haven't flown the actual aircraft".

More generally, this response implies that operational experience is a prerequisite for credibility as an evaluator. This view would be perfectly rational if the evaluator's responsibility was to improve or practice his skills as, for example, a pilot. Some users even take the extreme view that evaluators must be equally proficient at operating the actual equipment. Obviously, however, the user is the operational expert and it would not be cost-effective to require of R&D specialists more than a minimal degree of operational experience. Logically, the R&D scientist could also insist that the user be as skilled as he at performing R&D. Of course, this logical alternative to requiring the R&D specialist to be operationally experienced is seldom stated since it is recognized that there are necessary and complementary forms of expertise represented by both operational and R&D personnel. If the R&D specialist's skills overlapped completely with those of the user he would have nothing unique to contribute to improving training effectiveness.

Although it would be difficult to insist that operational experience is detrimental to one's effectiveness as an evaluator, it is not always possible to show that such experience improves effectiveness. It has long been thought in clinical psychology, e.g., that direct experience with a client's symptoms would facilitate a counselor's effectiveness. However, specific research (30) with alcoholics treated by previous alcoholic counselors showed that success rates were no higher than for those treated by "non-empathetic" counselors. It is probably true that such empathy would increase the chance of the client accepting a treatment program in the same sense that the study proposed by a credible R&D evaluator would be accepted. This initial acceptance, in both cases, is based more on emotional grounds than on grounds of potential effectiveness, however. The user can easily identify with and accept operational task experience as grounds for credibility. The R&D specialist's expertise in such tasks as problem definition, development of methodological procedures, statistical analysis, oral and written communication of results, etc., none of which are dependent on operational experience, is much more difficult for the user to appreciate.

3. Emotional resistance based on attitudes towards ATDs undergoing evaluation.

a. "The TDs (Training Device Maintenance Personnel) fly the simulator better than real pilots".

With certain carrier landing trainers, users sometimes use TDs to provide ATD demonstrations to visitors because "They can catch the #3 target wire every time". Although there is nothing inherently irrational in this statement (it is true), the underlying attitude is negative towards the ATD since it is implied that the simulator teaches skills not required by an experienced carrier pilot. The illogic of this attitude is based on acceptance of the conclusion that TDs would not be able to land on a real carrier even if they were proficient in the simulator. However, TDs are not given the opportunity to actually attempt carrier landings and thus there is no empirical basis for accepting this conclusion. Even if the TD could not land on the real carrier, presumably because the landing trainer does not teach all the skills required for landing success, a significant portion of the required skills learned by the TD would transfer to the actual landing task.

b. "If a flight simulator doesn't feel right, it has no training value".

This response aptly illustrates a general phenomenon, observed by Mackie et al. (20). They found that users often feel that unless the ATD is perfect in all respects, its use for any reason is regarded as a waste of time. The device is then likely to be regarded as a "toy" or as a "pinball machine".

Deficiencies in Training Device Design. The primary systematic approach to acceptance has been identification of deficiencies in ATD design (7, 20). This approach is fundamental to the solution of acceptance problems because the deficiencies can be fairly easily isolated and future ATD design presumably modified to correct them. Deficiencies in device design is one of the most severe constraints on the acceptance of R&D studies introduced to training organizations. However, it is in the ATD design area that the scientific approach can be most easily applied to predict and control the level of acceptance of ATDs. Changing the machine (i.e., the ATD) to fit the man (i.e., the ATD instructor and student) may be much easier than attempting to change the man (user) who does not accept the machine.

The acceptability factors in ATD design fall into two general classes: (1) hardware/firmware features, and (2) software/courseware features. This first class essentially includes a variety of physical fidelity factors relating to the student work station (and the physical layout of the instructor work station). It would include, e.g., the presence and appropriate positioning (absolute and relative) of necessary controls and information displays inside the cockpit. The second class includes both physical fidelity factors created by computer simulation (e.g., visual and/or motion effects) and various instructional features designed into the software.

AN INITIAL MODEL OF THE PROCESS OF ACCEPTANCE OF R&D - INDUCED CHANGE

Figure 1 portrays a preliminary model of acceptance. The model identifies these stages of innovation as formulated by K. Lewin (19) and the four related changes conceptualized by Rogers and Rogers (27). The first stage for Lewin is called "unfreezing" which implies that change, e.g., introduction of an R&D study, can occur only after the individual or organization is ready for it. Listed under this stage are several kinds of factors or "forces" (discussed in this paper) that would decrease the risk of transitioning to the second stage, termed "changing", wherein the changes would actually be made.

Separate from the forces that would support change is the original recognized need or requirement for change. This recognition, of a discrepancy between available training technology and current capabilities, is the first stage of innovation for Rogers and Rogers. Both a recognized need for change and the presence of forces supporting the change are necessary to transition to the second stage in which changes are trial tested, e.g., in the form of an R&D study. The last stage for both theorists is "refreezing" (19) or *institutionalization of the change* (27), e.g., integration of R&D results into ongoing training methods to improve organizational effectiveness.

Five levels of change, ranging from a change in individual knowledge to a change institutionalized in organizational policy, adapted from Hersey and Blanchard (16), is also presented in Figure 1. These levels of change correspond roughly with the stages of the innovation process. Knowledge (e.g., of the latest technology), the lowest level of R&D-induced change, is the basis for Rogers and Rogers' first stage in which

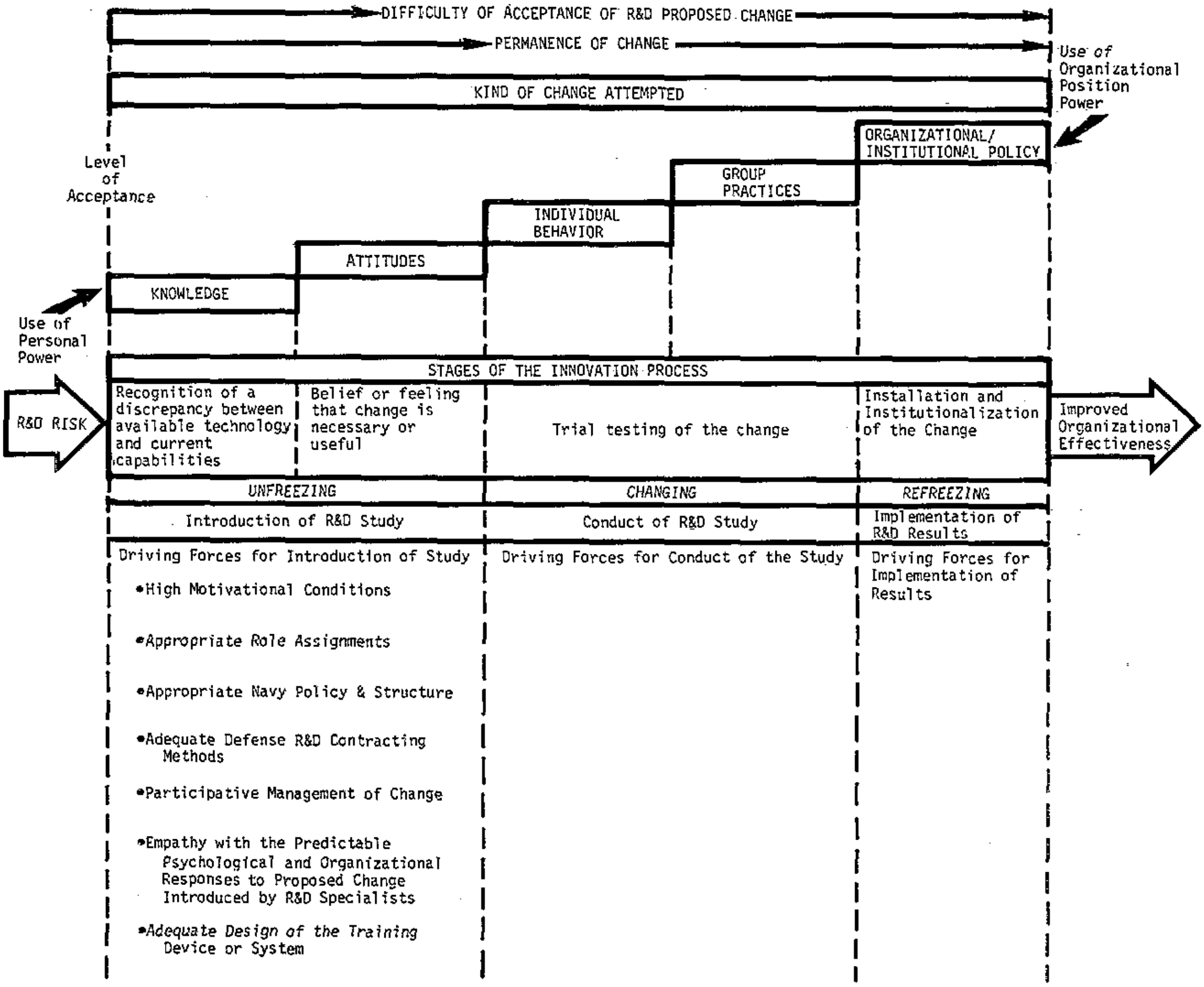

FIGURE 1. A preliminary model of the acceptance process. Indicated are the stages of change and a listing of factors supporting the initial stage of introducing an R&D study (as emphasized in this paper). The use of personal power typical of R&D specialists vs. the organizational power present in the training command structure is shown applied to different levels of attempted change. The model includes elements from Hersey & Blanchard (16), Lewin (19), & Rogers & Rogers (27).

the user recognizes the existence of improved technology. Their second stage, which is the belief or feeling that change is necessary or useful, corresponds to the next highest level of change in which attitudes are supportive of the change proposed by the R&D specialist. This motivation to change is the third necessary ingredient, along with recognition of a need and the presence of driving forces supporting change, for successful initiation of R&D.

The present paper has focused on acceptance of the introduction of an R&D study. The stages of innovation, however, also include individual and/or group behavioral commitments in order to trial test the changes successfully introduced by the R&D study. These commitments represent more advanced levels of acceptance of change because they include all the lower level knowledge and attitude changes and are therefore more difficult to achieve. The highest level of acceptance is change translated into institutional policy such that it is no longer recognized as a change. The forces supporting changes at these higher levels of acceptance are probably similar to those driving change during the first stage of innovation and will be presented in other papers in this area.

The model also indicates that the "shall do" kind of influence based on the power of positional authority (13) comes from the top organizational levels such as the commanding officer (CO) whereas personal power starts at the bottom levels. R&D personnel are ultimately trying to make changes at a relatively high level (i.e., at the group and/or organizational level). If change is achieved at these relatively high levels, the change is more permanent and may even become institutionalized. However, this task is extremely difficult since R&D personnel are usually limited to personal power. Whereas a CO could initiate an immediate and dramatic organizational change through the power of his position, the R&D specialist must begin his goal of organizational change by first changing knowledge of, and attitude toward, the proposed change. The concept of personal power involves the power of technical content expertise in interpersonal relations. As suggested elsewhere, most human factors R&D personnel have not fully developed their personal power of influence in terms of interpersonal relations based on an understanding of the operational user's emotional/motivational/value system of acceptance.

ISSUES IN USER ACCEPTANCE

The general constraints on user acceptance appear to be a useful means for classifying approaches to acceptance problems. However, there are a number of specific issues regarding acceptance which remain to be addressed. Two of the more critical and controversial issues introduced in this paper are: (1) how are subjective user reports best used in the measurement of acceptance; (2) to what extent should maximal physical fidelity be the goal of training system design?

These two issues are related in that user opinion often seems to take the stance that higher device fidelity is always better. As indicated earlier, physical fidelity seems to be the single most important determinant of user acceptability. In contrast, many R&D efforts lead to the conclusion that deviations from maximal physical fidelity are possible and even desirable in the interest of cost-effective training. These differences in orientation are reflected by the use of the concepts, "simulator" and "trainer". The former term has come into vogue with unfortunate consequences on training efficiency, since it implies that training devices are superior only when they closely resemble operational conditions. This implication is strengthened by the challenge from users that training designers do not yet know enough about training to risk deviations from maximum possible levels of simulation fidelity. However, enough is known now to deviate significantly from the "simulation" criteria of acceptability and to place emphasis on the device's "trainer" features (i.e., features that facilitate positive transfer to operational settings).

Discussions of the processes by which training device fidelity (and consequently costs) can be reduced and learning can be maintained or even increased are presented in a variety of sources (e.g., 4, 7, 18). Two separate R&D demonstrations of these processes are underway at NAVTRAEQUIPCEN. A low-cost, low-fidelity cockpit procedures trainer (CPT) for the SH-3H aircraft has been developed and partially evaluated and early results indicate essentially equivalent training at about 17 percent of the cost ($310,000 vs. $1,800,000) of an existing more conventional, higher fidelity CPT for the same aircraft. Similar approaches are being taken and similar results are expected with a low-cost part task trainer for the EA-3B aircraft.

Further evidence corroborates the notion that high fidelity is not essential nor even necessarily desirable for effective learning (18, 31). For example, up to 50 percent savings in flight hours has been obtained from practice on low fidelity flight trainers. Also, fidelity requirements are found to depend on factors such as the amount of transfer of training required, the prior experience of the student, and strategies of instruction. Numerous studies have demonstrated that the training of aircraft piloting can be effective where patterns of stick forces, rather than the absolute amount of force or displacement of stick movement, correspond with operational conditions. Such deviations from high fidelity may be highly justified on a cost-effective basis, but rejected by users based on fidelity considerations.

Traditional practice has been and to a large degree still is to buy user acceptance by increasing the fidelity of simulation. A topical question regarding this practice is: how much can we afford to spend on device features for the sole sake of user acceptance? A trend appears to be at hand where such expenditures will be minimized and more low cost trainers will be replacing high cost simulators.

The issue remains, however, that if R&D indicates the desirability of lower cost/fidelity trainers, how do we deal with subjective impressions of user personnel which are often in conflict with their use? These subjective reports are the traditional and most common form of acceptance. One approach to resolving this dilemma is to empirically ascertain the ability of users to subjectively assess the training value of devices. This can be done in part by determining the reliability of user opinion (i.e., agreement among users) regarding both the acceptability and training value of particular device features (17). According to Sammet (28), there is seldom a cohesive or unitary operational user when operational needs are specified by the user. The same lack of consistency may be documented for user evaluations of ATDs. However, if user opinion is reliable, further R&D would be needed to document the relationships between user assessments of the training value of device features and actual student learning with these features. In this way, an empirical basis for the utilization of user evaluations could be established. There is evidence at NAVTRAEQUIPCEN, e.g., that user judgments of the necessity of motion in flight simulators are related to their actual performance in these devices for some types of motion systems but are not for others (26).

CONCLUSIONS

The user acceptance area appears to be in a condition similar to the instructional development field prior to the advent of the Instructional Systems Development (ISD) era. That is, no systematic procedures are available and little sharing of information occurs regarding naval user acceptance problems and their solutions. Further, very little science has developed in the area and, at best, practices represent a very under-developed art. As a result, one must depend mainly on his own personal experiences and mistakes and his own independent actions to solve the problems.

Given the obvious cost benefits and improved readiness resulting from increased acceptance, it is surprising that so little empirical work has been done to identify a set of acceptability factors and factor priorities for different classes of trainers. Similarly almost no guidance exists as to how to successfully introduce R&D studies into training organizations. It is hoped that this paper has adequately stated the severity and scope of the acceptance problem. A second paper is planned to identify solutions which will involve overcoming the system constraints on acceptance described herein and to continue development of the model of the acceptance process.

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*An intent of this paper is to stimulate discussion of different points of view in the acceptance area. This report represents the opinions of the authors and should not be taken as official Navy policy.

ABOUT THE AUTHORS

DR. GERALD R. STOFFER, LT, MSC, is a Naval Aerospace Psychologist at the Human Factors Laboratory at the Naval Training Equipment Center, Orlando, Florida 32813. He is currently engaged in R&D programs dealing with air combat performance measurement, carrier landing simulator training effectiveness evaluation, user acceptance of R&D, measurement and profiling of air combat stress, and automated aircrew proficiency measurement systems. His B.S. is from Washington State University and M.A. and Ph.D. in Research Psychology from the University of Montana.

DR. ARTHUR S. BLAIWES is a Research Psychologist at the Human Factors Laboratory at the Naval Training Equipment Center. He is currently engaged in R&D programs dealing with low-cost training devices, instructional systems development programs, user acceptance issues, and automated data management systems. He received a B.S. from Ohio State University and an M.A. and Ph.D. from the University of Kentucky in Experimental Psychology.

DR. CLYDE A. BRICTSON is President of the Western Division of Dunlap and Associates, Inc., located in LaJolla, CA. He has over 20 years experience in applied human factors research, specializing in performance measurement and training effectiveness. His most recent work has been in air combat and carrier landing training improvements through the development of automated performance measurement and appraisal systems. His Ph.D. is from the University of Southern California.