DOCUMENT RESUME

ED 070 309 EM 010 610

AUTHOR	Mackie, Robert R.; And Others
TITLE	Factors Leading to the Acceptance or Rejection of Training Devices.
INSTITUTION	Naval Training Equipment Center, Orlando, Fla.
REPORT NO	NAVTRAEQUIPCEN-70-C-0276-1
PUB DATE	Aug 72
NOTE	171p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	Adoption (Ideas); *Military Training; *Program Evaluation; Psychological Patterns; Simulators; Trainers; *Training Techniques

ABSTRACT

The use and acceptance by Navy personnel of sixteen major training devices were studied in relation to: situational factors affecting training; simulation characteristics of the trainer; instructional characteristics of the trainers; reliability of the trainers; formal and informal communications regarding trainer capabilities, and level of experience of the users in the systems simulated by the trainers. The participants included students, instructors, administrative, and maintenance personnel. An acceptance profiling technique was developed that appeared to be highly diagnostic of the reasons for acceptance or rejection of particular trainers. It was evident that both highly accepted and seriously rejected trainers were represented in the sample. Methods for increasing trainer acceptance were outlined in terms of improvement in specific areas of simulation; improved software; greater qualifications for instructors; improved evaluations of performance; and improved understanding of the purpose, capabilities, and limitations of trainers by the users. (MC)

NAVTRAEQUIPCEN 70-C-0276-1

FACTORS LEADING TO THE ACCEPTANCE OR REJECTION OF TRAINING DEVICES

Robert R. Mackie
with
Gene R. Kelley
Gary L. Moe
Michael Mecherikoff

Human Factors Research, Incorporated
Goleta, California
Contract N61339-70-C-0276
NAVTRADEVCEN Task No. 8345

August 1972

DoD Distribution Statement

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NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

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FOREWORD

An important determinant of the effectiveness of training device systems--one that has received relatively little research attention--is the attitude of the trainees, instructors, and managers toward them.

This study was undertaken to identify the factors leading to the acceptance or rejection of training devices by their users and to determine the extent to which these factors were present in "effective" and "ineffective" training devices. Future training devices, including the associated training materials and recommendations for patterns of use, can be developed with a knowledge of these facts on hand. A second objective was to develop a methodology which could be used in the future by the Naval Training Device Center to assess the acceptability of training devices.

Factors found to influence acceptance are subsumed under six main categories. These are: (1) simulation factors, (2) specific trainer features, (3) characteristics of users, (4) characteristics of instruction, (5) patterns of use, and (6) the manner in which devices are introduced to the user.

Although no trainer is totally "acceptable" or "unacceptable," improvement in the above listed categories will result in higher acceptance of trainers with the consequence of improved training.

Specific recommendations to increase acceptance and improve methods of utilizing complex trainers include: (1) greater investments in training software, (2) providing better technical documentation, (3) providing for higher levels of fidelity in the "feel" of the simulated vehicle, (4) developing uniform and high standards for instructors, and (5) developing a "trainer advocate" for devices representing a major investment.

The acceptance profiling technique developed for this study should be applied periodically to all complex trainers so that a body of knowledge is developed that will be useful for design decisions.

Leonard E. Ryan

LEONARD E. RYAN
Research Psychologist
Naval Training Device Center

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS
(Continued)

LIST OF ILLUSTRATIONS
(Continued)

SECTION I

INTRODUCTION

The critical role of training devices in developing and maintaining the skills of Navy personnel is accepted by virtually everyone. Recognition of the need for a training device, however, does not automatically insure a high level of acceptance of the device by its users. Many factors operate, some perhaps obvious and some quite subtle, to determine the level of acceptance and method of use of training devices by military personnel. In extreme cases, strong patterns of rejection can develop that can defeat the very best of intentions and large-scale investments in training systems.

The problem is not peculiar to training devices. The Navy has become increasingly concerned about the potential degradation of systems performance associated with non-acceptance of various kinds of operational equipment by the personnel who must maintain and use it. Several studies have shown that in the hands of the users, new equipment often fails to achieve its full potential performance capability. It is obviously in the interest of all to identify the factors that operate in the acceptance or rejection of Navy hardware systems and to try to develop techniques whereby acceptance can be maximized.

In the economic world, the process of acceptance has been a major concern of every manufacturer of consumer goods--how does one gain acceptance on the part of the public to which he wishes to sell his product? In the marketplace, the consequences of consumer resistance are immediate and economically severe. In the military, where there usually is no competition (i.e., the user has no choice), the consequences are more subtle but very likely just as serious.

It was the objective of the study reported here to (1) identify the factors leading to the acceptance (or rejection) of training devices by their users; and (2) to determine the extent to which these acceptance factors were present in "effective" and "ineffective" training devices.

SOME BACKGROUND CONCERNING THE PROCESS OF ACCEPTANCE

The processes of acceptance and rejection have long been studied from the academic viewpoint by the social scientists concerned with attitude formation and change. The appropriate literature was carefully reviewed in an effort to develop hypotheses that might be pertinent to the acceptance of training devices. Within the literature there was also a small

number of studies directly concerned with the acceptance of hardware developments by Navy personnel. In one of the earliest such studies, Simpson and Parker (18) performed a field study of the acceptance of the ASPECT sonar system by fleet personnel. The investigation was concerned both with the operational use of this equipment and the degree to which it had been maintained in good operational order. It was found that the equipment on board over half of the ships visited was either incapable of producing target signals at all, produced signals of very poor quality, or was so severely miscalibrated that proper operation was impossible. Simpson and Parker suggested that the principal problem lay in the fact that a *lack of understanding of the purpose and operation* of the device had engendered biases against it. These biases led to insufficient maintenance, thus reducing potential operational effectiveness, which in turn further strengthened the biases, and so on, in a never-ending cycle.

A number of investigators have stressed the importance of firsthand personal experience, in contrast to the simple presentation of factual information, in promoting the acceptance of new equipment. Berger *et al.* (1) suggested that the importance of personal trial was the result of the opportunity to overcome negative attitudes based on unfamiliarity, to compare one's own performance using the new equipment with that using older equipment, to build confidence in how to use the equipment, and finally to provide an opportunity to communicate attitudes and ideas about the equipment to one's peers.

An important incidental finding of Berger's study was that attitudes toward new equipment may change over time without any additional firsthand experience, as a result of informal communication. A period of initial resistance to innovations may well be overcome, in time, provided that the proper provisions for trial have been made. If not, negative attitudes become stabilized and possibly increase in strength with time.

There is little objective documentation of user acceptance problems with respect to training devices. However, in an earlier NTDC study (20), a committee of engineers, training specialists, and maintenance personnel investigated the use of two operational flight trainers. The trainers were studied from the viewpoint of how effectively they were utilized by both training commands and the fleet. These investigators identified significant differences between design capability and the manner in which the trainers were actually used. They found that neither of the operational flight trainers was in a condition that permitted use of all of its

capabilities, either in a single problem, or in a series of problems. It was found that despite their other capabilities, the OFT's were used almost exclusively for cockpit familiarization training in normal and emergency procedures. They reported that squadron training officers for the most part had little confidence in the trainers, and did not as a rule make OFT instruction a part of the training syllabus. It appeared that some pilots had a "generalized dislike" for simulators as a result of early negative experiences. It was concluded that the problem of OFT utilization might be principally one of educating the users.

In many respects, the problem of optimizing the utilization of a training device is similar to that of maximizing the demand for a consumer product. The ultimate user of a trainer must be convinced of its worth, and educated concerning its capabilities and limitations. Apathetic acceptance may lead to poor methods of utilization which, in turn, may eventually result in actual rejection of the training device. The latter can also result from overselling or misinformation concerning a trainer's capabilities.

In a recent study of the acceptance of Navy equipment, Mecherikoff and Mackie (11) showed that the effects of design deficiencies can become accentuated through personality dynamics. One of the most important dynamic reactions that clearly led to rejection was the "not invented here" phenomenon. This refers to the formation of negative attitudes that can result from the absence of personal involvement in a technical innovation in one's own area of expertise. Any deficiency in the design of the innovation may be magnified in importance by the "not invented here" reaction.

Another factor identified in this study as important to the acceptance process has been clearly emphasized in the extensive literature on attitude formation and change. Attitudes toward new equipment or other innovations are critically determined by the "change advocate"--some individual who functions, formally or informally, in the role of initial communicator concerning the advantages and capabilities of the device to the potential users. The qualifications and other characteristics of the change advocate, real or perceived, are critically important to the development of acceptance, particularly if the innovation is in an area where the potential users consider themselves experts. Such factors as the change advocate's credibility, prestige, perceived motivation, relationship to the users, apparent impartiality, intent to influence, methods of handling criticism, etc., are factors that significantly affect his success in promoting the acceptance of new equipment.

While the importance of the change advocate has been known to social scientists for many years, it is apparent that there has been no systematic attempt to employ well qualified advocates for the introduction of new equipment into the Navy, whether that equipment be operational or training equipment. In fact, in many cases, the role of change advocate is never filled at all, with the not unpredictable consequence of disuse or misuse of the equipment. In some cases, the role of change advocate falls by default on petty officers whose primary responsibility toward the training device is its operation and maintenance. In a few instances, the role of change advocate has been unofficially assumed by some highly motivated individual who recognizes the need to solve a training problem and is willing to do something about it, however sophisticated his approach may be. But in many cases, there is no qualified advocate at all, official or otherwise.

When a training device is designed, the designers make judgments and decisions based on *their* understanding of important parameters of the total situation. These hopefully include:

1. The deficiencies of present devices (procedures or systems).

2. How learning occurs.

3. How the device will fit into an existing curriculum and what changes in curriculum may be required.

4. The range of usefulness of the device (specifically what it is intended to accomplish and what it is *not* intended to accomplish).

It seems likely that the designers themselves may not be fully aware of the extent to which they are making such decisions; certainly, the assumption is doubtful that the eventual users understand all of these factors *in the same way that the designer does*, or that the hardware itself will somehow convey its purposes.

McClelland (10) in his extensive analysis of the processes of effecting change, has identified a number of fallacious propositions that clearly appear to be pertinent to the introduction of training devices to military personnel:

1. *A good product will succeed on its own merits.* (Don't you believe it.)

2. *The introduction of a new device is a final act. No further attention is required.* (In the absence of a formula for maintenance and feedback, many training innovations are gathering dust and teachers and managers have reverted to former practices.)

3. *There is an orderly process from research to development to use.* (The fallacy of this proposition has been emphasized by numerous investigators.)

Quesada (15) has identified five criteria that appear to play significant roles in the acceptance of innovations. These have been paraphrased with reference to training devices.

1. *Relative Advantage.* The degree to which the training device is perceived as being superior to the one it succeeds.

2. *Compatibility.* The degree to which the device is perceived as consistent with operational requirements, equipment, and past experience.

3. *Complexity.* The degree to which the device is relatively difficult or easy to understand and use.

4. *Visibility.* The degree to which the results of using the device may be transmitted to others in a way that is easily seen or demonstrated.

5. *Divisibility.* The degree to which the device may be tried on a limited basis to gain first-hand personal experience.

It seems likely that all of these criteria apply, in one way or another, in determining the user's acceptance of Navy equipment and training devices.

Quesada also distinguishes between three types of decisions in the acceptance process. An "authority decision" results when those high in the power structure require adoption of an innovation. A "contingent decision" permits the individual to adopt or reject the innovation but only after an enabling decision is made by the organization. Finally, a "collective decision" occurs when individuals in a particular group participate in the verdict concerning a given innovation. Decisions of all these types may be made in

connection with an individual's use of a training device. They need not be mutually exclusive. An authority decision may be made that requires periodic use of the device, but this in no way prevents independent individual or group decisions concerning the value of using the device. Clearly, true acceptance must be a function of the "collective decision" for it is the decision at the user level that eventually determines whether the device is used effectively or not.

Chin (3) has a similar trichotomy of what he calls *strategies* for change. The "power approach" involves compliance and submission with a limiting of alternatives and shaping of consequences by those in authoritative positions. Chin points out that this may be counterproductive of the desired acceptance pattern. A second strategy is called "normative-reeducative." This approach depends on the role of values in a group with which the innovation is identified. An example of this approach is "sensitivity training." The third is the "empirical-rational" approach which depends heavily on demonstration of the relative merits of the innovation.

In his studies of factors influencing the acceptance of planned changes in other cultures, Niehoff (13) has studied the transfer of innovations to new cultural groups. A number of conditions were identified that helped expedite this process: (1) the innovation should be compatible with cultural patterns of the recipient group (the amount of new behavior required, and old behavior given up should be minimal); (2) the innovation should meet existing or felt needs of the recipient, probably those they have tried to solve through their own efforts; (3) the innovation should provide practical (economic) benefits; (4) the strategy of introduction should involve adapting to and working through the local cultural patterns, particularly the pattern of local leadership; (5) channels of communication should be established through a change agent who provides for an efficient two-way flow of information (feedback from the recipients to the change agent is particularly vital); (6) the recipients should be involved in the introduction process through full participation; (7) the change agent should be flexible in his strategies; (8) the change agent should establish patterns of maintenance (of the innovation) among the recipients so that the innovation can be continued when his influence is withdrawn.

When it comes to innovations in training systems, it seems likely that the attitudes of the instructor (as well as his competence) can be critically important to user acceptance. The literature on teacher attitudes toward

various approaches to instruction and training media is voluminous. One recent study, which is perhaps typical, was reported by Finch, *et al.*, (6) who studied the attitudes of 100 instructors in vocational-technical schools to determine interrelationships among teacher attitudes toward resources, resource utilization and availability. The results indicated that "the teacher group generally had a more favorable attitude toward 'traditional' instructional resources as opposed to 'progressive' materials. The traditional materials were used more often and were more readily available. Relationships between attitude and use and between availability and use were generally positive and significant." A factor analysis of the attitude variables revealed that "teachers may view instructional resources in accordance with their personal involvement with resource preparation, selection, presentation, and application. The results indicate that pre-service and in-service experience should be provided to acquaint teachers with new resources."

On a related point, Toye (19) makes the apparently not so obvious observation that a training program has to be capable of working not only when it is installed but of continuing to work despite organizational changes and accidents that beset any operation. "The literature on training and training methods rarely mentions how a training scheme works after its initial validation." As will be seen, this is a significant observation for the continued successful use of Navy training devices.

SECTION II

SOME SPECIFIC HYPOTHESES CONCERNING ACCEPTANCE

In their study of attitudinal factors influencing the acceptance of new equipment in the Navy, Mecherikoff and Mackie (*op. cit.*) attempted to summarize all of the influencing factors that appear to operate in the pattern of acceptance or rejection. These factors relate in part to the hardware, in part to the processes of introducing and promoting the device (advocacy). Not all of the factors were considered equally important or even applicable in every case. However, the list appears fairly exhaustive of the factors that should be considered in the course of introducing any new equipment. In the reproduction of this list, the statements have been paraphrased as they might apply specifically to training devices.

HARDWARE OR SYSTEM FACTORS

Conceptual

1. Agreement on definition of the need or requirement for a particular training device.

2. Various engineering approaches to device design.

Physical Factors

1. Equipment reliability and maintainability.

2. Problems of mismatch with the operating environment.

3. Problems of mismatch with the capabilities of user personnel.

4. Possibilities of mismatch with other elements of the training system.

Psychological Factors

1. Reaction to the appearance of the training device.

2. Perception of its "fit" into the training environment.

3. Reactions to delays in delivery (the device itself, components, spare parts, software).

4. Opinions formed on the basis of hearsay and rumor.

5. Opinions formed on the basis of limited experience with the device.

Support

1. Documentation of the purposes and functions of the device.

2. Documentation on how the device should be operated.

3. Documentation of technical specifications and maintenance data.

ADVOCACY FACTORS

Consideration of:

1. What different kinds of persons or groups will use the device and what are their relevant characteristics.

2. What communication channels were provided for user inputs during the design phases.

3. What means were provided to detect and resolve differences in approach or philosophy concerning the design of the device.

4. What users likely will want to know about the device.

   a. Overall purpose.

   b. Direct and indirect benefits to themselves.

   c. Benefits to the Navy.

   d. Data on reliability.

   e. Real or apparent drawbacks compared with earlier trainers.

   f. Real or apparent advantages compared with earlier trainers.

   g. Adjustments that must be made in the user's behavior patterns.

   h. How these adjustments will be achieved (formal retraining, assumption of personal responsibility, etc.).

i. New responsibilities that are entailed.

j. Present responsibilities that are to be reassigned to others.

k. Who these other persons are and what preparation will be given for carrying them out.

l. How those in the chain of command will be made aware that these responsibilities have been met.

5. Who is to be in charge of promoting usage of the trainer (trainer advocate).

6. What are the credentials and authority of the trainer advocate.

7. What threats the new device might present.

   a. Physical.

   b. Threat to current confidence with respect to operating skills.

   c. Threat to other aspects of the user's self-image, prestige, etc.

8. What the trainer advocate expects of the potential users and what the users expect of him. Are the two sets of expectations explicit and agreed upon by both parties?

9. What provisions there are for direct experience with the new device.

10. Whether the introduction communications (both oral and written) are designed for maximum appropriateness considering the characteristics of the users.

A simple listing of factors, however, is not enough to describe the *process* of acceptance or rejection. Clearly, this process is dynamic and many of the factors operate in an interactive way. An attempt has been made to summarize the factors hypothesized to influence training device acceptance, and their interrelationships, in Figure 1. It seems likely that a device will not be accepted or rejected in all details, but rather will have certain outstanding characteristics or deficiencies, whose combined influences place the device on some position on an acceptance-rejection scale. This consideration is reflected in the figure.

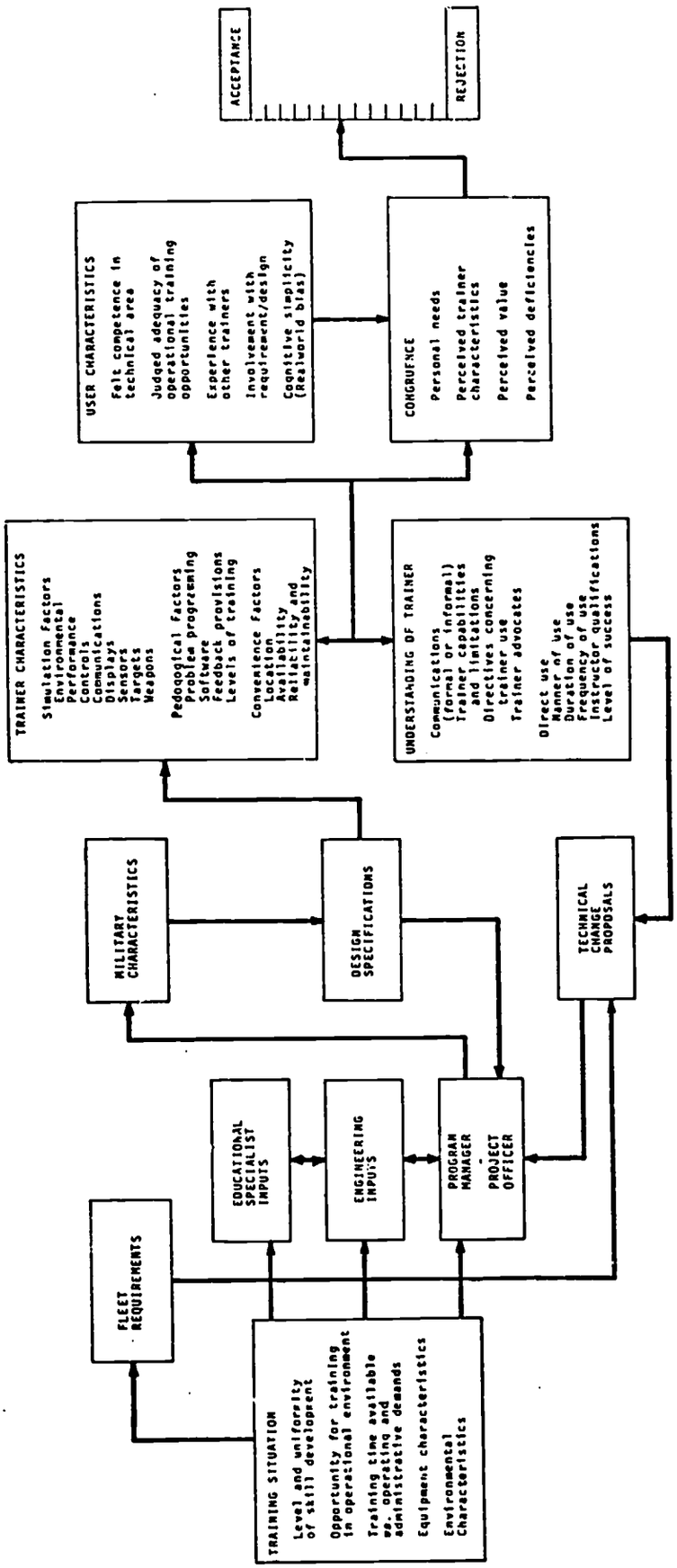

Figure 1. Factors Hypothesized To Influence Acceptance of Training Devices.

It was our objective to try to identify the influence of as many of the factors shown in Figure 1 as possible. We assumed from the outset that some of the factors influencing acceptance would be subject to the control of design engineers and others would not.

INFLUENCE OF THE TRAINING SITUATION

Perhaps the most important factors influencing training device acceptance insofar as the training situation is concerned are (1) the opportunity for training in the operational environment (or lack of it), and (2) certain characteristics of the equipment or the environment that may make the regular practice of some skills virtually impossible from either a safety or economic viewpoint. If there is ample opportunity for practice of critical skills using operational equipment, the trainer is not likely to be the preferred training vehicle. However, there are nearly always some procedures that, for practical reasons, simply cannot be systematically trained during routine operations. Examples include drill in emergency procedures under simulated catastrophic conditions, the firing of expensive or high yield weapons, and the manipulation of environmental factors that have major influences on operating effectiveness, such as sonar detection ranges.

Level and uniformity of skill development in the fleet is an obvious influence on the acceptance and use of training devices. A less obvious influence is the amount of time actually available for training in relation to operating demands and administrative responsibilities that compete for the same time. This is a major consideration in evaluating statistical data that may reflect trainer acceptance such as *percent utilization* figures. In many cases fleet personnel simply are not able to utilize a trainer to the extent they would like because of administrative duties. Any perceived deficiencies in the trainer, however, may serve to resolve the conflict between administrative demands and exercises in the trainer in favor of the former.

MILITARY AND DESIGN SPECIFICATIONS

It was beyond the scope of this study to perform a training situation analysis for all of the trainers whose acceptance was studied, or to analyze how fleet requirements and the inputs of educational specialists and engineers were translated, first into military characteristics, and then into training device design specifications. We felt it necessary, however, to examine the military characteristics for each trainer to identify its general design objectives.

Clearly, the question of trainer acceptance must be related to what it was intended to do and whether or not the users perceive it as fulfilling the same role as the designers did. It seems quite possible that a trainer might be accepted (or rejected) for a particular pattern of use which might be qualitatively different from the purposes stated in the military characteristics.

SIMULATION FACTORS

Prophet (14) has pointed out that a training device has one principal purpose--to provide an environment in which one can be trained. The most obvious characteristics of a trainer that influence its acceptance, then, are those features of the operating environment that have been selected for simulation and the fidelity of such simulation. Prophet has emphasized that simulators do *not* train; rather, it is the training program that trains. The critical factor is *task fidelity*. While we fundamentally agree with this viewpoint, it is nonetheless true that the features selected for simulation determine important boundaries within which the training must be accomplished. In fact they determine the extent to which task fidelity is possible. We felt it was important therefore to identify all major areas of simulation applicable to major training devices and to determine user impressions of the adequacy of that simulation. The factors selected for study were as follows:

SM-1. Simulation of the Internal Operating Environment. This factor was concerned with the adequacy of simulation of such characteristics of the internal operating environment as the type and location of equipment, arrangement of displays and controls, illumination, noise, motion, temperature, vibration, and other internal features that might be considered critical for training.

SM-2. Simulation of the External Environment. This included consideration of such features as the visual scene, auditory stimuli or noise from the external environment, and ambient temperature, pressure, atmospheric or water conditions that might affect equipment or personnel performance.

SM-3. Simulation of Vehicle/Equipment Performance. This factor was concerned with how well the performance characteristics of the vehicle or equipment were simulated. In the case of vehicles, consideration was to be given to maneuverability, response time, and range of operation; in the case of equipment, consideration centered on accuracy of operation, limits of

operational effectiveness, typical operating difficulties, etc.

SM-4. Simulation of Controls. Control effects were to be considered from the standpoint of the "feel" of the simulated vehicle and the effects of control manipulations on how the system operated or how various information was developed and displayed.

SM-5. Simulation of Communication Procedures. This was concerned with the various communication links and procedures in the trainer with respect to communications both within and between operational units.

SM-6. Simulation of Communication Problems. Consideration was to be given to such problems as environmental noise that might interfere with communications, faulty equipment and various other sources of interference with the communicated information.

SM-7. Simulation of Information Displays. This was concerned with the fidelity of information as displayed on scopes, plots, dials, and status boards. Both video and audio displays were to be considered.

SM-8. Simulation of Sensor Performance. Consideration was to be given to such factors as the physical representation of objects or conditions in the environment as sensed through the equipment; the number and variety of objects simulated; how detectable the objects were as a function of environmental conditions, etc. If applicable, consideration was to be given to the different classes of targets that were simulated.

SM-9. Target Evasion. For trainers that included target simulation, consideration was given to how realistically the target employed evasive tactics, agressive tactics, and countermeasures.

SM-10. Simulation of Weapon Firing and Control. For trainers that involved the firing or control of weapons, consideration was to be given to the simulation of target tracking, localization, solution to the fire-control problem, choice of weapons, weapon launching procedures, and realism of the results of the attack in terms of typical weapon effectiveness.

TRAINING EFFECTIVENESS AND SITUATIONAL FACTORS

Although the simulated operational environment provided by a training device is undoubtedly a major consideration in

training device acceptance, it is by no means the only characteristic of major importance. In discussing the importance of training requirements information in the design and use of aviation training devices, Prophet (*op. cit.*) contended that the "usual" approach is to provide the engineer with cockpit and performance specifications and let him build the device. Little mention may be made of what is to be learned, the psychological nature of the tasks involved. For Prophet, the most important characteristic of an effective trainer is "task fidelity." The achievement of task fidelity is made more likely by proper simulation but other factors must be taken into account. Further, the fidelity of simulation desired in a trainer is in part a function of situational factors in the operational environment.

A number of situational and training requirements factors were hypothesized to be important to training device acceptance. These were as follows:

TSF-1. Problem Setup. Within the purpose for which the trainer was designed, how readily can a variety of operational problems be set up on the trainer? Consideration was to be given to representativeness and scope of problems in relation to operational requirements, and the relative ease or difficulty of setting up the problem for execution.

TSF-2. Software. Consideration was to be given to the thoroughness, effectiveness, and sophistication of the utilization guides and other training materials associated with the trainer. The question was asked, "How effectively could the trainer be used if *only* the information contained in these guides were used to program and operate it?" (Technical and maintenance manuals were not to be included in this factor.)

TSF-3. Completeness of Performance Evaluation. Consideration was to be given to the trainer's provisions for providing information to individual students concerning all important elements of their performance.

TSF-4. Immediacy of Performance Evaluation. The trainer's provisions for *immediate* feedback were to be considered in contrast to situations where there is feedback only after extensive delay.

TSF-5. Reliability and Maintainability. Consideration was to be given to the amount of down time, and the level of effort required to keep the trainer operational. How readily can it be kept operational by the *average* training device technician?

TSF-6. Level of Training. Consideration was to be given to whether the trainer was suitable mainly for basic training and familiarization or whether it could be used effectively for advanced or refresher training as well.

TSF-7. Training Opportunities. Consideration was given to the skills developed by the trainer in relation to the opportunity for acquiring and maintaining those same skills in the operational environment.

TSF-8. Comprehensiveness of Training. Trainer capabilities were to be considered in relation to *all* of the skills that must be acquired for effective performance in a selected area of Navy operations. Are there any critical skills that receive insufficient emphasis?

TSF-9. Value of Time in the Trainer.. In relation to all the activities that occur in the trainer, what proportion of time is spent in actually acquiring or improving *essential* skills.

TSF-10. Use of the Trainer vs. Operational Equipment. One of the recognized advantages of trainers is that they permit training on activities that are either impractical, too costly, or too dangerous to perform on actual equipment. The disadvantage, however, is that the trainer may differ in some significant way from actual operational gear. The respondent was to consider how much advantage there is to using the trainer as configured vs. using actual operational equipment for training at shore-based schools.

TSF-11. Repeated Use of the Trainer. When a trainer is used on some regular basis, at least some of the skills may already be well trained. Consideration was to be given to how useful the trainer is for repeated use in maintaining or refreshing the essential skills.

TSF-12. Comparison with Similar Trainers. From an overall training viewpoint, the respondent was to compare the trainer in sophistication and effectiveness with other trainers that simulated similar Navy systems.

UNDERSTANDING THE PURPOSES, CAPABILITIES, AND LIMITATIONS OF THE TRAINER

The literature on the acceptance of innovations clearly reflects the dual roles of communications, either formal or informal, and direct personal experience with the innovation, in developing patterns of acceptance or rejection. We were

interested in three basic kinds of communications in relation to training devices and attempted, insofar as possible, to identify their existence and the possible roles played in generating each trainer's reputation.

1. Formal or informal statements of trainer capabilities.

2. Official directives concerning use of the trainer.

3. The actions of individuals who were openly promoting the use of the trainer (trainer advocates).

It was assumed that direct personal use of a trainer would be a major factor governing level of acceptance. It is insufficient, however, simply to determine whether the trainer has been used by a particular individual, or how frequently he has used it, unless there is inquiry also into the manner of use. As suggested earlier, it is quite possible for a trainer to be used in one fashion, for example as a procedures trainer, when the military characteristics call for an operations trainer or a weapons system trainer. Consequently, an effort was made during the study to distinguish between acceptance of a trainer, *as used*, versus acceptance *as designed*. This included an inquiry into the qualifications of instructor personnel who operated the trainer and the level of satisfaction felt by the trainee as a result of his experience in it.

CHARACTERISTICS OF THE USER

The literature on attitude formation suggests that many "psychological" factors are involved in the acceptance of innovations (Mackie and Mecherikoff, *op. cit.*). Examples include such individual characteristics as self-esteem, level of chronic anxiety, cognitive rigidity, need for authority approval, status in group, etc. Some of these factors are extremely subtle and adequate techniques for their measurement probably do not yet exist. However, it was felt that some user characteristics could be measured reasonably objectively and an attempt was made to do so in the following areas:

1. Felt level of personal competence in the technical area represented by the trainer. Except in the case of neophytes, each user of a training device has a different background of experience, compared to other Navy personnel, that possibly affects his attitude toward the trainer.

2. Sufficiency of operational training. It was hypothesized that a major influence determing attitudes toward training devices was the extent to which the user felt that sufficient training was obtainable in the typical operational environment. Some Navy personnel seem to develop biases against trainers because of the assumption that the necessary operational skills can *only* be obtained in the operational environment.

3. Cognitive simplicity-complexity. This refers to the relative rigidity or flexibility with which an individual regards a particular innovation. Cognitive simplicity is exhibited by the tendency to categorize things as either all white or all black, or the inability to consider more than one dimension of an argument at a time. In the context of training device acceptance, cognitive simplicity seemed to be reflected in the viewpoint of some that unless the trainer were perfect in all respects, its use for any reason was a waste of personal time.

4. Experience with other trainers of this type. Experience with other trainers results in a set of personal expectations, often predominantly positive or negative, that was thought to condition acceptance of a new trainer.

5. Personal involvement with the design or original requirement for the trainer. The negative influence of the "not-invented here" phenomenon in developing attitudes toward innovations has been mentioned previously. Personal participation in the development of an innovation and the opportunity to contribute to the solution of a problem in one's own area of expertise plays a highly significant role in acceptance. The great majority of Navy personnel who use training devices have, of course, no opportunity to contribute to the design of that device. Nevertheless, they are continually passing judgment on how well someone else designed the device.

ACCEPTANCE DETERMINED BY CONGRUENCE BETWEEN PERSONAL NEEDS AND TRAINER FEATURES

At the final stage in the dynamic process depicted in Figure 1, it was hypothesized that the level of acceptance for any particular trainer was a complex function of the felt needs of the individual (both technical and psychological), and the *perceived* value and deficiencies of the trainer

resulting from various types of communications and direct personal experience. The word perceived is emphasized because we did not assume that the judged characteristics, value, or deficiencies of the trainer would necessarily be based on objective fact. Further, there was reason to believe that most users lacked detailed knowledge of the design objectives and military characteristics of the trainers.

There was, of course, no direct measure of congruence. However, it was possible to obtain measures that apparently reflected deficiencies in trainer characteristics in relation to the felt importance of those characteristics for effective training. The methodology employed is described in the following section.

SECTION III

STUDY METHODOLOGY

To summarize the considerations set forth in the previous section, this study was particularly concerned with five major sources of influence on the process of trainer acceptance:

1. The training situation, particularly the level and uniformity of skill development in the fleet; the opportunities for training certain functions in the operational environment; various characteristics of the equipment and environment that influence the opportunity to exercise particular skills; and the training time available in contrast to operating and administrative demands.

2. Trainer characteristics. Two broad areas were considered: (a) simulation factors; (b) training effectiveness and situational factors, including convenience, location, availability, and reliability.

3. Understanding of the trainer. The user's comprehension of the trainer's capabilities, limitations, and purpose; knowledge of the trainer through both formal and informal communications and through direct personal use.

4. User characteristics. The user's felt level of confidence in the technical area represented by the trainer; his experience with other similar trainers; his personal involvement with the design or successful use of the trainer; his assessment of the training need.

5. Congruence. The degree of conformity (or disparity) between (a) the physical characteristics of the trainer; (b) the user's understanding of its capabilities and limitations; and (c) how important he judged these various characteristics to be for effective training.

The investigation required the development of a means to obtain scaled judgments of all trainer and user characteristics hypothesized to exert major influences on the acceptance process. It was desired to develop definitive profiles of different trainers that, on the basis of various operational criteria, could be shown to be differentially "accepted" or "rejected," "effective" or "ineffective."

To accomplish these objectives, the following procedures were followed:

1. Specially designed quantitative rating scales were developed that could be used to rate training devices on 10 areas of simulation and 12 training effectiveness and situational factors.

2. A structured questionnaire was developed to provide detailed information that might amplify the ratings.

3. A group of training devices was identified whose members were thought to reflect significant differences in level of acceptance as well as various kinds of operational training.

4. Qualified groups of users were identified, contacted and interviewed using the rating scales and structured questionnaires. To insure that various viewpoints were adequately represented, the user sample was carefully selected from administrative, instructor, student, and maintenance personnel associated with each trainer.

5. An operational definition of acceptance (rejection) had to be developed that reflected, in some logical way, all available objective and subjective data. In addition to opinion data, it was considered desirable to include objective indices such as percent utilization and the percent of requested training accomplished.*

6. A technique had to be developed whereby some of the more subtle factors, such as felt level of competence, and the perceived importance of various characteristics of the trainer could be conveniently identified and quantified.

SELECTION OF TRAINING DEVICES FOR INCLUSION IN THE STUDY

The selection of devices for inclusion in the study was a critical step in the investigation. On the one hand, the sample size had to be large enough that one could feel confident about generalizing the results to the population of trainers. Clearly, this objective could not be reached if only two or three trainers were rather intensively studied.

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*This was defined as the number of hours used divided by the number of hours requested.

The possibility existed that there might be different considerations with respect to comparatively simple part-task trainers from those pertaining to very complex weapons systems trainers. Another issue was whether trainers designed for air operations would involve the same kinds of acceptance criteria as trainers oriented toward surface ship or submarine training.

For the study to be of maximum value, it was decided first that the sample should include trainers that were relatively complex and represented comparatively large investments either in terms of their size or the number of installations throughout the Naval establishment. Second, it was considered necessary to include trainers that represented air, surface, and subsurface operations. Third, a decision was made to include trainers which were known, or suspected, on the basis of *a priori* information, to represent cases of both high and questionable acceptance. (In one case there was evidence of outright rejection.) Finally, it was decided that a few trainers should be included where the installations at two different locations represented certain known design differences. This would make it possible to determine whether the measurement techniques were sensitive to these differences.

It was not possible, however, to establish level of acceptance on any thorough basis prior to the investigation. For the most part, the only *a priori* information available to the investigators were the general impressions of educational specialists and engineers at NTDC together with some available data on the extent of utilization. The latter criterion was recognized as an imperfect index of acceptance because of the many practical considerations that influence trainer utilization that have little to do with acceptance. It was decided, therefore, that *a posteriori* criteria would have to be developed from the study data to help identify "effective" and "ineffective" trainers. In addition to the criteria already mentioned, these would include the method in which the trainer was actually being used (i.e., in relation to its design objectives) and the various expressions of user attitudes toward the value of time spent in the trainer.

The sample of 16 training devices selected for the study is listed in Table 1. It will be evident that the trainers were very heterogeneous in nature, involving surface, subsurface, and airborne operations, and including devices intended for part-task training of individual operators up through some of the most complex coordinated tactics trainers ever developed.

TABLE 1. SAMPLE OF TRAINING DEVICES

Designator		Type	Location (of Unit Studied)
Weapons Systems Trainers	2F66A	S-2E aircrew	North Island
	2F66A	S-2E aircrew	Quonset Point
	2F55B	F-4B aircrew	Miramar
	2F65	E-2B aircrew	North Island
	2F69A	P-3 aircrew	Barber's Point
	2F69B	P-3 aircrew	Moffett Field
	21A38	SS(N) S/M crew	Pearl Harbor
Flight Trainers	2F64B	SH-3D helicopter	Quonset Point
	2B21	T-28 instrument trainer	Pensacola
	2H87	Carrier approach landing	Pensacola
Tactical Team Trainers	14A2	ASW team trainer	San Diego
	14A6A	Coordinated ASW tactics	San Diego
Sensor Operator Trainers	14B35	JULIE/JEZ operations	Moffett Field
	14B40	Radar/Mad operations	Pax River
	15E16	Electronic countermeasures	Moffett Field
Emergency Procedures Trainer	21C5	Submarine casualty control	Pearl Harbor

PROCEDURE

The basic procedure followed during the study was for one or more members of the HFR staff to visit a trainer installation, usually for a period of several days. During this time, project personnel became acquainted with the trainer, how it was being used, and the instructor and maintenance personnel assigned to it. Arrangements were made to administer the rating scales and questionnaires to key administrative, instructor, and maintenance personnel and to a representative group of students.

The rating scale and questionnaire were designed so that they could be self-administered. However, it was felt that the resulting data would be much more reliable if each individual participant was personally instructed by a project member in the objectives of the study, and the mechanics of completing the rating scale and questionnaire.* Wherever possible this was done with groups of individuals and the participants were encouraged to complete the data forms, independently, asking questions of the project representatives as they arose. In some cases it was necessary to permit the respondent to complete the data forms at their convenience and later return them to the project representative at the trainer site. On the average, about twenty-five minutes was required to complete the rating scale and thirty-five or forty minutes for the questionnaire.

Upon receiving the completed materials, the project representative immediately reviewed all ratings and responses to various key questions (such as statements about deficiencies in the trainer, recommendations for changes or improvements, etc.) for the purpose of eliciting additional detailed information about attitudes, both positive and negative, toward the trainer. In a few cases, these interviews were short and perfunctory; in many cases, however, they generated extended commentary by the participants in discussions that sometimes lasted an hour or more in length. The time required for complete data collection at a trainer site, involving on the average about twenty participants, varied from as little as two or three days to as long as a week depending on the availability of personnel. For example, in some of the complex team trainers, the trainees could not be interviewed at the trainer site but rather had to be located on individual ships at a time when their usually busy work schedules permitted an opportunity for discussion.

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*Examples of the Rating Scale and Questionnaires are given in Appendix A.

A description of the 326 participants in the study is contained in Table 2. They varied greatly in rank and in personal experience in the area of operations represented by the trainer. They were classified as having low, medium, or high experience in accordance with the distribution of self-ratings of experience shown in Table 2.

Most had had considerable experience with the trainer they were called upon to rate. Fifty-five percent of the respondents knew the trainer in the role of student; the remaining 45% was comprised of instructors, maintenance personnel, and administrators. The number of people shown in Part C of Table 2 exceeds the number of trainees shown in Part A because some administrative and instructor personnel had also used the trainer in the role of student.

For each trainer that was designed for team training an attempt was made to obtain opinions from four levels of personnel:

1. Officers with command responsibility.

2. Officers having responsibility for technical specialties (for example, CIC officers, ASW officers, TACCO'S, engineering officers, etc.).

3. Senior or supervising petty officers.

4. Basic operators of major units of equipment.

With respect to non-students, an attempt was made to obtain the opinions of the following types:

1. Administrative personnel (the officer in charge of the training facility, the operational staff training officer, the school training officer, etc.).

2. Instructor personnel. The principal instructors for all stations, both officer and enlisted.

3. Maintenance personnel (the electronics material officer having responsibility for the device, as well as the leading enlisted maintenance personnel). In some cases these were Training Devicemen; in others, they were ET's, SO's, DS's, etc.

TABLE 2. DESCRIPTION OF STUDY PARTICIPANTS

N = 326

A. Relationship to Trainer

	N	%
Trainee	181	55.5
Instructor	57	17.5
Maintenance	58	17.8
Administrative	30	9.2
	326	100.0

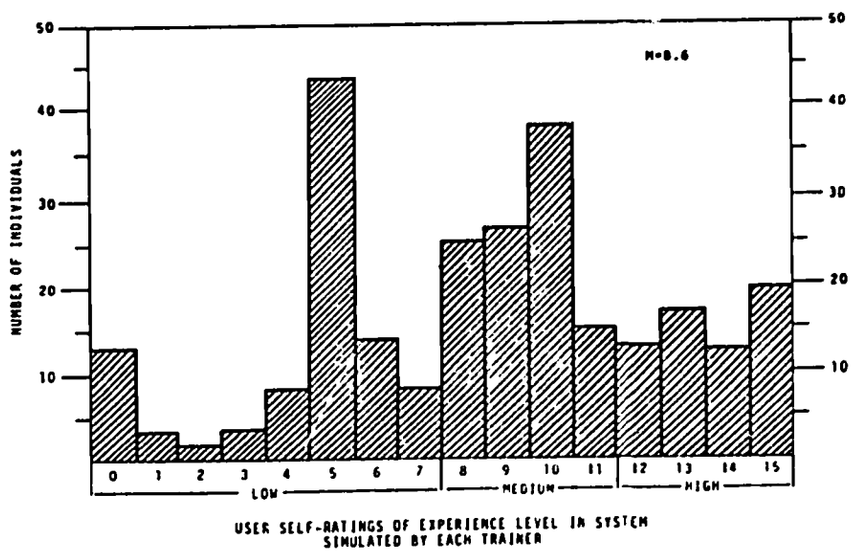
B. Rank or Rate

	N	%
LCDR or above	44	13.5
LT	38	11.7
LT (j.g.) or ENS	51	15.6
CPO or PO1	89	27.3
PO2	26	8.0
PO3 or below	59	18.1
Civilian	15	4.6
Not determined		1.2
	326	100.0

C. Times Used Trainer (As Trainee)

	N	%
1 or 2	16	8
3 - 6	54	26
More than 6	138	66
	208	100

D. Personal Experience in this Area of Operations



Since it was hypothesized that acceptance of a training device might be a function of how expert the participants considered themselves to be in the technical area represented by the trainer, all participants in the study were asked to rate themselves on a 0-to-15 point scale with respect to the following statement:

> "Compared with other Navy personnel who work in the area of operations or type of equipment represented by this trainer, how extensive is your experience? Consider the number of closely related billets you have had and recency of experience."

The distribution of ratings on this variable are shown in Part D of Table 2. It seems evident from the wide distribution of scores that the participants were quite candid in reporting their experience. To interpret this result, the following definitions of anchor points which appeared on the scale will be helpful.

0 - My experience in this area of operations or with this equipment is nil.

5 - My experience is somewhat limited; the majority of my assignments have been in other areas or with other equipments.

10 - My experience is substantial; although I have had other types of assignments, I have had more in this area of operations, or with this type of equipment than any other.

15 - My experience is extensive; I consider this operational area, or particular type of equipment, my special field.

For the purpose of some data analyses, the participants were divided into three experience groups at the points shown in the Table. Those classified as "low" all rated themselves below the midpoint of the scale, the majority describing themselves as being somewhat limited in experience with this type of equipment. A large middle group, who rated themselves from just above the midpoint of the scale to about the three-quarter point, were classified as being of "medium" experience. Finally, a third group that rated themselves in the upper one-fourth of the scale were classified as "high" in experience. While this method of classification was somewhat arbitrary, it was felt to be adequate for testing the general hypothesis that level of experience is an influencing variable insofar as trainer acceptance is concerned.

SECTION IV

DEVELOPMENT OF AN OPERATIONAL DEFINITION OF TRAINER ACCEPTANCE

NATURE OF THE STUDY DATA

The basic data deriving from the study were in the following forms:

1. Numerical ratings of the judged adequacy of each trainer on each of 10 simulation factors.

2. Numerical ratings of the judged *importance* of each simulation factor.

3. Numerical ratings of 12 characteristics relating to training effectiveness and situational factors.

4. Responses to the questionnaires designed to amplify the information obtained from the rating scales.

5. Data on trainer utilization from the NTDC trainer utilization reports.

With respect to the rating scale data, a numerical score was assigned (from 0-15) representing the judgment of each participant on each characteristic of each trainer. This was a simple one-to-one linear translation of the location of the check mark in relation to the numerical indices on the scale (see Appendix A). These values were averaged across all respondents.

With respect to questionnaire data, frequency counts were made of the various categories of response provided. In the case of open-end questions, the nature of the response was coded in terms of its substantive content, and whether it was a generally positive endorsement of the trainer or reflected a negative viewpoint toward it. It was determined for various characteristics of each trainer whether the preponderance of comments made was positive or negative and, further, whether the distribution of positive or negative reactions was *disproportionate* in relation to the comments offered on all trainers as a group.

Both the rating scale and questionnaire data represented the subjective opinions of the users, although every effort had been made through the design of the data collection instruments to structure the judgmental task as carefully as

possible. It was considered desirable, however, to include at least one source of external data, preferably totally objective in form, to complement the opinion data in forming a definition of acceptance. This requirement was met by the inclusion of utilization data from the Training Device Utilization and Application Report (NAVTRADEVCEN Report 10171-4), which provided monthly data on utilization of all training devices. Utilization data do not, in themselves, constitute an adequate criterion of trainer acceptance. Nevertheless, they have the merit of a high degree of objectivity and logically cannot be excluded from a comprehensive definition of acceptance. Some of their deficiencies are described later.

A COMPOSITE INDEX OF ACCEPTANCE

In the interest of convenience and to facilitate communication, it was desirable to develop a single composite index that reflected, as comprehensively as possible, the obtained data about each trainer that apparently reflected its acceptance by the users. Although many approaches to such an index were possible, it was felt that the index should reflect the user's ratings concerning the value and comprehensiveness of training; their judgments concerning the adequacy of simulation; their voluntary comments about the trainer's particular capabilities and limitations as reflected in the questionnaire; and the objective data concerning actual utilization.

A composite "acceptance" score was developed from six subscores that in turn were defined as follows:

1. Felt value of training. This score was a simple summation of the rating scale values assigned to the trainer by all respondents on the following five scales from the training effectiveness section.

   a. Comprehensiveness of training.

   b. Value of time in the trainer.

   c. Use of the trainer vs. operational equipment.

   d. Value of repeated use of the trainer.

   e. Comparison with similar trainers.

The resulting scores for all trainers are shown in Column 1 of Table 3.

2. Simulation deficiencies. Since each training device was rated not only on the simulation factors *per se* but also on the felt importance of each simulation factor, it was possible to compare each rater's judgment of the importance of each factor to the score he assigned his particular trainer on that factor. If the judgment of importance were higher than the score assigned to the trainer, this resulted in a "negative differential" score for that trainer on that factor. Negative scores were interpreted to mean that in the view of the user, the trainer had a deficiency in that area of simulation. Two kinds of deficiency indices were calculated for each trainer:

   a. The algebraic sum of differential scores on all 10 simulation factors;

   b. The number of simulation factors on which each trainer received a deficiency score of 1 rating scale unit or more.

   It was hoped that both the severity of the felt deficiencies and the generality of the deficiencies would be reflected in the two scores. The resulting scores are shown in Columns 2 and 3 of Table 3.

3. Voluntary positive and negative statements about each trainer. There were seven open-end questions in the questionnaire which provided the respondents with an opportunity to reflect favorable or unfavorable judgments about the trainer.

   Attention was focused on these particular questions, not only because of their content, but because some effort on the respondent's part was required to formulate his answer. For this reason it was felt that these responses might be particularly relevant to underlying user attitudes.

   Responses to the following questions were classified as essentially positive or negative and then tallied for each trainer:

   a. Based on your experience with the trainer, what would you be likely to say to someone else about it, both pro and con?

b. As far as you know, does this trainer have any kind of a reputation with regard to maintenance or reliability? For instance, is it regarded as a generally reliable or generally unreliable machine? I would like to know if the trainer has a reputation in this respect, even if it might be different from your own opinion.

c. To your knowledge, are there any people now, or have there been any in the past, with an *unfavorable* opinion of the trainer?

d. Considering your training needs and the needs of other trainees, what limitations are there in what this device was designed to do?

e. Overall, in terms of actually accomplishing effective training, what would you say are the most *serious* deficiencies of trainers of this type?

f. What changes would you suggest in order to make it *easier* or *more pleasant* to use the trainer without sacrificing necessary realism?

g. What design changes would you suggest to make the trainer more cost-effective?

For each trainer the relative frequencies of positive and negative statements to each question were tabulated. Then, it was determined whether the distribution of positive and negative statements about that trainer differed substantially from the distribution for all trainers as a group. In cases where the trainer received a disproportionate number of positive or favorable comments, the trainer was given a score of 2 for that question. In cases where a disproportionate number of unfavorable responses was recorded for a particular trainer, that trainer received a 0 for that particular question. In the event that the responses were generally positive but not disproportionate to those for the total population of trainers, a score of 1 was awarded.

A total score reflecting the reactions of all respondents to all seven questions was then developed for each trainer. The results are shown in Column 4 of Table 3.

4. Trainer utilization data. As was suggested earlier, the amount of utilization of a trainer may or may not be an indication of its acceptance by the users. Many administrative and practical constraints affect the extent to which a trainer is utilized. A trainer that is held in high regard by operational personnel may simply not be scheduled because of the urgency of upkeep responsibilities. Conversely, a trainer can be heavily utilized without necessarily being highly accepted by its users because it is the only thing available. For the most part, however, high utilization probably signifies substantial acceptance. For this reason it was felt that utilization data should comprise a part of the composite index of acceptance.

Data on utilization were taken from a four-month sample of NTDC's records. The data were selected from the four-month reporting period immediately prior to the time that this study went into the field. In most cases, only dat. covering the particular trainer installation that the project team visited were utilized. In one or two cases, data on the same trainer at several different locations had to be substituted because there was no report from the location studied. In one case, the trainer installation was too recent for a data base to have been built up. Two measures of utilization were used:

a. Percent utilization. This was defined as the total number of hours per month the device was used for student training, regardless of type, divided by 160 hours (the number of hours presumed to represent full availability over a working month). These scores could exceed 100% if the device was typically used on more than one shift. (See Column 5, Table 3.)

b. Percent of requested training accomplished. Because of the shortcomings associated with a straight percent utilization factor, it was decided to include a second index from the training device utilization report. This was based on the ratio of the total hours the device was used for training to the total number of training hours requested. It was felt that this index might provide an additional indication of the user's regard for the trainer since a trainer with a comparatively low percentage utilization might nevertheless be utilized a high percentage of the time the users had *available* for training. Scores on this variable are shown in Column 6 of Table 3.

TABLE 3. RAW SCORES FOR SIX ELEMENTS OF THE COMPOSITE CRITERION OF ACCEPTANCE

Trainer	1 Σ of 5 Ratings of Trainer Effectiveness	2 Simulation Deficiencies (Algebraic Total)	3 Simulation Deficiencies (Number of Areas)	4 Σ Disproportionately Positive Recommendations	5 Percent Utilization	6 Ratio of Hours Used to Hours Requested
1. 21C5 Emerg. Diving	64.0	9	6	13	42.5	59.3
2. 15E16 ECM Operators	57.0	7	4	12	16.1	76.7
3. 14B40 Radar/Mad	55.4	9	4	10	No Data	No Data
4. 21A38 SS(N) Attack	54.6	7	4	12	69.2	78.1
5. 14A2 ASW Team	53.9	5	3	11	87.3	87.3
6. 2F64A SH-3D Helo	53.1	14	7	11	29.3	73.0
7. 2F65 E-2B Crew	53.0	25	8	2	56.0	70.2
8. 2F66A (Quonset) S-2E Crew	51.0	23	8	1	34.3	96.3
9. 2F66A (San Diego) S-2E Crew	47.8	10	5	2	76.8	76.3
10. 14A6 ASW Tactics	47.5	14	6	8	58.3	69.0
11. 2F55B F-4B Crew	46.4	22	8	4	30.5	80.8
12. 2B21 T-28 Instrument	46.4	12	3	4	45.3	78.8
13. 2F69A P-3 Crew	45.2	19	7	5	24.8	42.3
14. 2F69B P-3 Crew	41.3	12	6	4	122.9	93.9
15. 14B35 JULIE/JEZ	38.4	28	8	0	26.8	23.4
16. 2H87 Carrier Landing	32.4	46	6	3	0	0

The next step in developing the composite index of acceptance was to combine the scores for the six separate elements described above. In the absence of any obvious rationale for doing otherwise, it was decided that a simple unweighted composite of the six scores would serve as the desired criterion. However, since the raw scores had greatly different means and variances, it was necessary first to convert these to standard scores as shown in Table 4. The algebraic sum of the standard scores was then taken as the composite index.

One other procedure needs to be noted. The size of the scores on Elements 2 and 3, in their raw form, reflected negative viewpoints toward the trainer's simulation characteristics whereas in all other cases, the higher the score the more positive the attitudes presumably were. Consequently, in computing the sum of standard scores, the signs for these two variables were reversed.

Table 4 shows that the composite criterion scores ranged from +6.36 to -10.11. The mean was 0.7. For the purpose of definition, trainers with standard scores of +3.0 or better were classified as generally highly accepted; those with -3.0 or less were regarded as having serious acceptance problems. Table 4 is useful for identifying the reasons for the magnitude of the composite scores. The trainers are ordered in accordance with their score on the first element of the composite criterion, i.e., the summation of the five training value ratings assigned by the users.

In cases where similar trainers are involved, the source of any difference in their composite scores can be determined by inspection. In comparing the 2F66A's at San Diego and Quonset Point, for example, it is evident that the former trainer received a somewhat higher overall criterion score than the latter. Inspection of the various elements of the criterion reveals notable differences between the trainers in judged adequacy of simulation and quite different patterns of utilization. However, they received very similar scores with respect to positive recommendations (Element 4).

The 2F69A and 2F69B offer another such comparison. In this case, the 2F69B received a considerably higher composite score than the 2F69A. However, it is evident that most of this difference stems from differences in utilization. The 2F69B, in fact, received a lower overall rating on effectiveness factors, although it did receive a somewhat higher rating on adequacy of simulation than did the 2F69A.

The significance of these scores in relation to the overall acceptance profile for each trainer is discussed in greater detail in Section V.

TABLE 4. STANDARD SCORES FOR SIX ELEMENTS OF THE COMPOSITE CRITERION OF ACCEPTANCE

Trainer	1 Σ of 5 Ratings of Trainer Effectiveness	2 Simulation Deficiencies (Algebraic Total)	3 Simulation Deficiencies (Number of Areas)	4 Σ Disproportionately Positive Recommendations	5 Percent Utilization	6 Ratio of Hours Used to Hours Requested	7 COMPOSITE (Σ of Standard Scores)
1. 21C5 Emerg. Diving	1.909	0.706	-0.104	1.474	-0.181	-0.303	3.501
2. 15E16 ECM Operators	1.006	0.896	1.008	1.245	-1.052	0.379	3.482
3. 14B40 Radar/Mad	0.800	0.706	1.008	0.787	0.000	0.000	3.301
4. 21A38 SS(N) Attack	0.696	0.896	1.008	1.245	0.698	0.434	4.977
5. 14A2 ASW Team	0.606	1.086	1.565	1.016	1.295	0.795	6.363
6. 2F64A SH-3D Helo	0.503	0.231	-0.660	1.016	-0.616	0.234	2.028
7. 2F65 E-2B Crew	0.490	-0.813	-1.217	-1.045	0.263	0.124	-2.198
8. 2F66A (Quonset) S-2E Crew	0.232	-0.623	-1.217	-1.274	-0.451	1.149	-2.184
9. 2F66A (San Diego) S-2E Crew	-0.206	0.611	0.452	-1.045	0.949	0.364	1.125
10. 14A6 ASW Tactics	-0.219	0.231	-0.104	0.329	0.339	0.077	0.653
11. 2F55B F-4B Crew	-0.361	-0.528	-1.217	-0.586	-0.577	0.540	-2.729
12. 2B21 T-28 Instrument	-0.361	0.421	1.565	-0.586	-0.089	0.462	1.412
13. 2F69A P-3 Crew	-0.516	-0.243	-0.660	-0.357	-0.765	-0.970	-3.511
14. 2F69B P-3 Crew	-1.019	0.421	-0.104	-0.586	2.469	1.054	2.235
15. 14B35 JULIE/JEZ	-1.393	-1.098	-1.217	-1.503	-0.699	-1.712	-7.622
16. 2H87 Carrier Landing	-2.167	-2.808	-0.104	-0.815	-1.583	-2.630	-10.107

INTERCORRELATIONS OF THE ELEMENTS IN THE COMPOSITE CRITERION OF ACCEPTANCE

Since the various elements making up the composite criterion reflected a mixture of relatively subjective and objective measures, it was of interest to determine the extent to which they correlated with one another. In fact, the utilization data could be considered as external criteria against which the rating and questionnaire data might be validated. Large correlations probably would not be expected, however, because of the previously mentioned fallible nature of the utilization data. The intercorrelations of the 6 elements are shown in Table 5.

TABLE 5. INTERCORRELATIONS OF SIX ELEMENTS OF THE COMPOSITE CRITERION OF ACCEPTANCE

	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6
Element 1 Training Value	1.00	-.72	-.28	.73	.12	.54
Element 2 Simulation Deficiencies (Algebraic)	-.72	1.00	.60	-.70	-.54	-.71
Element 3 Simulation Deficiencies (Number)	-.28	.60	1.00	-.58	-.30	-.23
Element 4 Positive Recommendations	.73	-.70	-.58	1.00	.10	.25
Element 5 Percent Utilization	.12	-.54	-.30	.10	1.00	.61
Element 6 Hours Used/ Hours Requested	.54	-.71	-.23	.25	.61	1.00

It is evident that the various elements derived from the rating scale and questionnaire data correlated substantially. This was to be expected because they reflected a common source of opinion--namely that of the users. It is notable, however, that Element 1 (Training Value) correlated .54 with Element 6 (Hours Used/Hours Requested) and that Element 2 (Simulation Deficiencies) correlated -.54 with Element 5 (Percent Utilization). These are substantial relationships between very independently derived measures and strengthen the conviction that the various indices do reflect underlying attitudes of acceptance.

On the other hand, none of the correlations was so high to suggest that any of the elements was simply duplicating the contribution of another in making up the composite criterion. The highest correlation (.73) was between the judgment of Training Value, Element 1, and the number of disproportionately positive statements volunteered about a trainer (Element 4). The two scores reflecting utilization (Elements 5 and 6) correlated only .61, indicating that they do, to some extent, mean different things with respect to the pattern of use.

The composite criterion score was used to classify the trainers in the study into three broad categories:

1. High acceptance.

2. Moderate acceptance.

3. Low acceptance.

In the section that follows, the individual trainers comprising these groups are examined in detail and further interpretation is made of the probable significance of the composite criterion score, and its elements, for each trainer individually.

SECTION V

ACCEPTANCE PROFILES OF INDIVIDUAL TRAINERS

The main results of the study have been summarized in descriptive profiles for each trainer. Two types of profiles were prepared, one reflecting the 10 simulation factors and the other the 12 situational and training effectiveness factors.

The profiles permit easy analysis of the judged capabilities and limitations of each trainer and how each trainer compared with all others in the study. In addition, they reflect how *important* the participants considered a particular feature to be and whether the trainer measured up to their expectations on each factor.

INTERPRETATION OF THE PROFILE

The profile on simulation factors is shown in two dimensions, one boundary reflecting the average ratings given to the trainer on each factor and the other reflecting the judged importance of that factor for effective training. In Figure 2, a composite simulation profile for all trainers is shown. The heavy dark line shows the average values assigned to the trainers; the shaded area represents the amount of difference between those values and the judged importance of each factor (importance differentials). Thus the amount of shaded area can be interpreted rather directly as an indication of the amount of felt deficiencies. It is clear, from Figure 2, that the trainers as a group were felt to be most deficient in simulation of vehicle performance, effects of controls, displayed information, sensor performance, and target reactions. They were generally in accord with expectations in simulation of internal and external operating environments, communication procedures, and communication problems.

It will be noted that, in general, the profile for the group of trainers varies about a scale value of approximately 10. In designing the rating scales (Appendix A) a scale value of 10 was defined as generally adequate or acceptable. Deficiencies might be recognized but they were not considered so serious as to detract significantly from the value of trainer experience. Scale values of 5 or lower were defined as an indication of an unacceptable feature or condition. Finally, scale values of 15 were defined as reflecting clearly superior characteristics, perhaps (in the case of simulation factors) being virtually non-discriminable from operating equipment or conditions.

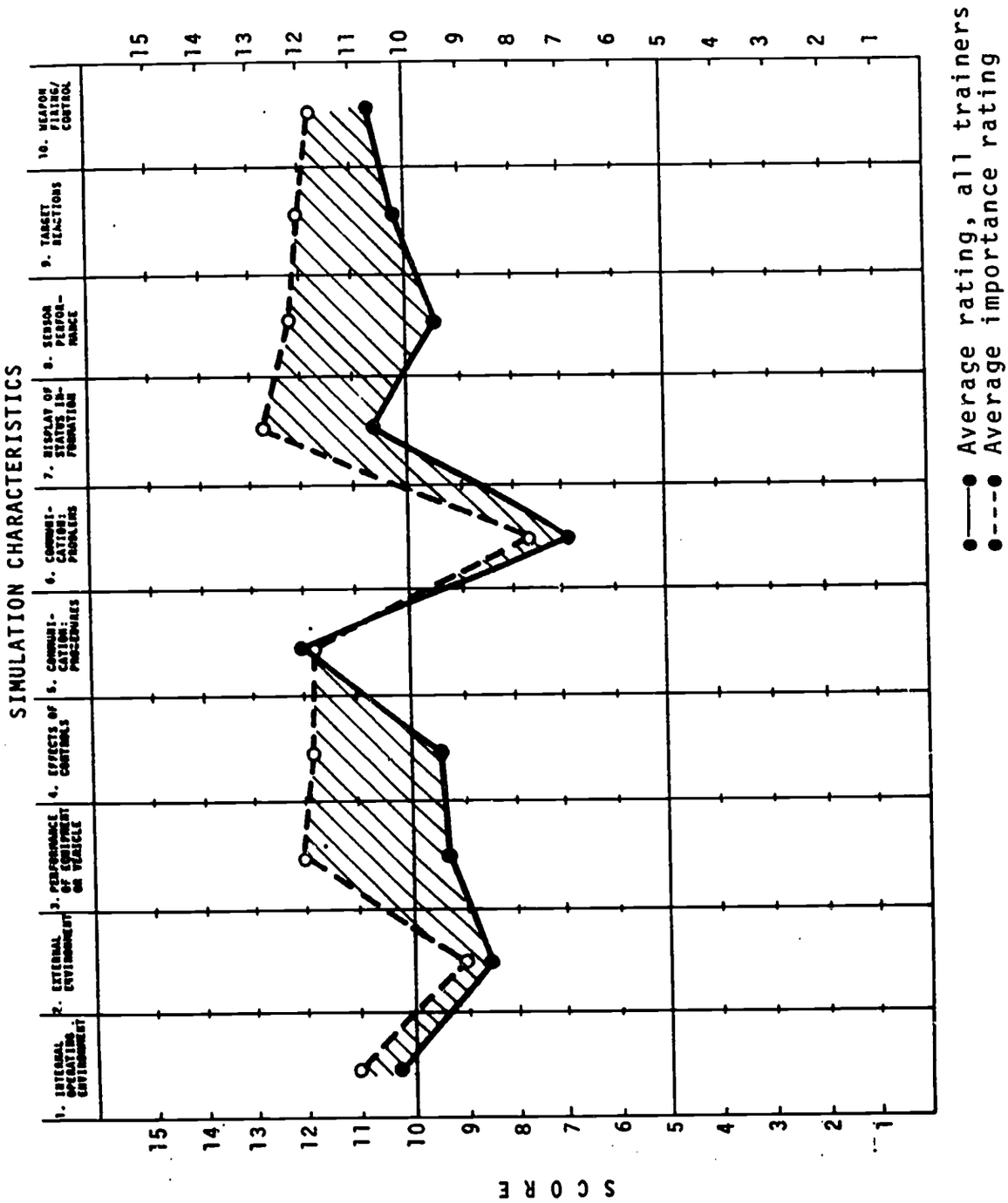


Figure 2. Average Profile of All Trainers on Simulation Factors Compared with Average "Importance" Ratings.

Both the scale values assigned and the importance differentials should be taken into account in interpreting the profiles. For example, it is clear from Figure 2 that most trainers were rated low in simulation of communication problems; however, the importance differential for this factor was quite small. Most users did not consider this to be a serious deficiency.

The composite profile for all trainers on training effectiveness and situational factors is shown in Figure 3. It is evident that, as a group, the trainers were considered most deficient in the areas of software and completeness of performance evaluation. They received their highest assessments in the opportunity they provided for supplementing operational experience and value of repeated use (refresher training).

The profiles of individual trainers show much greater variations than the two "average" profiles presented in Figures 2 and 3. On the following pages, profiles are shown first for a group of highly "accepted" trainers, then for a group that clearly have acceptance problems. Finally, trainers that are more or less average in acceptance are described. The criterion of acceptance was, of course, the composite standard score developed for each trainer and shown in Table 4.

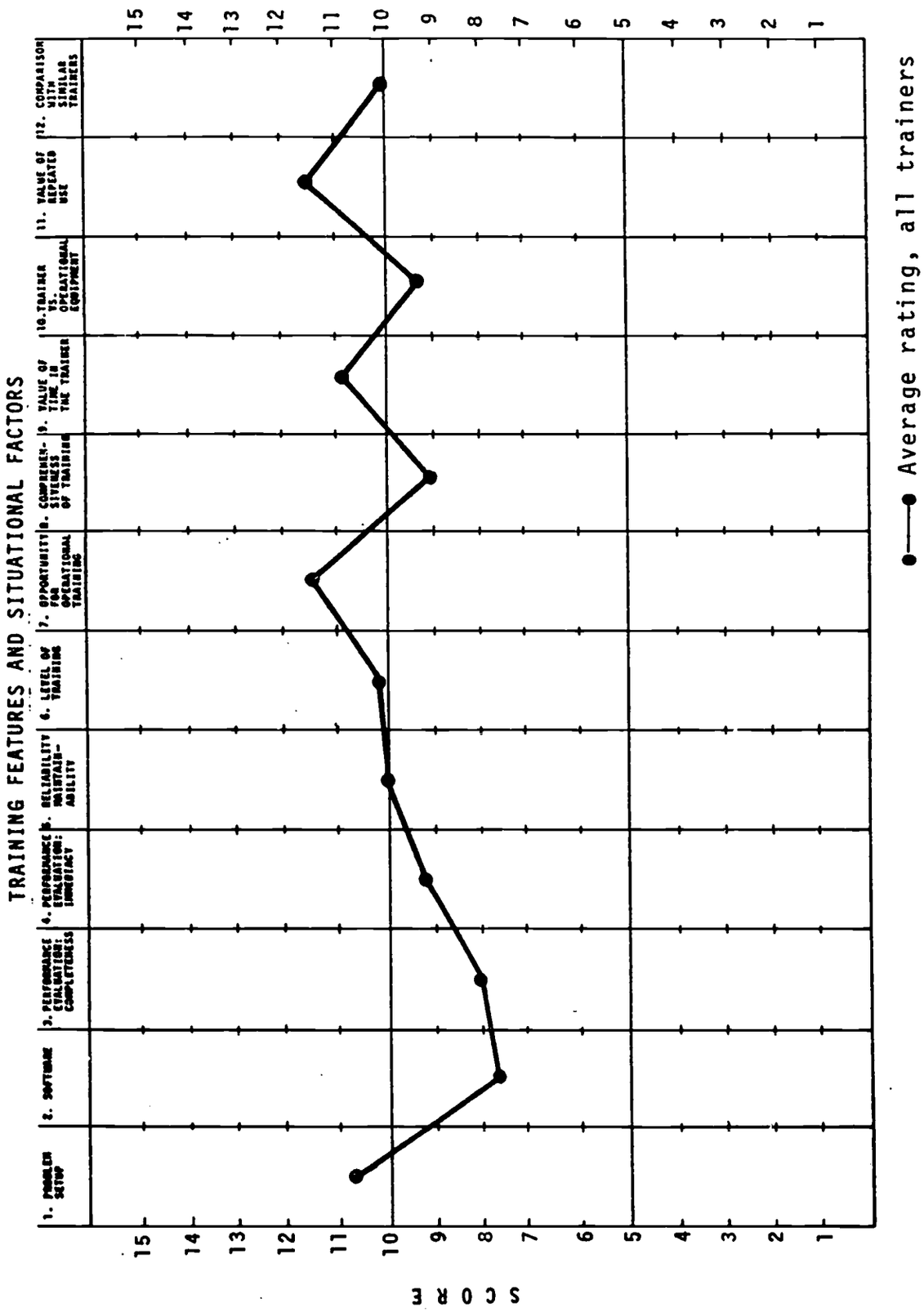


Figure 3. Average Profile of All Trainers on Training Effectiveness and Situational Factors.

PROFILES OF SOME HIGHLY ACCEPTED TRAINERS

DEVICE 21C5: ADVANCE SUBMERGED CONTROL TRAINER. The 21C5 was designed to be a "shore-based, realistic, high fidelity, dynamic training device capable of providing training for problems peculiar to steering, diving, and casualty control operations in STURGEON class submarines." It was intended to provide training in the principles of diving, surfacing and submerged control; casualty and emergency operations that might occur singly or in combinations; to demonstrate the effects on ships' performance of various casualties; and to accurately simulate critical recovery factors and effects such as time required to stop flooding, the action of planes and rudders, speed, main ballast tank blow and vent, negative tank blow and vent, and low pressure blow system. The device is mounted on a platform which is free to move in pitch and roll. Movement in depth is simulated through sensor displays.

The device is computer controlled in accordance with the latest available equations of motion for the STURGEON class submarine (SSN637). The simulated effects of environment include surface effects, wave motion (various sea states), and bathythermal effects. The steering and diving stations are faithful reproductions of the submarine's interior. The platform accommodates three planesmen, one ballast control panel operator, and one diving officer. Simulated malfunctions and flooding are controlled by the instructor by means of a keyboard control.

The 21C5 is a highly accepted trainer with a composite criterion score of +3.5 (see Table 4). The acceptance profiles for the 21C5 are shown in Figures 4 and 5. With respect to simulation, it is clear that the design objective of high fidelity simulation was clearly met in the eyes of the fleet. The device was rated uniformly higher than average in virtually every respect; further, the discrepanancies between felt importance of various simulation factors and their actual implementation in the trainer were, in almost every case, very small. Particularly high ratings were obtained with respect to simulation of the internal operating environment, vehicle performance, effects of controls, information displays, and sensor performance.

With respect to training effectiveness factors, the 21C5 also shows a highly superior profile. It was rated particularly high in problem setup, software, reliability, level of training, the training opportunities it provides, value of repeated use, and in overall comparison with similar trainers. Only in completeness of performance evaluation did

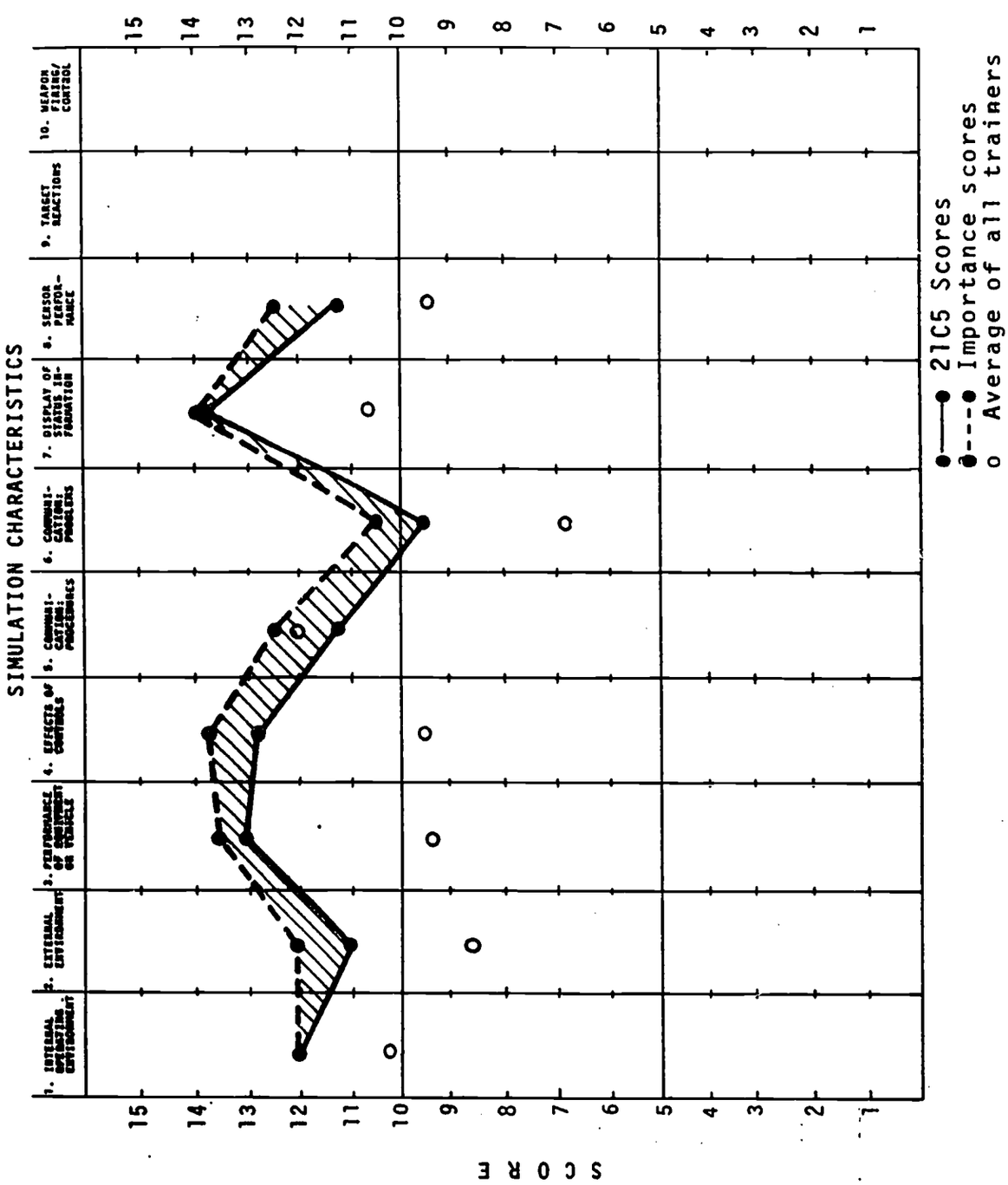


Figure 4. Profile of Simulation Scores for Device 21C5, Emergency Diving Trainer (Pearl Harbor).

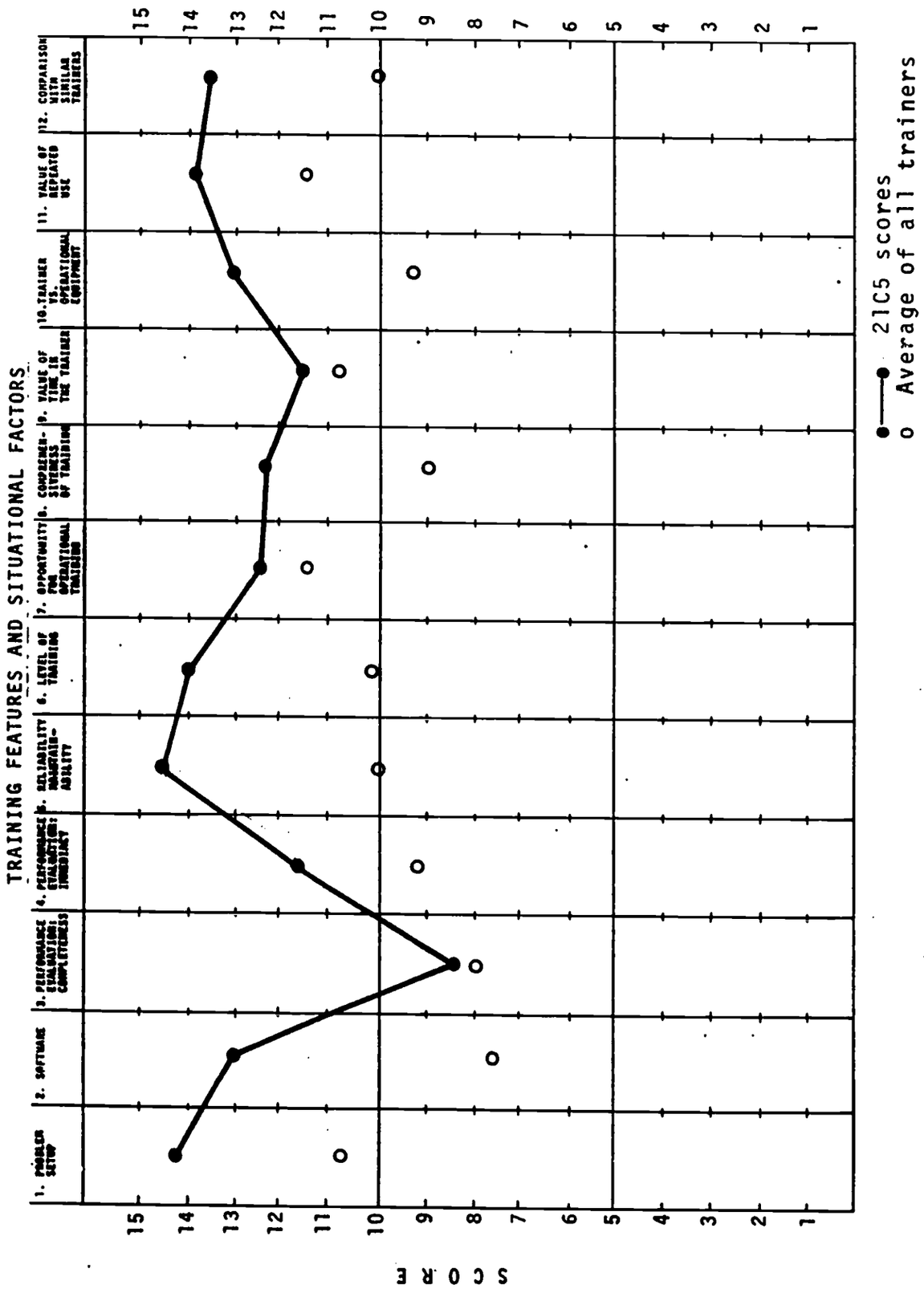


Figure 5. Profile of Training Effectiveness Scores for Device 21C5, Emergency Diving Trainer (Pearl Harbor).

it fall to approximately the average level assigned to all trainers. This is an interesting exception to the generally very high rating of this trainer. It may reflect a concern expressed at the training facility over the lack of permanently assigned instructor personnel who are qualified in submarine operations. The officer-in-charge indicated that the availability of a qualified officer for this billet would greatly enhance the trainer's value. The instructor operating the trainer at the time of our visit was a highly motivated training deviceman who had "never seen a submarine." He had essentially taught himself how to instruct others in the use of the trainer through a period of on-the-job training. Undoubtedly he was greatly aided in this process by the *Instructors Handbook for Advanced Submerged Control Training--Device 21C5* prepared by the Electric Boat Division of General Dynamics. This publication provides 25 diagnostic exercises with detailed descriptions of the training objectives, the responsibilities of the instructor, and the means of problem setup. It is interesting to note that this publication strongly recommends that the instructor be a qualified OOD on a nuclear powered submarine or a qualified engineering watch officer.

The point was emphasized by some submariners that it is desirable to use their own personnel as instructors because of the need to follow their own particular standing orders. They felt the instructors at the device knew the basic operation of the trainer well enough, but not their own particular operating procedures.

> "The instructor should be a qualified submariner so that the proper information is given to the crews at the proper time and in proper sequence. As far as operation of the trainer, the instructors are more than qualified. As far as instructing the correct procedures, there are times when it takes a qualified submariner to know what the causes and effects are."

Th. instructors themselves strongly felt their own inadequacies:

> "The operators are well-qualified to operate the trainer, but have never been trained in operating actual equipment. I don't see how an inexperienced person can instruct to the full capabilities of the trainer. I have seen a fully qualified man instruct and he can cover so much more it's ridiculous."

It was felt by training personnel that acceptance of the trainer would vary among individual submarine crews.

Utilization had increased since notices were sent out from the training center describing the trainer's capabilities. However, it was felt that some submarine crews would not use the trainer because it did not represent their esact configuration.

It was evident that most users accepted the trainer highly, even though they detected certain ways in which it was different from actual equipment. One planesman commented:

> "It reacts a little faster than our boat--but every plane feels different. It's just a matter of getting used to the feel."

> "The trainer is dry. The boat is not. You don't get some of the environmental effects (consequences)--you're not under the same pressure."

> "The trainer acts a little different from the boat. Also, the gauges are set up somewhat differently. Some of the indications are *instantaneous*, whereas in the boat the changes are gradual."

> "Background sounds are not as high as they are on the boat--it lacks realism in this respect. You notice every sound when you have a casualty. For example, the blow valve is extremely loud. We're training mostly new people--it's OK for them. If it were used for refresher training, some of the noises would be desirable. I couldn't talk to you if we had an actual casualty because of the background noise."

It was stated that the trainer originally had been programmed differently than it is now and was not acceptable until it was programmed to more closely reflect the performance of the 637 class submarine.

> "Originally the program was designed toward what they 'thought' the 637 would do on the basis of theory. It was necessary to change the program to reflect the operating characteristics that the submarine proved to have with experience. There were many initial complaints when the trainer was first installed for this reason. Operational feel and handling are very specific to a submarine class and may prove to be different from design expectations."

In contrast to this view was the following comment:

"The trainer is very good, even for SSN594 class submarines. The control room arrangement is different but the response characteristics, which is the important thing when training on ship's control, is very similar and should prove to be very useful for training."

However, the same individual, when asked how he would possibly like to see the trainer improved, could suggest only that the trainer be made specifically for the SSN595 class.

It will be recalled that the participants in the study were divided into three groups based on their level of experience in the area of operations represented by the trainer. The ratings of each trainer were analyzed separately for each experience group to determine whether there was differential acceptance as a function of felt "expertise." The results for the 21C5 are shown in Table 6. It is evident that there is no clear relationship and that acceptance was high for all groups. For reasons that are not clear, the "medium" experience group rated the trainer lower than the other groups on simulation of communications, communication problems, sensor performance and external operating environment. Perhaps this group is at a level of training that makes one particularly sensitive to any detected deficiency.

TABLE 6. AVERAGE RATINGS OF THE 21C5 BY LEVEL OF OPERATIONAL EXPERIENCE OF USERS

	Experience Level		
	Low (N=2)	Medium (N=7)	High (N=7)
Average Rating, Simulation Factors	13.1	10.7	14.0
Average Rating, Training and Situational Factors	13.8	12.2	13.6

DEVICE 15E16: ELECTRONIC WARFARE TRAINER. The 15E16 is used to teach all phases of electronic countermeasures to individual operators and electronic warfare officers. It is intended to train the principles of operation of various EW equipment; skill in the interpretation of displays and readouts; skill in classifying intercepted electromagnetic radiations and ability to analyze those radiations in detail; recognition of the electronic characteristics of various types of radar equipment; and the ability to determine the priority of a threat signal. It was expected that the trainer would be used by operators with relatively little experience as well as provide refresher training to highly experienced personnel.

The device provides a means for synthetically generating and distributing a number of signals to each of several user ECM stations. The signals are supposed to simulate either friendly or hostile emitters, and are to appear not as "optimum signals," but as signals that would be received under actual operating conditions.

The qualifications considered necessary for instructors using this device are that they be commissioned officers or senior petty officers with a "thorough knowledge" of electronic warfare, of the capabilities and limitations of Device 15E16, and of the corresponding electronic countermeasures equipment and procedures it is designed to simulate.

The 15E16 is a trainer that evidently had some early acceptance problems but is now highly accepted at Moffett Field. Its composite criterion score was +3.5. Figures 6 and 7 show the acceptance profiles for this trainer. With respect to simulation, the 15E16 was rated distinctly above the average of all trainers in five areas: external environmental effects, equipment performance, control effects, display of status information, and simulated sensor reactions. It received only one below average rating, that in the area of communication problems. However, it is important to note the high importance attributed to fidelity of simulation, particularly in equipment performance, information displays, and sensor performance. Thus the profile shows several negative "importance differentials," a fact that very likely somewhat reduces its level of acceptance.

With respect to training effectiveness factors, it was rated above the average of all trainers as a group on all but three factors. In fact, it received only one below average rating, on immediacy of performance evaluation. It was also rated low on completeness of performance evaluation although it did not compare unfavorably with other trainers in this respect (Figure 7).

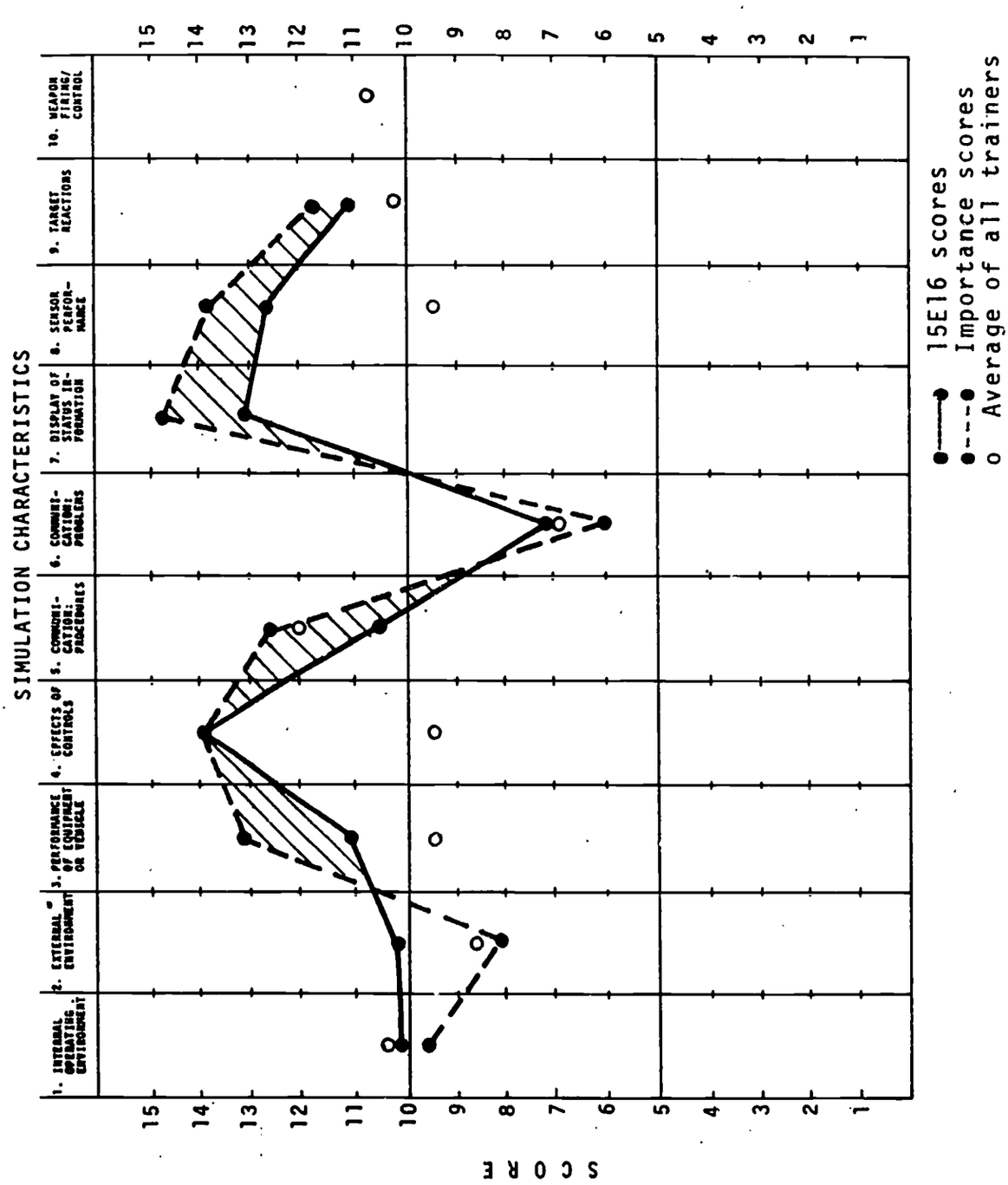


Figure 6. Profile of Simulation Scores for Device 15E16, Electronic Warfare Trainer, Moffett Field.

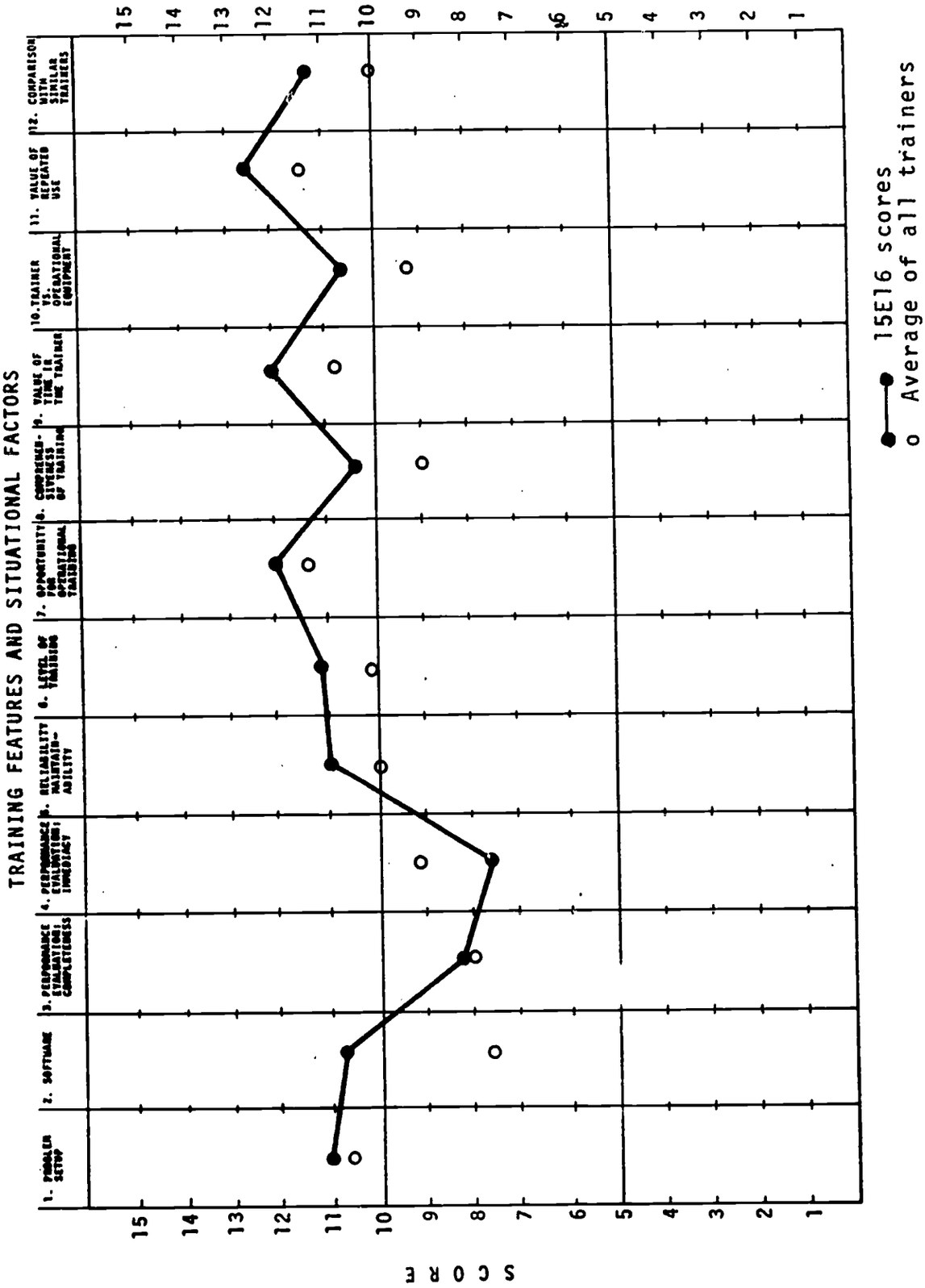


Figure 7. Profile of Training Effectiveness Scores for Device 15E16, Electronic Warfare Trainer, Moffett Field.

The comparatively low rating of the trainer on completeness and immediacy of performance evaluation appears to stem from the fact that the instructor is unable to determine how well the student is doing without getting up and going to each individual student position.

The qualifications of instructors are considered critical in this trainer and it was indicated that training sometimes suffers from the unavailability of qualified personnel.

Although the trainer received an above average rating on reliability and maintainability, it is evident that it is not without its difficulties insofar as maintenance personnel are concerned. The trainer is "preflighted" every morning so that any problems that might arise are identified before the students arrive. However, troubleshooting is complicated by incomplete or incorrect documentation; the documentation for the trainer as a whole is the subject of considerable mistrust. Further, the modified GFE is not covered in all the documentation. The master scan generator is considered a source of particular difficulty.

It was indicated that some negative attitudes developed early toward this trainer because of an unusually long period of time before it was accepted.

> "The allowance parts list did not become available until two years after delivery. In the interim several modifications were made which limited the value of this list. Many things were missing and many added."

> "Explanations for various systems in the technical manuals, drawings and schematics are often too brief considering the complexity of the device and the lack of any formal maintenance training course. There are too many errors in the maintenance instruction."

Use of the device is being promoted actively by the FAETUPAC and by the instructors who are enthusiastic about it. The following comments were offered by students:

> "It is a very good trainer. I learned a lot from it. It's the closest thing to being actually flying that I have seen. I'm sure it's nothing like flying, though. I do have a few hours flight time in the radar seat, and that was nothing like the trainer."

"I had heard that this was a million dollar trainer, that it was quite elaborate and supposed to be one of the best around. I was very impressed when I first walked into it. It made me get the feeling that I couldn't wait to use it."

The need for training in the recognition of individual signal sources is clearly recognized:

"You can never get enough experience in the identification of possible enemy emitters. More time should be spent listening and watching emitter signals."

A shortcoming of the device was considered to be the absence of cameras for taking pictures of signals and recorders for tape recording the signals:

"In the actual aircraft you must use these (recorders)."

A point repeatedly emphasized was the inability of the instructor to monitor the performance of six students simultaneously and to receive all of the reports that they might initiate for evaluation. It was felt that communication between the operators and the instructor was much less immediate than in the case of actual operations where communications between operator and TACCO is nearly instantaneous. These criticisms probably are reflected in the somewhat low average rating given the trainer in communication procedures.

The reputation of the trainer insofar as signal realism is concerned was mixed. While some held that the trainer was adequate for training in the recognition of individual signal emitters, there were others who felt "it is good for learning operation of the gear, but a waste of time as far as individual signal recognition goes." One problem mentioned was the absence of simulated background noise associated with the aircraft. Generators and other equipment radiating electronic noise reportedly complicates the problem of ECM operation in the aircraft in a way that is not reflected in the trainer.

The number of signals made available by the trainer at any one time was considered to be a limiting factor. In contrasting the 15E16 with the 15E18, it was pointed out that in the latter trainer the computer has "every" signal available and can compound the problems that the operators will be expected to cope with during an actual mission.

It was also felt that there was insufficient accuracy in target course, speed and position information. This added to the difficulty of evaluating student performance. In addition, lack of provision for tape recording target information led to an inability to demonstrate the importance of tapes to the student and a limitation on evaluating his performance.

Several comments were made concerning the lack of correspondence between the arrangement of equipment in the trainer and that in the aircraft:

> "Designers made gear installation as convenient rather than simulating real installations. It doesn't prevent good instruction, just realism."

It was felt that an improvement would be to arrange the equipment in a manner that it would be identical to that in the aircraft. It was also suggested that all associated controls should be represented even though they might have no function in the trainer. These included such controls as the tape recorder control box, ASA-16 marker panel, ECM audio switch, etc.

In general, it was felt that the trainer was fulfilling a most important role:

> "It gives the operator a simulated contact and can show his capabilities and limitations. Without the trainer the operator might detect a contact in the real world and never know what it is. It provides training in a field the operator could not get otherwise."

It was clear that the instructors are playing a very positive role in publicly promoting the value of this training device and took considerable pride in it being the "best in the training environment" at Moffett Field. It was generally felt that use of the trainer should be increased through, for example, the use of "mandatory operator proficiency courses" but that there were insufficient instructors at this time to permit such usage.

One instructor who had over 1200 hours of operator experience in the P3B, most at the ECM station, strongly emphasized the importance of electronic background noise experienced in the aircraft itself. The noise emanates from the aircraft generators and other equipment and there is also a great deal of weather noise in the form of static electricity. It was felt that a provision should be made to

simulate this problem in the 15E16, in the form of a variable noise control, so that students "would know what the real world situation would be like and get used to analyzing signals under adverse conditions."

It was evident that the 15E16 at one time had a very poor reputation with respect to reliability. However the trainer at Moffett Field has been kept in an excellent state of repair by the maintenance technicians. Nonetheless, there were numerous complaints about the difficulty of conducting maintenance, performing calibrations and alignments, and the modifications necessary in the trainer to accept government furnished equipment. Schematics and interconnect diagrams were reportedly extremely difficult to follow from system to system and there is an absence of overall system block or flow diagrams. Explanations in the maintenance textbooks were considered too brief in relation to the complexity of the device and the absence of any formal maintenance training course. Maintenance instructions were reportedly replete with errors. Thus, though the equipment was generally regarded as reliable, it was also regarded as very difficult to troubleshoot.

Evidently, the trainer's reputation with respect to poor reliability stemmed from an installation on the Atlantic Coast where, following a major modification of the device, maintenance personnel found themselves "insufficiently qualified due to a lack of interest and/or participation in the modification." Consequently, trainer reliability proved very poor.

It is evident that the FAETUPAC Detachment at Moffett Field is doing a systematic promotional job with respect to this trainer. It was reported that they have held open house and invited squadron commanding officers and electronic warfare officers to a presentation on the capabilities and limitations of the device. This has led to a renewed interest at the squadron level and higher morale among the instructors who teach ECM. It has also helped overcome an initial negative viewpoint associated with the eleven-month period of time prior to acceptance of the trainer. During this time NTDC reportedly instructed the technicians not to get involved with the equipment because it was felt the contractor might use this as an excuse for subsequent system failure.

Table 7 shows that there were no systematic differences in acceptance of the 15E16 associated with amount of operational experience. However, experienced personnel rated it much lower than inexperienced personnel with respect to the level of training for which it is suited.

TABLE 7. AVERAGE RATINGS OF 15E16 BY LEVEL OF OPERATIONAL EXPERIENCE OF USERS

	Experience Level		
	Low (N=8)	Medium (N=3)	High (N=7)
Average Rating, Simulation Factors	10.4	12.7	11.2
Average Rating, Training and Situational Factors	10.4	11.5	10.7

DEVICE 14A2: ASW TEAM TRAINER. The 14A2 is a heavily utilized team trainer for surface ship ASW operations. It has simulated spaces for the bridge, CIC, sonar, and weapons control aboard typical destroyers. It is equipped with simulated AN/SQS-23 sonar, MK 111 and 114 fire-control systems, fire-control radar, weapon control and launcher control stations, and a target control station manned by the trainer operator. The entire complex is driven by a general purpose digital computer.

The 14A2 is one of the most highly accepted trainers in the Navy. It received a composite criterion score of 6.4, the highest of any trainer in the study.

The simulation profile for the 14A2 is shown in Figure 8. It is evident that the trainer is considered superior with respect to simulated performance of the equipment and vehicle, the effects of controls, communication procedures, and weapon control. It was considered about average, although somewhat below judged importance, in display of status information, sensor performance, and target reactions. The size of these discrepancies was comparatively small, however, so that overall the trainer received positive standard scores on simulation factors (see Table 4).

The 14A2 was rated consistently above average on training effectiveness factors. This was particularly true in the areas of software and performance evaluation (see Figure 9). It is believed that these superior ratings reflect an unusual investment in the development of utilization

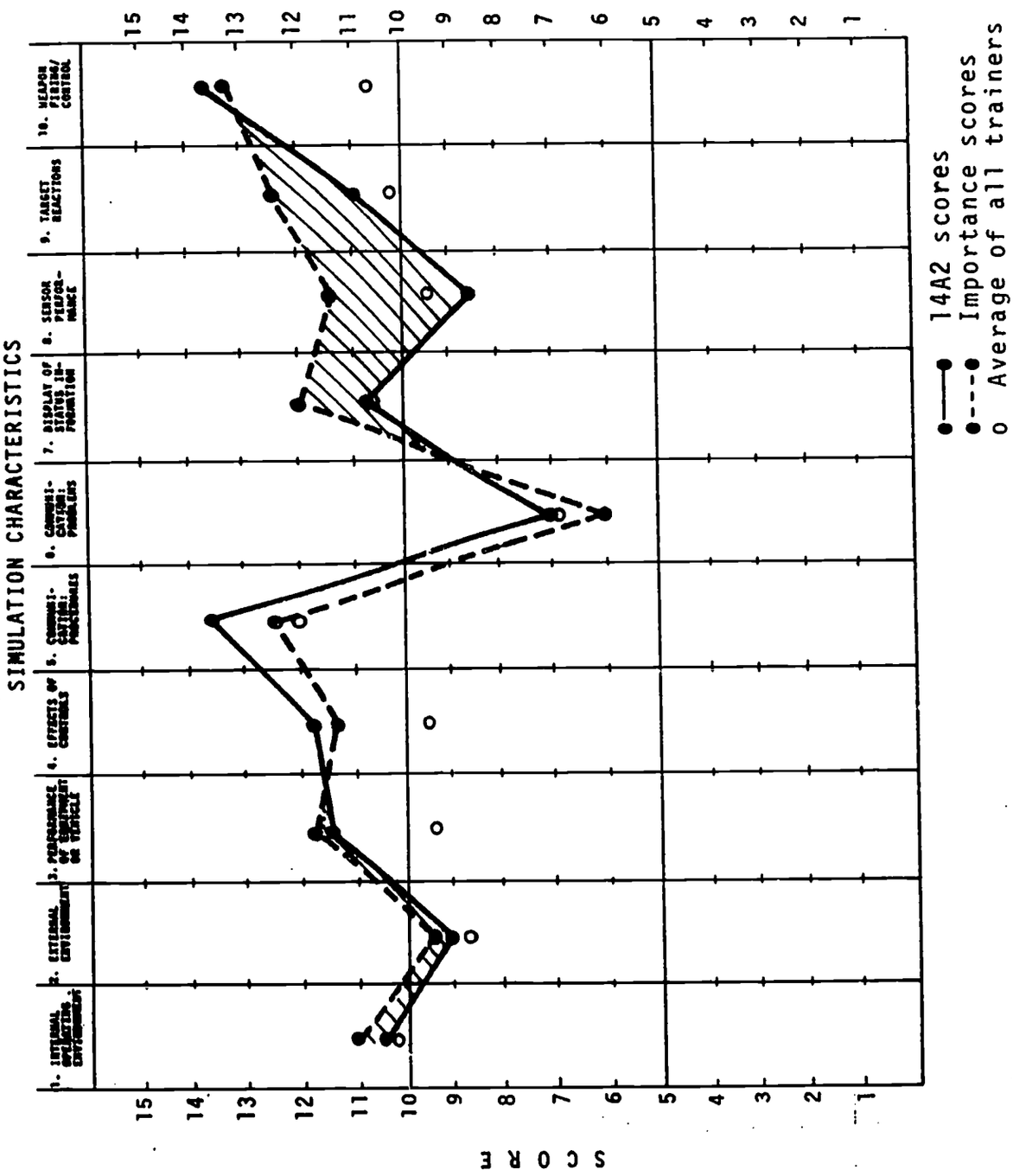


Figure 8. Profile of Simulation Scores for Device 14A2, ASW Team Trainer, San Diego.

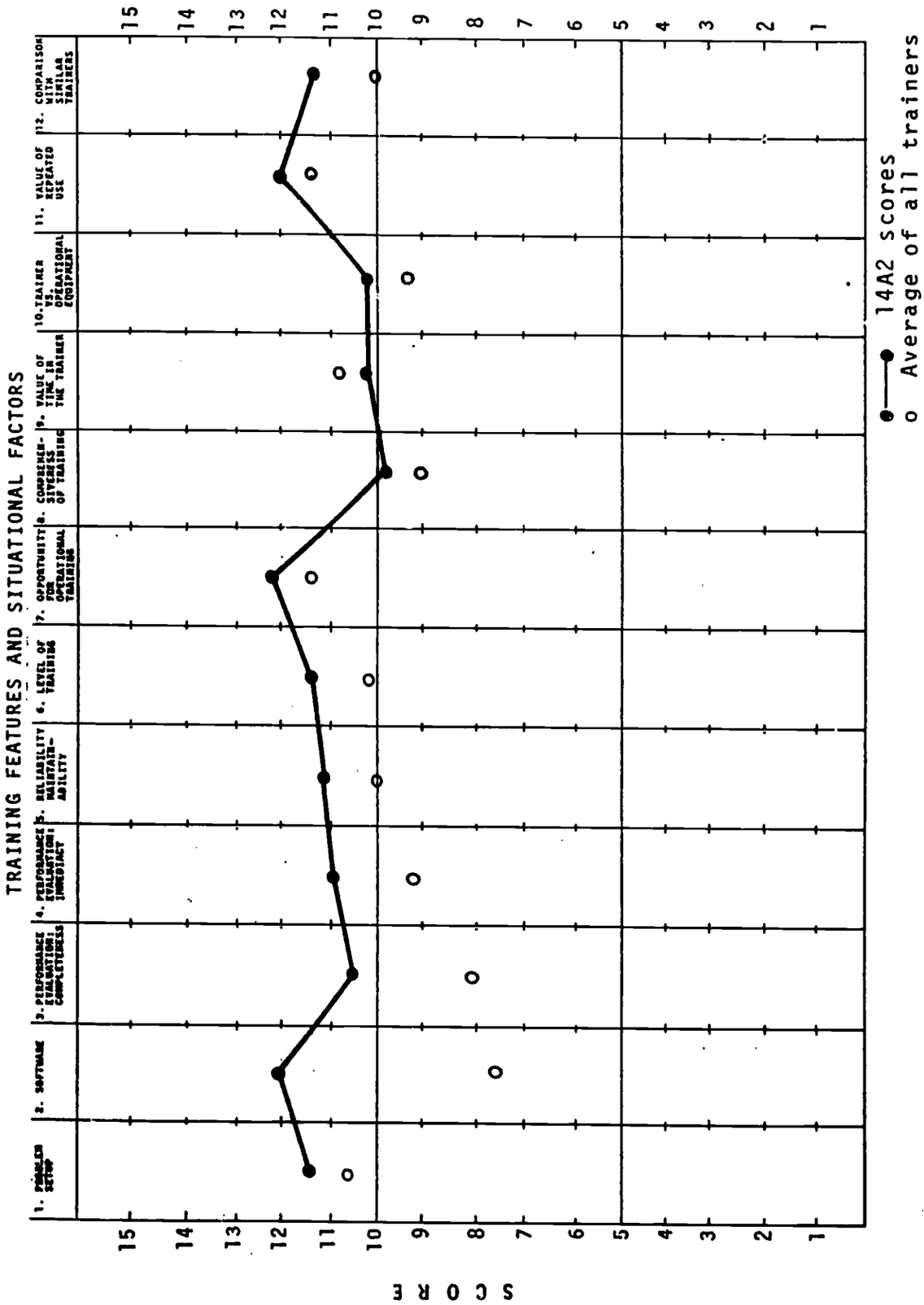


Figure 9. Profile of Training Effectiveness Scores for Device 14A2, ASW Team Trainer, San Diego.

guides and methods of performance appraisal associated with this trainer.* In fact, in interviews with personnel operating the 14A2F (Pearl Harbor), the officer in charge stated that "we would have been lost without it (the utilization guide) at the beginning."

Some observations with respect to the simulation profile appear in order. Performance simulation was rated very high, in part, perhaps because the 14A2 equipment actually operates "better than operational equipment." It is more accurate, more effective (fewer missed targets--better range--no detection uncertainty), and suffers no equipment casualties. (If a casualty occurs, the exercise is interrupted until it is fixed.)

Although the majority of respondents rated control simulation very highly, it is interesting that the sonar technicians, as a group, disagreed with the overall judgment. That is, they did not think simulation was good enough. This reflects their appreciation of the problems of operating techniques in the real world. Several operators commented on the lack of provision for developing contact classification information. This criticism is also reflected in the comparatively low rating awarded to sensor simulation for this trainer. It is ironic, perhaps, that some of the acceptance of the 14A2 certainly stems from the fact that sonar simulation was much more sophisticated in this trainer than in earlier attack teachers. Nevertheless, the fleet has come to recognize the importance of high fidelity sonar simulation, i.e., classification quality.

In addition to the "low quality" of sonar simulation, it is perhaps useful to point out that no attempt was made to provide realistic radar simulation. The complaint registered most often in relation to radar simulation was that it made ASW air control too easy.

The ratings with respect to target reactions probably would have been higher except that some instructors still "play" with the student since target movement is directly under his control. A related shortcoming was felt to be lack of realistic countermeasure devices, beacons, false target cans, decoys, etc.

The high rating on weapons firing and control also deserves comment. A major objective in the development of

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*See Device 14A2 (Series) *Utilization Guide for Surface Ship ASW Attack Team Training*, Dunlap and Associates, May 1969.

the 14A2 was to provide realistic training in the firing of ASROC weapons. The rating on this item reflects the achievement of that goal. Some dissatisfaction was expressed with the fact that the trainer has no provision for torpedo kill probability, even though "not all well-placed torpedos result in hits and not all torpedos run hot, straight, and normal."

The high ratings on completeness and immediacy of performance evaluation probably reflect the somewhat special situation where a complete evaluation team of six or eight people is available. It is felt that the ratings would have been much lower if they reflected the more typical situation where only a single instructor, seated at a remote station, is prepared to offer post-exercise evaluative commentary.

It is believed that the comparatively low rating on value of time in the trainer probably reflects a number of considerations. The lack of high fidelity sonar simulation has already been mentioned and probably contributed to this rating. In addition, any simulated ASW exercise of necessity involves a certain amount of time during which nothing of great significance seems to be happening. Although this is a necessary element in realistic search plans and contact developments, it is possible that this is construed as time wasted by some personnel. Finally, and perhaps most important, some personnel reportedly felt that the exercises in the trainer do not advance to a very high level of complexity. Interestingly, the instructors sometimes claim the students are not ready; the students say the instructors cannot, or do not want to, develop highly complex problems.

Despite these identifiable problems, in general it is concluded that the 14A2 represents one of the most highly accepted and certainly most highly utilized training devices in the Navy.

There were no systematic differences in level of acceptance as a function of the user's level of operational experience.

TABLE 8. AVERAGE RATINGS OF 14A2 BY LEVEL OF OPERATIONAL EXPERIENCE OF USERS

	Experience Level		
	Low (N=5)	Medium (N=13)	High (N=12)
Average Rating, Simulation Factors	11.6	10.6	10.6
Average Rating, Training and Situational Factors	11.1	11.0	11.6

DEVICE 21A38: SUBMARINE ATTACK TRAINER. The 21A38 is a shore-based attack trainer comprised of three independent attack centers that share a common computer facility for problem generation and evaluation. The trainer is designed for the indoctrination and training of submarine fire control teams in (1) the basic characteristics and capability of fire-control techniques and equipments utilized in submarine ASW; (2) basic techniques involved in the approach and attack of single and escorted surface targets; (3) advanced tactical training in both pack and submarine *versus* submarine techniques; (4) the setup and firing of submarine weapons; (5) the integration of sonar equipment and operating personnel into the fire-control team; and (6) the possible development of new tactical doctrine.

The acceptance profile of the 21A38 is complicated by the fact that it is essentially three trainers in one. Attack Center No. 1 is designed to simulate modern diesel submarines and early nuclear submarines. It is equipped with corresponding sensor and fire-control equipment (BQS-4, BQR-2B, BQG-4, and MK 101 Fire-Control System).

Attack Center No. 2 is designed to simulate the fast attack submarine. It is equipped with the relatively more modern BQS-6B, BQR-7B, and BQH-2C sonar systems.

Attack Center No. 3 is designed to simulate the ballistic missile submarine. It is equipped with the BQS-4, BQR-7B, and BQR-2B sonars and the MK 113 Mod 7 fire-control system.

A difference of fundamental importance between the three attack centers is the presence of a periscope simulator which is a feature only of Attack Center No. 2. This has been a major factor in acceptance as reflected by steadily increasing utilization of Attack Center No. 2 since the periscope installation, and corresponding decreases in utilization of the other attack centers. Because it was reported to us that the periscope simulator was a major consideration in acceptance, and because of the relatively few available users of Attack Centers 1 and 3, the majority of the acceptance data gathered during this study reflects user appraisals of Attack Center No. 2. This portion of the device is highly accepted with a composite criterion score of +5.0.

The simulation profile for Device 21A38 is shown in Figure 10. The device is rated as superior in its simulation of the internal operating environment, performance of the equipment and vehicle, effects of controls, and weapon firing and control. Felt simulation deficiencies are reflected in the display of status information, sensor performance, and target reactions.

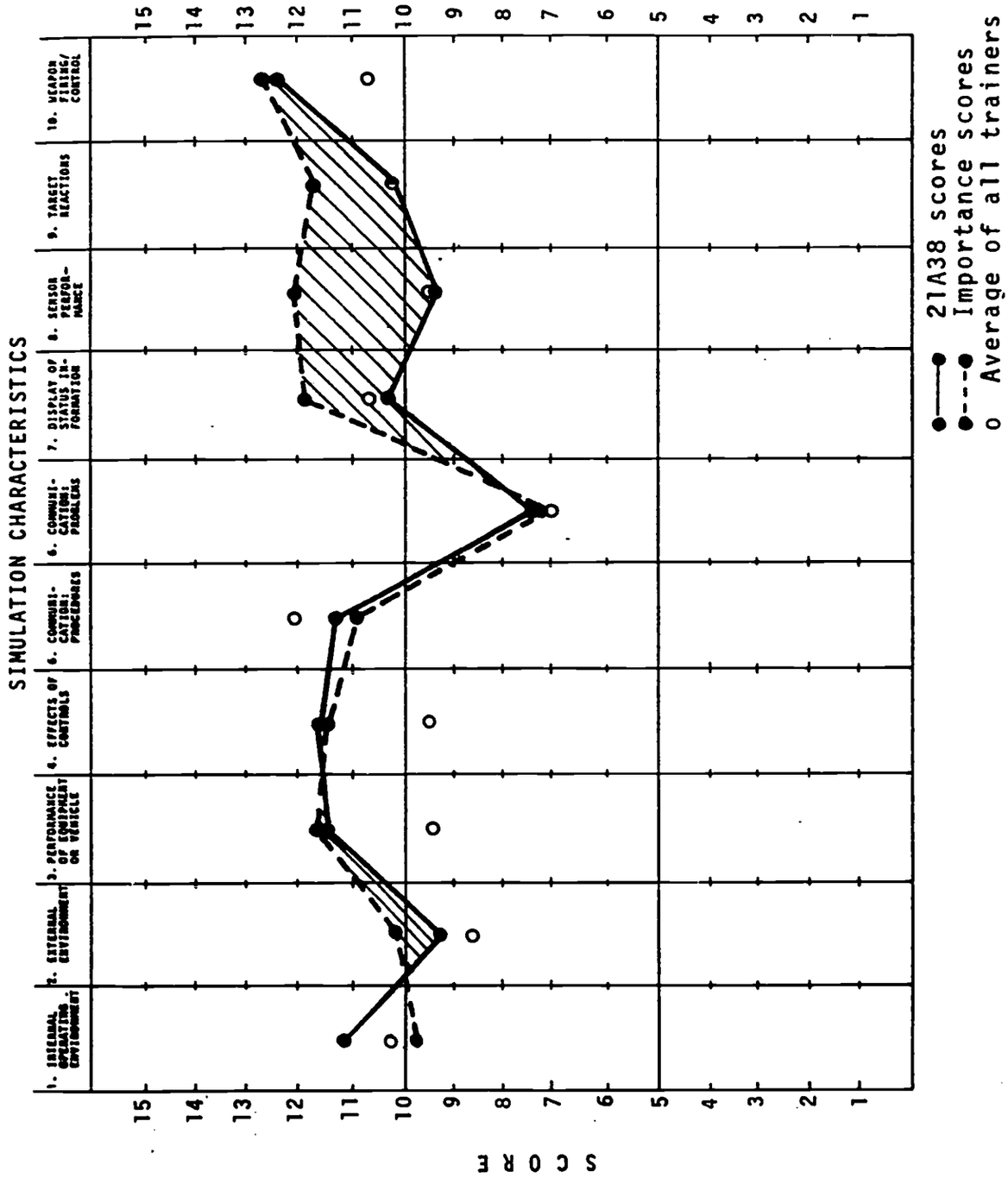

Figure 10. Profile of Simulation Scores for Device 21A38, Submarine Attack Trainer, Pearl Harbor.

In addition to the periscope requirement, the most frequently mentioned deficiency of the 21A38 has been the lack of realistic sonar simulation. Numerous complaints were registered by fleet personnel concerning the quality and variety of target sounds. Despite the critical role of the submarine sonar operator with respect to target detection, classification, and motion analysis, personnel with training responsibility aboard some submarines consider it a waste of time to send their sonar operators along with the attack team to the 21A38. In addition to poor audio simulation, the absence of a LOFAR type display is a source of complaints. Few of the operational problems encountered at sea are well simulated. The result is that the sonar operators feel they play only a minor role in the trainer and, once in the "automatic target following" mode, are called upon to do little but sit in their chairs.

The comparatively low rating on sensor simulation also reflects dissatisfaction with the periscope. The quality of target imagery was felt by some to be not as good as that in some earlier attack trainers. This makes "target identification more difficult that it is in the real world."

The training effectiveness profile of the 21A38 is shown in Figure 11. It is clear that the trainer was rated particularly high in problem setup, reliability, and level of training; it was also above average in most other respects.

The only below average ratings of the 21A38 occurred in the areas of performance evaluation and value of time in the trainer. There is an administrative problem that is probably responsible for these reactions. There is no standard syllabus or graded problem series through which submarine attack teams are regularly exercised. Rather, the facility tries to respond with the particular types of problems that a given team may request. While these requests almost always can be accommodated in a general way, the burden of evaluation and critique often falls on enlisted instructor personnel who are not fully qualified to assume these roles. This stems in part from their lack of complete technical knowledge about all stations in the trainer, in part from their lack of detailed information about various types of targets, and in part from the social difficulties of critizing one of higher rank than oneself.

It is interesting to note that although the trainer has a capability for submarine *versus* submarine action, with different submarine teams operating in the different attack centers, the trainer has rarely been used in this mode. In one exceptional case, two submarine teams were pitted against

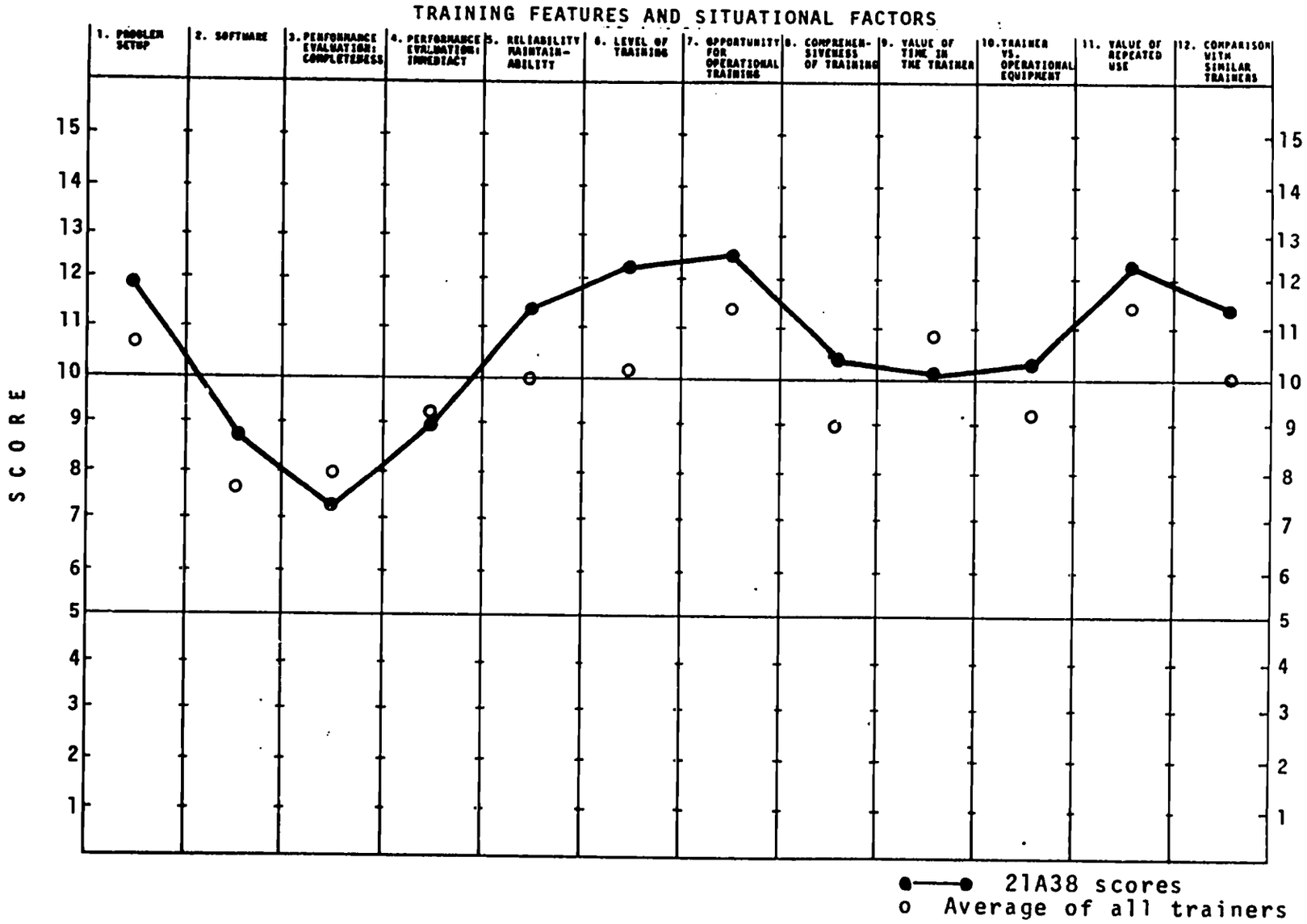

Figure 11. Profile of Training Effectiveness Scores for Device 21A38, Submarine Attack Trainer, Pearl Harbor.

one another without the knowledge of the commanding officers. The negative reaction of the commander whose submarine lost the contest has evidently created a lasting attitude of rejection insofar as this particular feature of the trainer is concerned.

There is a general feeling at the training center that qualified observers at the squadron level should participate more extensively in performance evaluation in the trainer. It was asserted that use of the trainer is diagnostic in that, after one or two runs, a qualified observer can readily determine what the deficiencies of that crew are. Further, predictions can be made concerning what types of difficulties the crew will have, given a particular tactical situation.

In summary, despite some notable deficiencies in the minds of the users, Device 21A38 must be regarded as a highly accepted trainer. Personnel at the training facility are actively supporting its use by the fleet and fleet acceptance appears to be generally high. To the extent that there are negative reactions, they are associated most strongly with inadequate sonar and periscope simulation and with deficiencies in performance evaluation and supporting software. There were no significant trends in acceptance as a function of experience level (see Table 9).

TABLE 9. AVERAGE RATINGS OF THE 21A38 BY LEVEL OF OPERATIONAL EXPERIENCE OF USERS

	Experience Level		
	Low (N=6)	Medium (N=4)	High (N=15)
Average Rating, Simulation Factors	10.3	10.2	10.7
Average Rating, Training and Situational Factors	11.4	9.6	10.8

TRAINERS WITH ACCEPTANCE PROBLEMS

It has been emphasized that probably no trainer represents a case of complete acceptance or rejection. Each trainer, whether generally accepted or not, may have its strong and weak points in the minds of the users. However, a number of trainers did show evidence of lack of acceptance with respect to many if not the majority of the characteristics studied. To emphasize the contrast between "accepted" and "non-accepted" trainers, a number of these will be described here.

DEVICE 2F55B: F4B CREW TRAINER. The 2F55B was designed to provide training in aircraft control, instrument procedures, engine control, emergency procedures, ECM operations, and coordination between pilot and RIO (Radar Intercept Officer) in the F4B aircraft.

The F4B is a supersonic, two-place, twin-engine, all-weather fighter aircraft. It was designed for intermediate and long-range high-altitude intercept work, using the APQ-72 and APA-157 radar sets, and for intermediate or long-range attack missions for conventional or special weapons delivery. The responsibilities of the RIO are to manage the airborne missile system, communications, navigation, and ECM.

The components of the navigation and bombing systems, which are viewed, controlled or operated by flight personnel, were to be "identical in appearances and operation" with the actual equipment. The aircraft is designed to carry a variety of missiles whose simulation was to accurately reflect flight characteristics, weight, and center of gravity changes. Simulation of launching, missile firing, and kill conditions was to be provided. Target performance was to be simulated on the radar indicators in a "realistic" fashion. In addition, "maximum implementation was to be made of human factor considerations in the design of the trainee and instructor stations to insure optimal training value."

Among the trainers designated as low acceptance cases, the 2F55B was the most marginal. Its composite standard score, -2.7, was not greatly below average, although it received negative scores on most of the elements making up the composite (see Table 4).

The simulation profile for the 2F55B (Figure 12) identifies the felt deficiencies in greater detail. It is clear that the trainer was rated below average on about half of the simulation factors but particularly on performance of the equipment, effects of controls, simulation of target reactions, and weapon firing and control. In addition, the trainer was judged to be significantly deficient, compared to judged importance, in its simulation of status displays and sensor operations.

With respect to training effectiveness factors, the profile of the 2F55B (Figure 13) shows felt deficiencies in the area of software, level of training, comprehensiveness of training, the value of repeated use, and in overall comparison with similar trainers of this type. To understand this profile, the following observations from the interviews are offered.

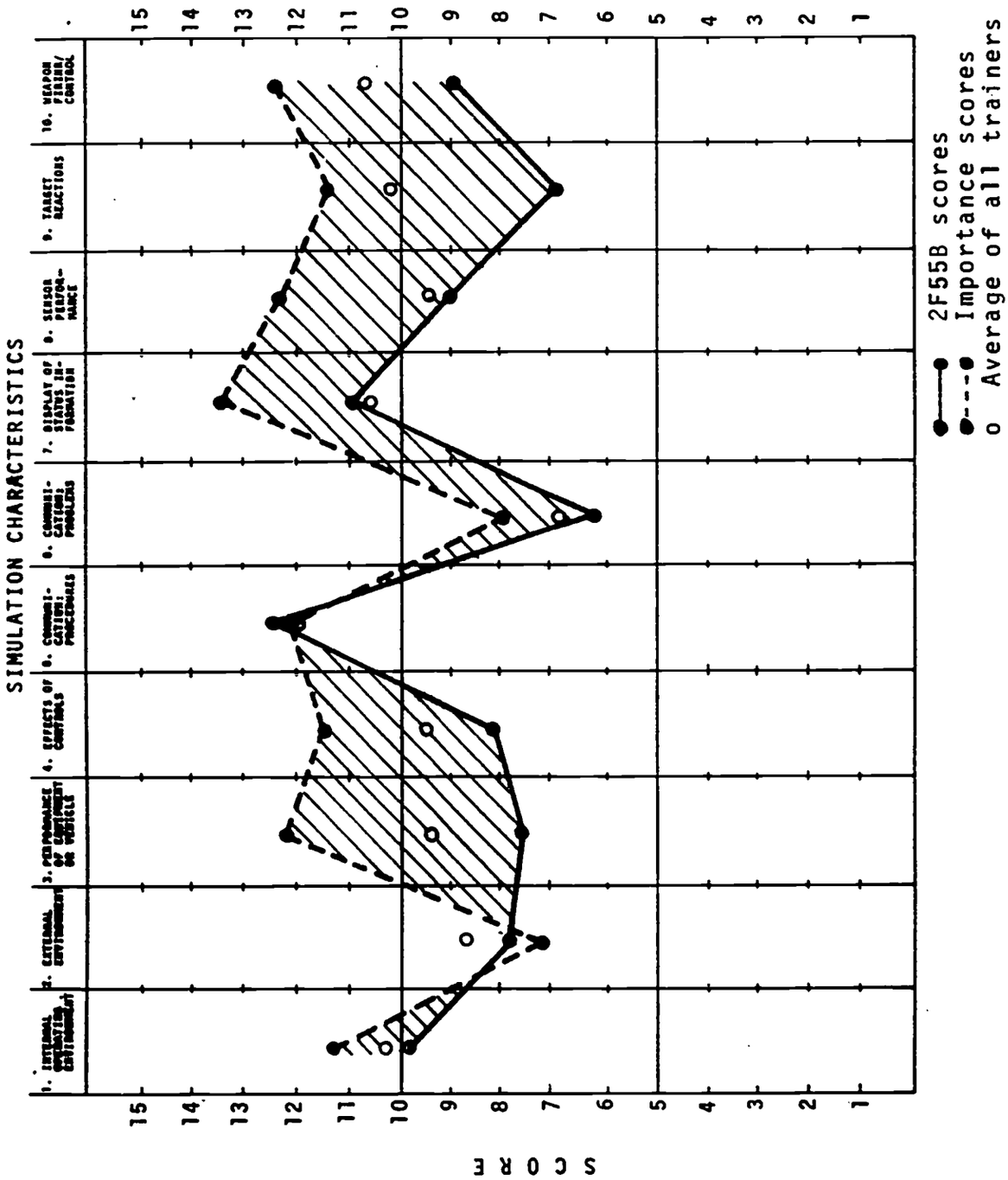

Figure 12. Profile of Simulation Scores for Device 2F55B, F4B Crew Trainer, San Diego.

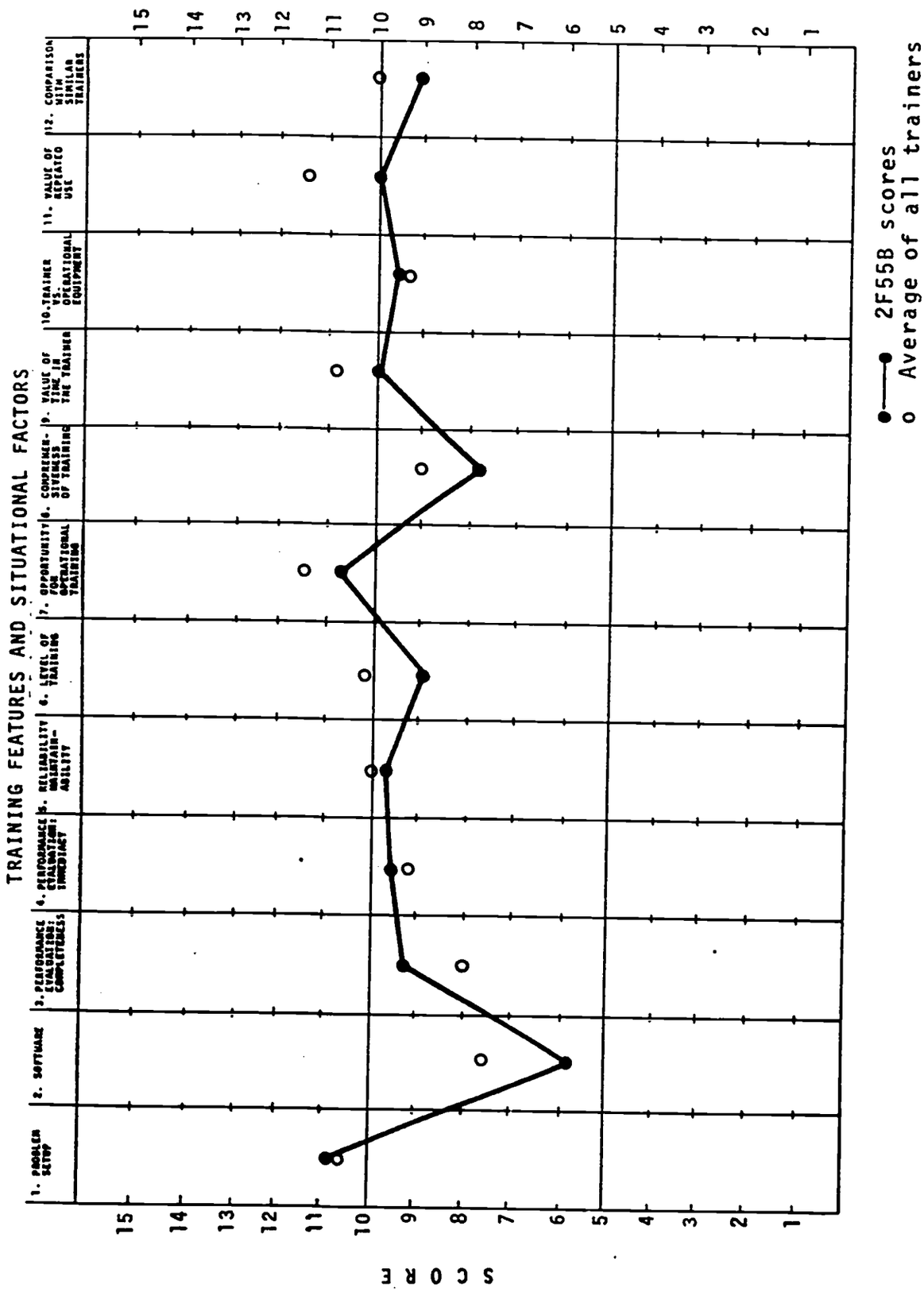

Figure 13. Profile of Training Effectiveness Scores for Device 2F55B, F4B Crew Trainer, San Diego.

It is "a poor package of hardware and there is poor documentation on the software. The trainer will not perform as a weapons system trainer. The radar and OFT portions cannot be operated as a package. The OFT definitely does not fly like the F-4 aircraft as far as general feel is concerned. The first trainer arrived shortly after the aircraft but was not operational for about eight months. The first trainer was designed around wind tunnel data and the aircraft proved to be quite different. The trainer then had to be returned for rework. This trainer was particularly bad and the whole program suffered because of it. Attitudes are just now changing because maintenance personnel have really worked to get it back in top shape."

Although it was felt that the flight equations eventually designed into the trainer were accurate and complete, it reportedly has been difficult to maintain the proper adjustments because of maintenance and the unavailability of parts. Because of insufficient air-conditioning, the trainer has had to be operated under adverse conditions. The packaging and hardware are considered to be of inferior quality and a major cause of troubleshooting problems. Drawings and schematics are reportedly incomplete; no flow diagrams were provided with the trainer with the result that maintenance people had to spend many hours developing them. Signal paths were reportedly difficult to follow.

While a major drawback to the trainer is associated with its handling characteristics and flying performance, it was also stated that the tactics portion does not meet local requirements.

> "The present trainer cannot track on multiple navigational aids, TACAN, etc., without great difficulty on the part of the operator. Although some RIO students feel that the trainer is good for knobology, ECM review, and navigation review, they tend to feel that there is insufficient reward for the time spent in the trainer. They feel that they often just sit there while the pilot plays with the trainer. They also complain that the radar cockpit systems are not compatible with the current cockpit configuration."

Coupled with the complaints about the hardware, there were very serious reservations about the quality of instruction associated with this trainer. It was asserted that the instructors do not take the time to find out what the device can and cannot do. Some of the instructors were not considered up-to-date on emergency procedures. Many students

felt that instructor pilots should operate the trainer rather than training devicemen. It was complained that unreal or unrelated emergencies were given to the pilot simultaneously and that this generates a bad attitude toward use of the trainer. Further, it was felt that the instructors are often not thoroughly familiar with what occurs in the air and how the aircraft responds to these occurrences. The complaint was summarized in the assertion that *"the things taught in the trainer are too simple."*

On the positive side it was stated that, "combined with a working radar and fire-control system, this F-4 trainer could be utilized extensively to great advantage. The trainer is worthwhile but by no means is it used to do all of the things it was designed for. It works adequately in many ways but the RIO, in particular, is being shortchanged."

It was evident that little promotional effort was being made to "sell" the trainer to its potential users. The instructors expressed a need for more access to the squadrons so that they could determine what was desired in the way of training. They indicated that, in the absence of any instructions requiring use of the device as a complete weapons systems trainer, a trend has set in to use it as an emergency procedures trainer only.

No standard of qualifications is set for instructor personnel with the result that there are some pilot personnel who are considered quite acceptable as instructors but other non-pilots who are not. It was asserted that "senior" instructors have an unfavorable opinion of the trainer and that this opinion has spread through the chain of command and to their flying peers. There was, however, no identifiable difference in overall acceptance as a function of level of experience with the F4B (see Table 10). But highly experienced personnel did rate the trainer considerably lower with respect to both value of time spent in the trainer and value of repeated use. The same personnel rated it higher than neophyte personnel in terms of completeness and immediacy of performance evaluation. Perhaps this was because they performed their own evaluations.

TABLE 10. AVERAGE RATINGS OF THE 2F55B BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=9)	Medium (N=10)	High (N=3)
Average Rating, Simulation Factors	9.0	9.0	8.9
Average Rating, Training and Situational Factors	8.1	10.0	8.9

DEVICE 2F69A: P-3 AIRCREW TRAINER. The 2F69A was designed to simulate the P-3A antisubmarine patrol aircraft, its associated sensors and weapons sytems. It was expected to (1) simulate the actual aircraft in both normal and emergency flight conditions; (2) permit training in the use of all radio navigational equipment for takeoff and en route flying, approach, and landing problems associated with instrument flying; (3) permit training in the use of all tactical equipment installed in the actual aircraft; and (4) teach team coordination, team training, and ASW tactics for the entire crew of the P-3A.

It was assumed that the pilots, engineers, and operators using the trainer would be previously checked out in the basic operating procedures for their respective equipments. For this reason, the military specification indicated "that the detail and realism often associated with operator trainers is not required. However, the device must provide all the inputs with sufficient realism so that the crew members can make the necessary tactical decisions."

The level of training associated with this device was described as "advanced." The device was expected to "knit the crew into a team which will permit them to operate the aircraft for its mission purpose. Through canned and dynamic problems they will learn to work together, exchange information, and search, detect, locate and attack simulated targets. In this trainer they should reach a level of proficiency enabling them to conduct actual ASW operations at sea in their aircraft."

The 2F69A has fallen well short of these objectives in the view of many users. Its score on the composite acceptance criterion was -3.5 (see Table 4). It is evident from the profile of simulation factors (Figure 14) that there were serious differences between the trainer as designed and the felt importance of various simulation factors. Deficiencies are particularly evident in the ratings of vehicle performance, effects of controls, display of information, sensor performance, target reactions, and weapon firing and control.

Notable deficiencies are also evident in the profile of training effectiveness (Figure 15). Particularly low ratings were given in problem setup, software, and reliability. Below average scores were also given on provisions for performance evaluation. These deficiencies did not preclude, however, relatively high ratings with respect to the value of trainer use (in comparison to opportunities in the operatinal aircraft) and the value of repeated use of the trainer. In the commentary that follows, an attempt is made to convey some of the reasons given for these quite different viewpoints.

> "The tactics portion of the trainer has never been used since it arrived at Barber's Point. Prior to that time it had operated in a coupled mode for about two years at Moffett. It was good in concept but the tactics portion was highly unreliable. It was down in some respect during every other problem, requiring as much as two maintenance shifts to keep it operating."

> "The JEZ simulation was always very poor, never really accepted. It took seven months for them to go through a three months acceptance program. NTDC acceptance checks were largely *static*; many of the tests met the specs but didn't really tell you how it would operate dynamically. The result is that the 14B31 is used for tactical training instead of the 2F69A. This is a very simple trainer utilizing manual inputs to the JULIE, JEZEBEL, and TACCO operators."

Some squadron personnel contended that they got more training done with the two sections of the trainer (OFT and Tactics) separated.

> "There is no need to get the whole crew to the trainer. We would, however, like to use the 2F69A as a full weapons system trainer for one reason--to demonstrate the qualifications of a

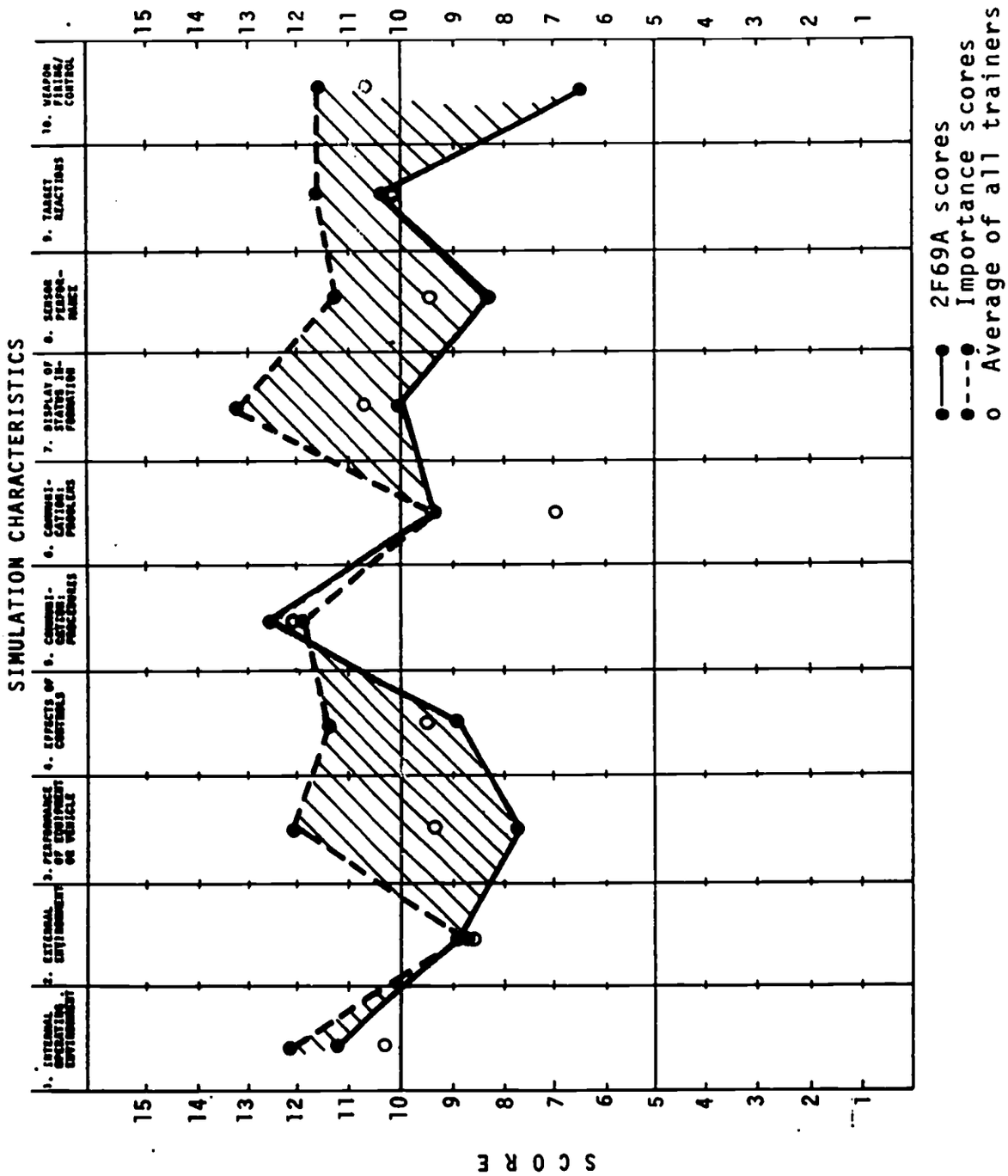

Figure 14. Profile of Simulation Scores for Device 2F69A, P-3 Aircrew Trainer, Barber's Point.

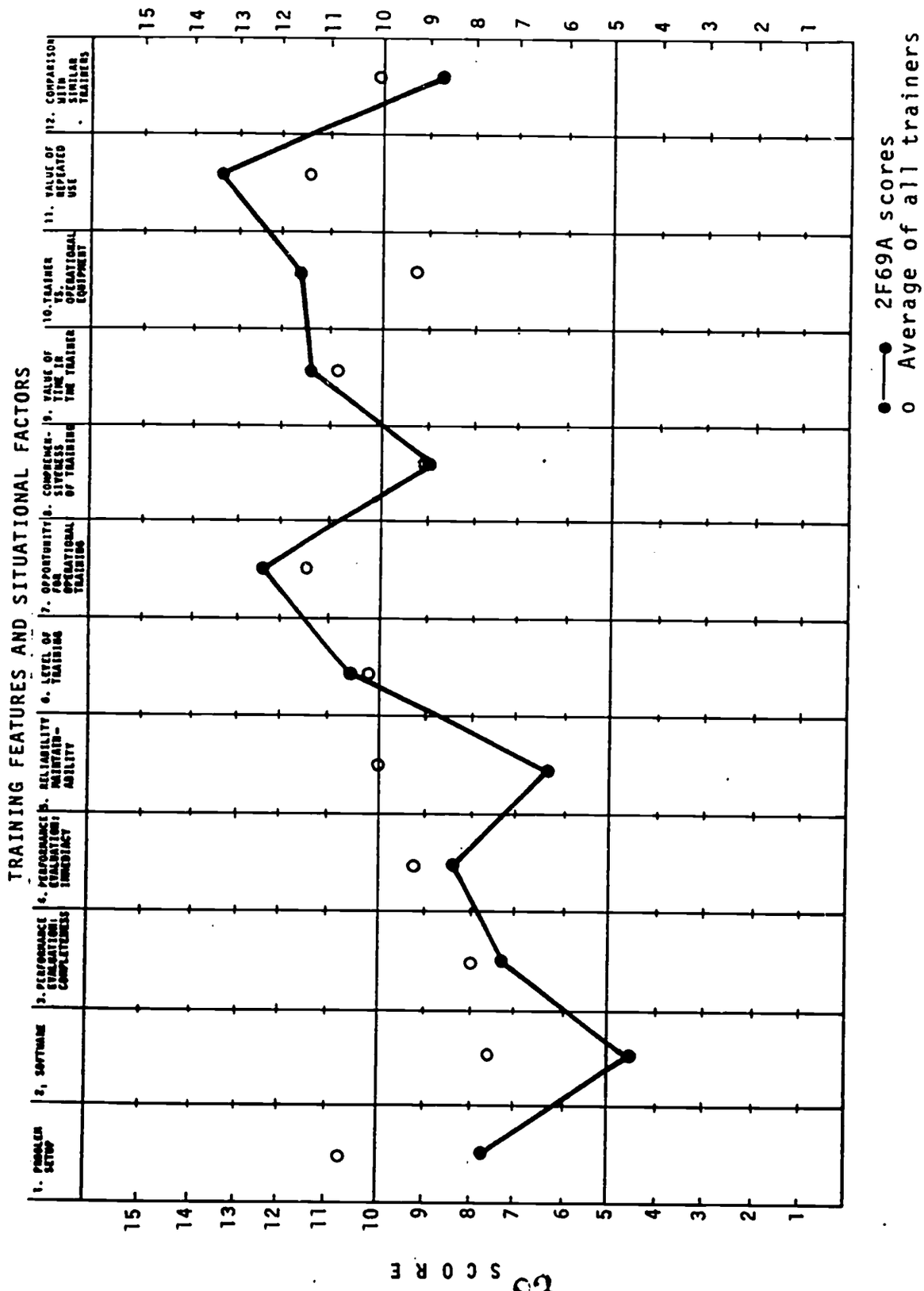

Figure 15. Profile of Training Effectiveness Scores for Device 2F69A, P-3 Aircrew Trainer, Barber's Point.

> particular crew member as a member of a coordinated crew. We can do this much more economically in a WST. We have 23 qualification exercises that must be achieved by each crew. We frequently can run the necessary exercises with only a partial crew in the trainer."

The software associated with the trainer was the subject of considerable criticism. The training guides were described as very sketchy.

> "We couldn't train simply using the guide. We (the training devicemen) learned to operate the tactics portion by observing the squadron instructor. The operator's guide we have is at the bottom of a drawer. The instructors generally get acquainted with the trainer's capabilities by asking the operator 'Can you do this?'"

Personnel in charge of the trainer had developed descriptions of all of the classes of problems they could generate, but they still depended on squadron personnel to define the manner in which they wished to use the trainer. The opinion was strong that they needed a qualified instructor attached to the training group. The fact that the training devicemen in the training group were not "NATOPS qualified" was a matter of some concern. It was felt that a syllabus should be developed by qualified people and then "...laid on the various squadron training officers. At the moment, we don't know what these people need."

It was evident that the trainer was being used to train flight engineers in emergency procedures more than for any other purpose. This was one purpose for which the trainer was felt to be extremely valuable. An attempt was made to schedule trainee engineers for the same exercise they would have the following day in the aircraft. It was felt that they could set up many problems that cannot be practiced in the aircraft with safety. However, the flight engineers complained that there were many system malfunctions and checks that they could not set up. They considered the trainer generally deficient in the area of simulating failures and malfunctions. It was stated that they frequently have to "...jerry-rig or cut out something in order to get the desired effects. It should be possible just to push a button to get the desired setup." A related problem was the inability to simulate sequential effects: "If one problem develops in the real world, another related problem is very likely to appear also. There is insufficient provision for this type of thing in the trainer."

It was evident that the trainer was being used a substantial proportion of the time in the absence of not only the tactical portion of the crew, but the pilots as well. One squadron engineer stated that they only have a pilot in the trainer about one-third of the time that the engineers are there. Therefore, "If the autopilot portion of the trainer is not working (and it frequently is not), then we cannot train. Sometimes the flight engineers end up flying the aircraft themselves."

In summary, it appears that the 2F69A has suffered extensively from an inability to keep the tactical portion of the trainer operational and, as a direct consequence, has been rejected in its designed role--that of a vehicle for coordinated training of the entire crew. In addition, there is concern over the ability of the instructor personnel to achieve the full potential of the trainer.

On the positive side, it was stated that before the trainer became available, transition from another type of aircraft to the P-3A was particularly difficult. It was necessary to learn all the required procedures and sequencing in actual flight--"a very tough proposition."

One training officer claimed that the users simply do not appreciate what they have in the trainer--they expect too much. The same individual asserted, however, that the 2F69A was a *procedures* trainer and that the pilots cannot expect it to fly like the real thing. Such a view is hardly in accord with the objectives set forth in the military characteristics for the P-3A trainer series. Certainly a device limited to procedures training, whether it be for pilots, flight engineers, or tactical personnel, could be achieved with far less complexity and investment than the 2F69A. As a procedures trainer, it may be accepted; as a complete weapon systems trainer, it obviously is not.

Unlike the other trainers discussed thus far, the ratings of the 2F69A suggested a general relationship between trainer acceptance and level of operational experience. Generally, the more experienced the participant was in P-3A operations, the more critical he was of the trainer (see Table 11). Criticism of the most experienced personnel was directed primarily toward vehicle performance, displayed information, sensor performance, problem setup, software, reliability, and overall comparison with similar trainers.

TABLE 11. AVERAGE RATINGS OF THE 2F69A BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=4)	Medium (N=7)	High (N=7)
Average Rating, Simulation Factors	10.6	10.5	8.6
Average Rating, Training and Situational Factors	10.2	9.7	8.8

DEVICE 2F69B--SOME CONTRASTS WITH THE 2F69A. Very likely in recognition of many of the problems cited in connection with the tactics portion of the 2F69A, the specification for Device 2F69B required that the trainer provide "realistic and accurate simulation for the search, detection, localization, and attack functions of the P-3B antisubmarine warfare aircraft." There was to be simulated activation of all controls, instruments, gauges, recorders, plotters, indicators, control panels, communication systems, lighting systems, and the like associated with MAD, JULIE, JEZ, ECM, navigation, and the tactical coordinator station. All modes of operation were to be simulated.

Provision was to be made at the instructor's control station for the development of targets having carefully specified underwater sound characteristics and signatures, emission characteristics, mode of operation, performance, and other target type characteristics. Detailed specifications were also provided for ocean environmental effects that affect signal propagation and display.

A comparison of the acceptance criteria for the 2F69B and 2F69A suggests that a number of significant improvements were, in fact, achieved. The composite criterion score for the 2F69B was +2.2 compared with -3.5 for the 2F69A. Inspection of Table 4 reveals that the 2F69B received much better scores on simulation deficiencies than the 2F69A. Unlike the 2F69A, it is being used as a complete weapons system trainer and enjoying considerably higher utilization. A comparison of acceptance profiles shows that the 2F69B was rated considerably higher than the 2F69A with respect to the display of information, sensor performance, target reactions, and weapon firing and control (Figure 16). It was also rated somewhat higher in equipment/vehicle performance. It is noteworthy, however, that in none of these areas was the 2F69B rated as high as the felt importance level of these simulation factors.

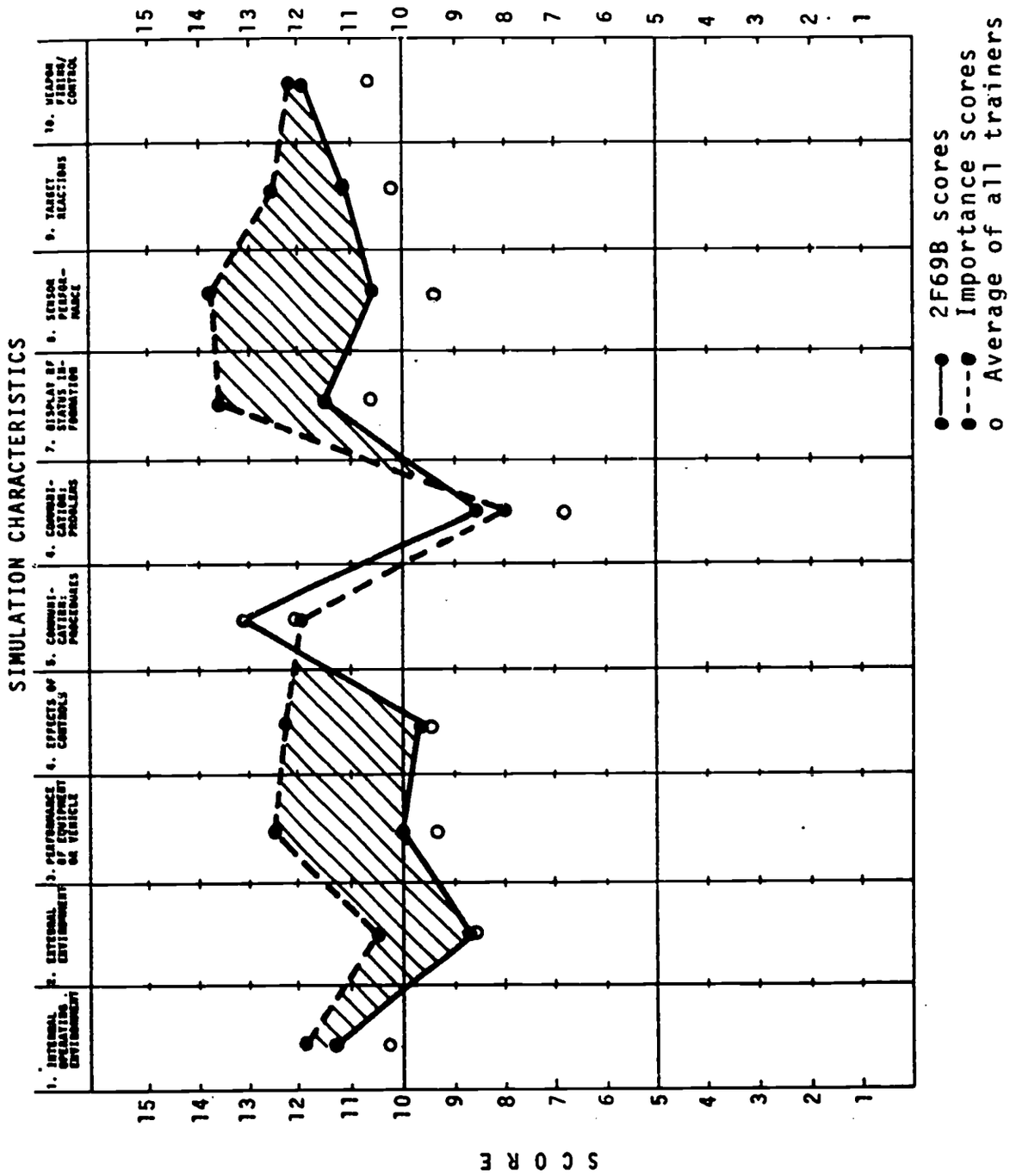

Figure 16. Profile of Simulation Scores for Device 2F69B, P-3 Aircrew Trainer, Moffett Field.

In comparing ratings on training effectiveness factors (Figure 17), it is evident that the 2F69B is still felt to have serious deficiencies in the areas of software and the completeness and immediacy of performance evaluation. In most other respects, it is similar to the 2F69A and closely approximates the general average for all trainers. Although the 2F69B is much more heavily utilized than the 2F69A, it still lacks endorsement in important ways from its users. The following comments are offered as illustrative of the problems:

> "Most instructors are familiar with aircraft operation but limited in their knowledge of the capabilities of the training device. The instructors are not always well-qualified and current with respect to tactics. ASW tactical techniques have changed dramatically in the last three years. The basic design of the trainer is satisfactory for the techniques of five years ago but it is outdated today. If the changes recommended for updating the trainer (were accomplished), the attitudes toward the trainer would change."

> "Some instructors appear to lack knowledge of the trainer and the exercises that can be provided by it. Where instructor operators are also maintenance personnel, general experience has shown that many are not interested in much except the trainer upkeep."

> "Some instructors don't give the student time to learn a basic skill before simulating emergencies."

> "The trainer does not fly like the real aircraft. It is a good trainer as it is used to teach checklist procedures and so forth. Although it does not fly like the aircraft, it does not really need to do so to accomplish training objectives."

> "The most serious deficiency of the trainer is in JEZ training, but there is no other device available to do it."

> "Simulation of underwater sound is also a problem. Due to poor design, the sound signals drift in volume, frequency, and everything else, and must be continually readjusted to keep them realistic."

> "The schematics and drawings are insufficient to familiarize maintenance personnel with the functions

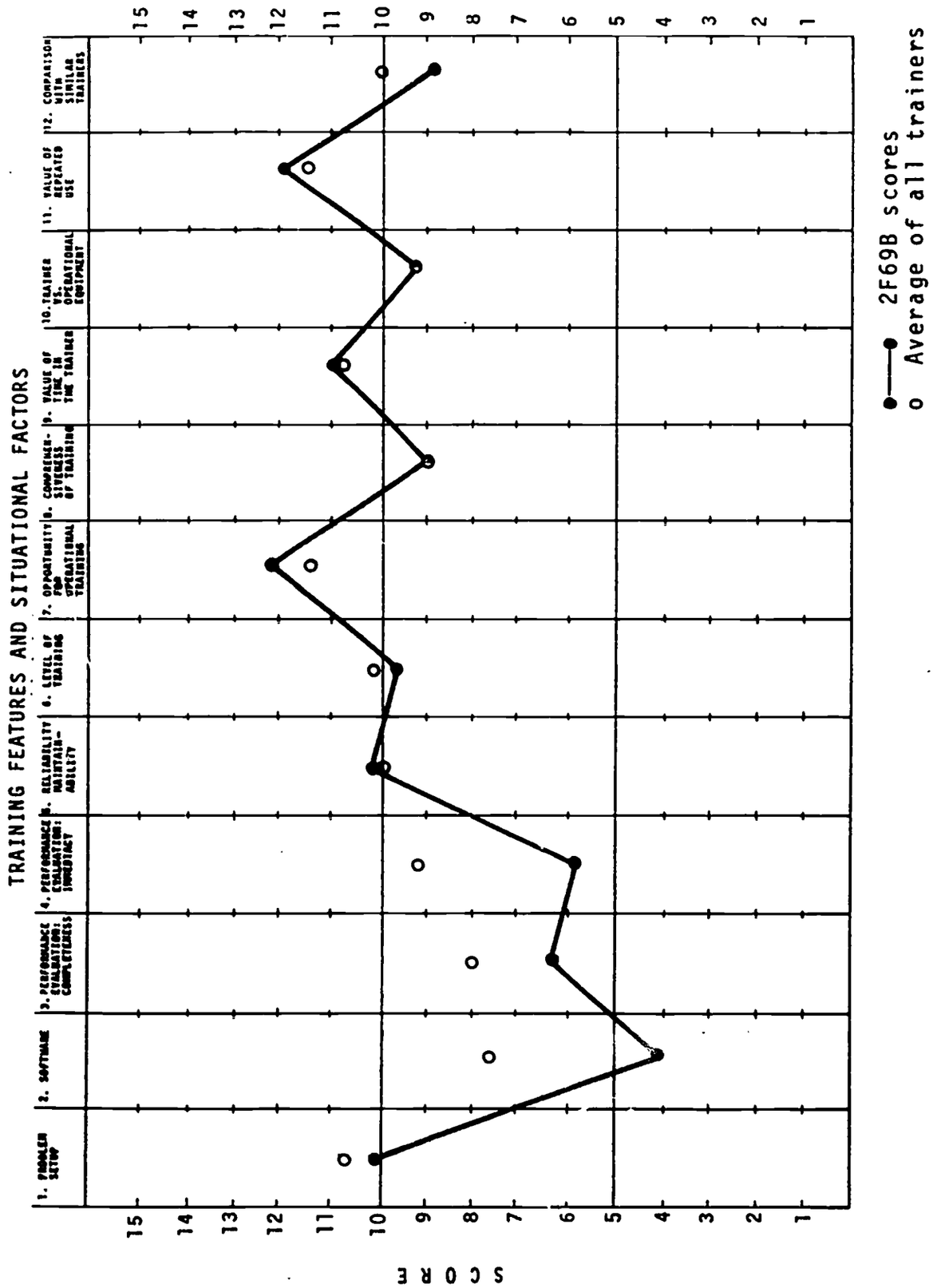

Figure 17. Profile of Training Effectiveness Scores for Device 2F69B, P-3 Aircrew Trainer, Moffett Field.

of the trainer. The manuals are generally inadequate in their explanations of the functions of various systems. A technician has to superimpose his own judgment on the adjustment of some of the simulation systems."

"Important topics in the manual such as calibration procedures and setup procedures, along with a detailed theory of operations, are omitted. Not all subsystems of the trainer are covered by drawings and schematics. For example, special weapons, D to A converters, LTV plotter cabinet, and subsystems for the land mass generation are missing."

"It takes a long time for someone to become familiar with the overall configuration of the trainer and how it works. A high degree of specialization is required on the part of the individual maintenance people. When TDs are transferred from one trainer type to another, their expertise does not necessarily carry over to the new trainer to which they are assigned."

"Someone is needed in the line of communication to report the results of complaints and try to see that the proper things are put on the trainer."

"There have been instances when paper work has been submitted for a modification to the trainer and there has been no word or feedback at all on the submission. A direct line of communication with the modification and acceptance group of NTDC is needed to find out what has transpired for follow-up."

"The OFT needs a complete change in the aero system computations to assure good simulation. A quality assurance checking procedure should be set up for the trainer, run by the people who fly the aircraft. This would assure the quality of the trainer by checking systems not in use for everyday training. A check crew composed of utilizing squadrons could easily be set up and be of benefit to all. They could learn of the various trainer capabilities and (use) this information (to achieve) a higher degree of learning in the squadrons. And the maintenance people would know the status of the trainer in relation to what the users want and expect."

"The trainer provides good experience for basic skill acquisition but needs improvement in actual instrumentation. Some instruments change too fast with power or switch positioning and others are too slow. Simulation of the cockpit is good and all items are properly located."

"In general, for the purposes intended, the trainer is all right. However, if it was designed to fly, it does not do an adequate job in training to do this. If the flying characteristics could be improved, it could help training and flying the aircraft for such things as approaches, takeoffs and landings."

"Performance reports should consist of a detailed critique of the entire period and of the actions of the individuals involved with the training. Operators or maintenance personnel assigned to a trainer do not have the means of evaluating a student pilot or flight engineer because they lack the specific knowledge of flying."

"The 2F69's reputation with flight crews alternates between favorable and unfavorable to a wide degree, depending entirely on its use or misuse by the period instructor."

"The trainer is limited only by not having a comprehensive program of use that is mandatory for everyone."

"For the tactics portion, if a kill is made by the crew the operators think that it was a good flight even if all kinds of errors were made in the tactical lead-up. They are unqualified to instruct each sensor station."

It was observed that there is a good exchange of information between the FAETUPAC Detachment at Moffett Field and the squadron users of this device. It appears that the heavy utilization of the 2F69B may be the result of aggressive salesmanship on the part of the commander of the FAETUPAC Detachment. "He sells the device as a trainer, not as a simulator." In the opinion of some, this distinction is an important factor with respect to acceptance. It is speculated that military personnel are more willing to accept limitations in a training device than in a unit that is purported to be a full-fledged simulator.

Table 12 shows that there were essentially no substantial differences in acceptance of the 2F69B as a function of operational experience in the aircraft. However, the most experienced personnel tended to rate the trainer higher in communication problems, problem setup, software, and level of training.

TABLE 12. AVERAGE RATINGS OF 2F69B BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=5)	Medium (N=11)	High (N=14)
Average Rating, Simulation Factors	10.3	10.8	10.7
Average Rating, Training and Situational Factors	8.1	9.0	9.5

DEVICE 14B35: UNIVERSAL JULIE/JEZEBEL OPERATOR TRAINER. The 14B35 is a portable, solid-state ASW tactical crew trainer capable of injecting dynamic simulated sonar signals into the sensor equipment aboard P-3 aircraft. The device is intended to provide ASW crews with a means of "increasing their levels of proficiency in the detection, classification, and localization of targets." The 14B35 can be used on board an aircraft during flight, on the flight line, in the hangar, or as a "rooftop" trainer for simultaneous training with several aircraft.

The 14B35 was developed expressly "to improve fleet performance in the prosecution of JULIE and JEZEBEL contacts, to reduce the number of false contacts and false classifications." With these objectives, the military characteristics clearly reflected the need for realism and sophistication in signal simulation "above that currently provided in existing part-task training devices." Training was to be directed at the intermediate and advance levels and to encompass all activities from initial LOFAR detection through final SONOBUOY fixing.

The instructors for the device were to be "highly qualified officers and senior petty officers with a comprehensive

background in ASW tactics and detection systems." It was recommended that the instructor be either a qualified ASW pilot or tactical coordinator. All trainees were expected to have had basic instruction in the operation of their equipment.

This device, which appears excellent in concept, received next to the lowest composite criterion score of all the trainers studied (-7.6). It was rated below average on all of the elements comprising the composite criterion (see Table 4). On the simulation profile (Figure 18), it received exceptionally low ratings on display of information, sensor performance, and target reactions. It was also rated well below the judged importance level on environmental simulation (presumably the effects of environment on signal presentation), equipment performance, effects of controls, and communication problems.

With respect to training and situational factors, it received below average ratings on almost all factors (Figure 19), but particularly problem setup, completeness of performance evaluation, value of time spent with the trainer, value of the trainer versus operational equipment, and in overall comparison with similar trainers.

The lack of adequate submarine target services for ASW training is one of the most widely recognized problems confronting the fleet. It is surprising, then, to find such a lack of acceptance of a device that was specifically designed to enable aircrews to use their operational equipment in the absence of submarine services. To determine why this was so, some of the responses from the questionnaires may be revealing. The following comments were offered by instructor personnel:

> "It is a rather complex device in some areas and requires sophisticated knowledge in regards to maintenance. The transmitter section is definitely critical."

> "The device is limited in that it does not simulate DIFAR. It is understood that a modification is under development that will permit this capability."

> "The device is not used by deployed squadrons to its full potential. Some instructors are well-qualified and some aren't. Some have trouble keeping up with the problem. Operators with varying experience are employed as instructors--obviously, fleet people have better knowledge than others."

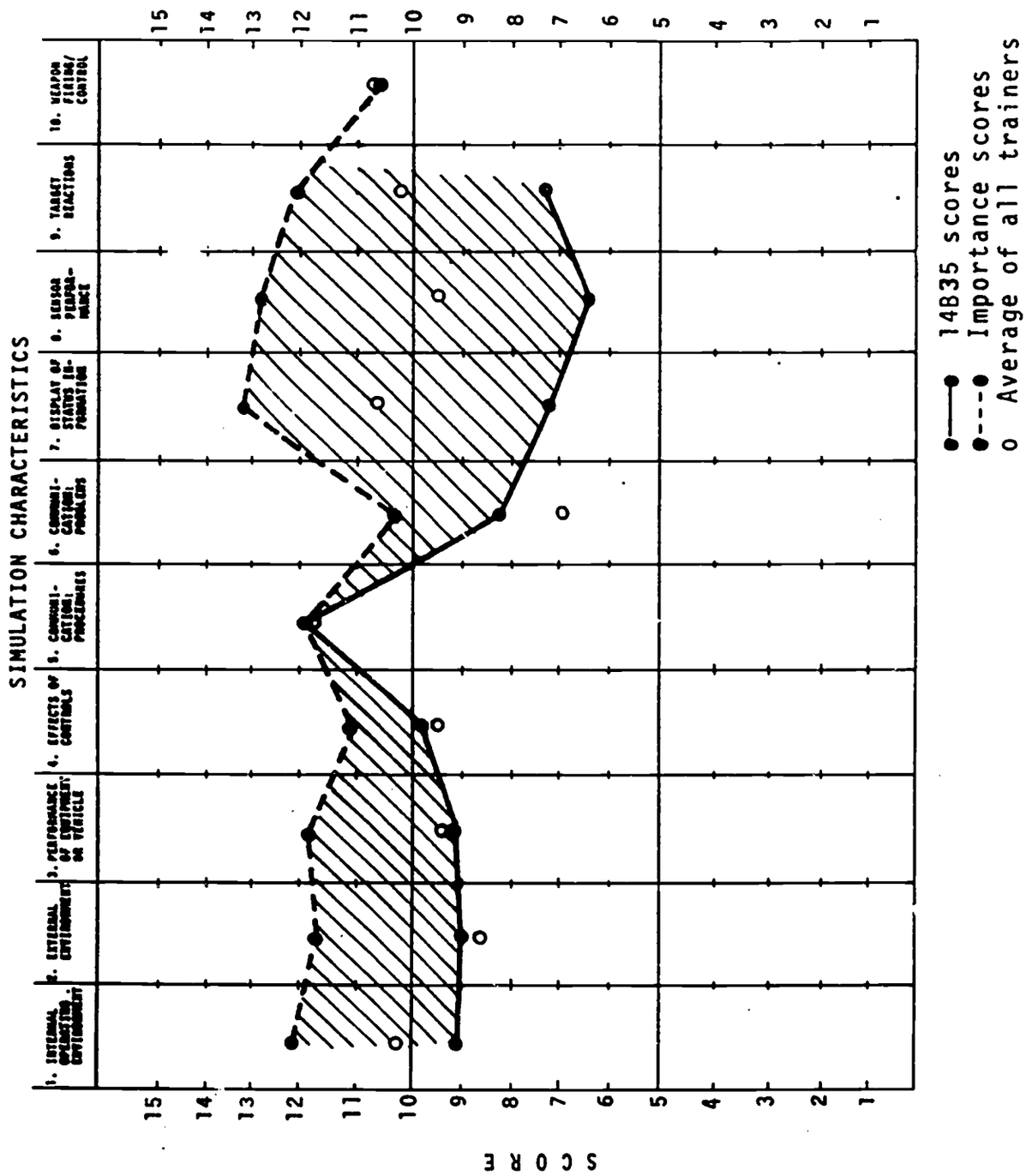

Figure 18. Profile of Simulation Scores for Device 14B35, Universal JULIE/JEZEBEL Operator Trainer, Moffett Field.

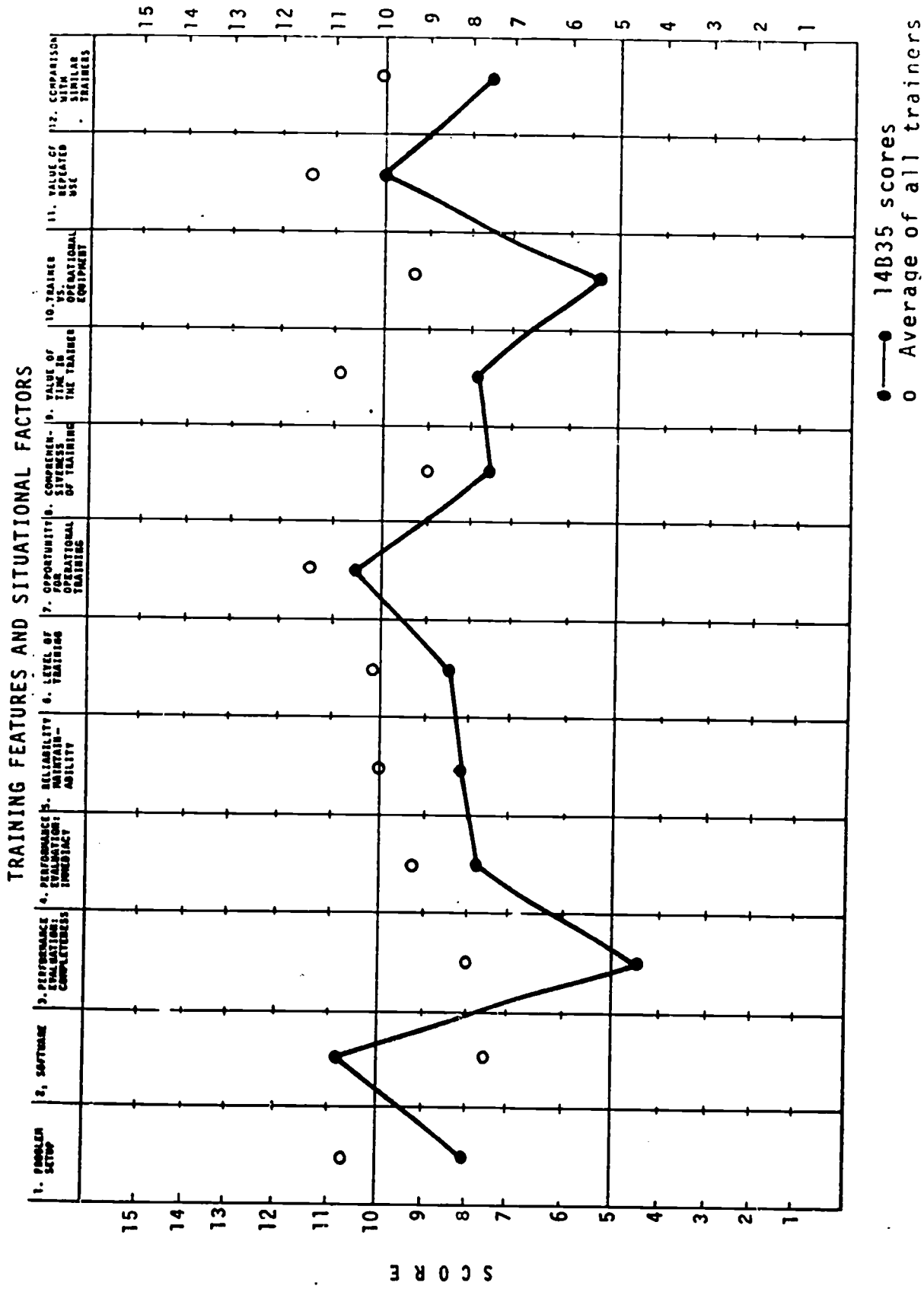

Figure 19. Profile of Training Effectiveness Scores for Device 14B35, Universal JULIE/JEZEBEL Operator Trainer, Moffett Field.

"The device is reasonably effective for basic skill training--however, two of these skills will soon be obsolete. Certainly it has no use for advance training as it is too dependent on human inputs."

"A deficiency of the trainer results from the necessity of the device operator having to insert the tactical information manually. The communication between the crew and device operator detracts from crew performance and problem flow."

"Due to the manual dependence, I can't think of any way of improving this trainer except to allow for thirty-one channel capabilities for search and one channel for localization. However, because the device is used for very basic skills, it is not critical that these improvements be made. It would probably cost the Navy more money than the effort is worth."

"The trainer is reasonable for very basic skills. The crew is at least in the air and you have aircraft movement (in contrast to) the ground trainers. I feel it worthwhile in a training environment only--I would venture to say there would be little use in an operational squadron."

"Another deficiency is restricted simulation. The device provides some unrealistic displays but these aren't serious enough to detract from the use of the device for basic skills. Remember we are talking basic skills and we are teaching more equipment manipulation than pure tactics."

"The device is limited in the number of modes in which it can be operated simultaneously. Some tactics require that we operate in two modes at the same time."

"The trainer has a poor reputation because everyone seems to think it should be just like the real thing. They can't seem to accept the fact that it is a simulator instead of a duplicator."

"New operators (acting as instructors) experience notable lag periods in making the proper inserts to the trainer when working with more experienced proficient trainees."

"Some skills cannot be trained because oceanographic phenomena cannot be introduced."

"Practical JEZ analysis cannot be adequately trained because of no ocean hindrances or simulation of such."

"The instructions necessary for operations are often garbled by the inexperienced student (90% of our student load), thus hindering proper use of the device. The instructions required are artificial and distract from good real-world oriented training."

The following comments were offered by students:

"Equipment malfunctions have limited the device in training hours accomplished. Lack of knowledge by equipment operators also limits its use. Bulkiness and weight do not make it conducive to frequent use. On the squadron level it is scheduled very infrequently on the flight schedule. (Nine times out of ten this is due to a lack of a trained 14B35 operator.)"

"We never know whether or not it is going to malfunction. If it does malfunction, and it does frequently, it always happens in the middle of an ASW problem. No one really feels confident that the trainer will hold up for the entire problem."

"We have had (trainer) operators who didn't even know how to hook up the 14B35 and were actually asking the crew members 'what went where?'" (However, this same respondent felt that it could be a good and valuable training aid if used correctly.)

"There seems to be a disparity between what the equipment was designed to do and what it has actually accomplished."

"There are deficiencies (who knows how to fix one at the squadron level?). If the operator doesn't know what is going on, what good is the trainer? and bulkiness and weight--when you have to lug this thing out to the aircraft you think twice before you do it."

"The operators do not have enough knowledge of tactics to fully operate the trainer to the best of its capabilities."

"By the time the squadron was proficient with the use of the trainer, we had new equipment on board the aircraft that would not accept the trainer outputs."

"The JEZ write-outs are deficient in that there are no accurate dynamic changes, very few target operating modes, and no aural characteristics."

"The trainer is very good if used to perfect crew coordination. But it does not give the different crew members good training in their area of operation."

"The trainer has a reputation for unreliability due to damage that occurs while moving the trainer from aircraft to aircraft or back to stowage space."

"The basic concept of the trainer is right--it just doesn't work all of the time."

"The trainer operator is required to manipulate the trainer so fast on occasions that mistakes are made by the operator with low experience levels. I think that if some of the controls could be operated automatically by the training device a more realistic problem could be experienced by the trainees. Computerized inputs would be highly desirable."

"The real world has more variables than this trainer simulates. Water conditions are quite erratic as are submarine source levels."

"The school for the instructors is too short. I've been there. Too much fix it, not enough operate it."

The following comments were offered by maintenance personnel:

"Not all computer logic symbols are explained in the maintenance manual. Not all equipment needed for troubleshooting is available. The parts list is incomplete and vague in the description of

component parts. Many times parts are not available when needed. Maintenance procedures in the maintenance handbook are not always correct or clear in description."

"Most of the troublesome problems have been rectified. However the transmitter unit requires frequent alignment and the PDC switch on the 1A1 console requires frequent replacement."

"Due to the purpose or function of this device, a thorough knowledge of ASW tactics and procedures is required (by maintenance personnel). Most TDs get *no* ASW training of any kind in "A" or "B" schools."

"I would say that it is easy to maintain and a very reliable trainer. Also I would say that the East Coast FAETUs have had a very poor 14B35 program and that the West Coast could give them valuable assistance in setting up a good workable program."

"East Coast personnel have an unfavorable view of the trainer because they were given the 14B35 devices cold. They received the device (I know for I was there at the time) and the manuals and were expected to operate it without a school. They therefore do not know how to use the device with the proficiency that is required to make the 14B35 an effective trainer."

In summary, the 14B35 appears to be a device that was excellent in concept but deficient in design for its intended purpose. The design objectives have been frustrated both by basic deficiencies in simulation and by an apparent failure by the users to recognize the investment required in training personnel for the proper operation of a device of this kind. The fallacy that every operator is an expert instructor was never more clear. Not only is the device *not* accepted for its intended purpose of advanced training in detection and classification, it has perhaps suffered a worse fate by becoming thought of as a "basic skill" trainer.

It is also clear (Table 13) that those personnel with the greatest amount of operational experience are the most critical of the trainer. They rated it much lower than inexperienced personnel with respect to displays, level of training, the training opportunities it provided, and value of time spent using the trainer.

TABLE 13. AVERAGE RATINGS OF THE 14B35 BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=4)	Medium (N=9)	High (N=5)
Average Rating, Simulation Factors	8.2	9.3	6.2
Average Rating, Training and Situational Factors	8.5	8.1	6.7

DEVICE 2H87: CARRIER LANDING TRAINER. The 2H87 is an aircraft carrier approach and landing trainer. The objective of its development was to provide a device which could be used to train and develop jet pilots in the skills and procedures necessary to make safe carrier landings. The trainer was to provide training in (1) cockpit procedures related to the approach and landing situations; (2) instrument flight procedures in the carrier vicinity; and (3) procedures required for the pilot to successfully land aboard a carrier under all visual conditions, day or night (from CAVU to minimum visual conditions).

It was anticipated that the device would be used in the basic training command by students prior to their carrier qualifications phase or by qualified carrier pilots to maintain proficiency when shore based.

The visual presentation was to be such that it would "realistically respond to the simulated aircraft movements and appear as a carrier would to the pilot whenever it was within viewing conditions." Geometric distortion and jitter in the display were to be minimized to the extent that they would not influence trainee acceptability of the device.

Sufficient resolution was required in the display so that the Fresnel simulation would provide usable glide slope information to the trainee within one and one-half miles from the stern of the carrier under VFR conditions.

The device was to conform to the T-2B aircraft configuration except that the full range of T-2B simulated performance

in flying qualities was not a simulation requirement. However, simulation was to "realistically duplicate the aircraft's flight control system in the landing configuration, including control displacement, forces, feel and aircraft frequency response characteristics." Simulated instrument responses were also to duplicate those of the aircraft when in this configuration.

Of all the trainers included in this study, the 2H87 carrier landing trainer enjoyed the least acceptance. In fact, it was not possible to get meaningful evaluations from student personnel because, at the time of the study, the trainer was being used only as a means of visually presenting the simulated scene during a catapult shot and landing as the trainees sat passively in the cockpit. They were permitted no active control of the training device at all. No trainees who had experienced the trainer used in this fashion were available to us at the time of the investigation. However it was possible to obtain ratings and interviews with highly qualified administrative, instructor, and maintenance personnel. The composite criterion score assigned by these personnel was -10.1. The results of their ratings are shown in Figures 20 and 21.

With respect to simulation factors, it is evident that the trainer was rated extremely low on virtually every factor: internal operating environment, external environment, vehicle performance, controls, displays, and sensors.

The trainer was also rated well below average in most training effectiveness factors but particularly problem setup, software, comprehensiveness of training, the value of the trainer in relation to operational equipment, and in the value of repeated use of the trainer. Because of the way the trainer was being used, no meaningful scores were obtained on trainer reliability or on comparison with similar trainers. In the former case, only one respondent provided any ratings and it was felt that, in its present mode of use, valid evidence of reliability was lacking. In the latter case, there were really no similar trainers with which the 2H87 could be compared.

It was evident that in the opinion of the users the trainer has major deficiencies both as a flight trainer and with respect to the visual presentation of the simulated environment. In an effort to understand the nature of these felt deficiencies, the following comments from instructor and administrative personnel are presented.

"The concept of this device was excellent but it exceeded the state-of-the-art at the time of

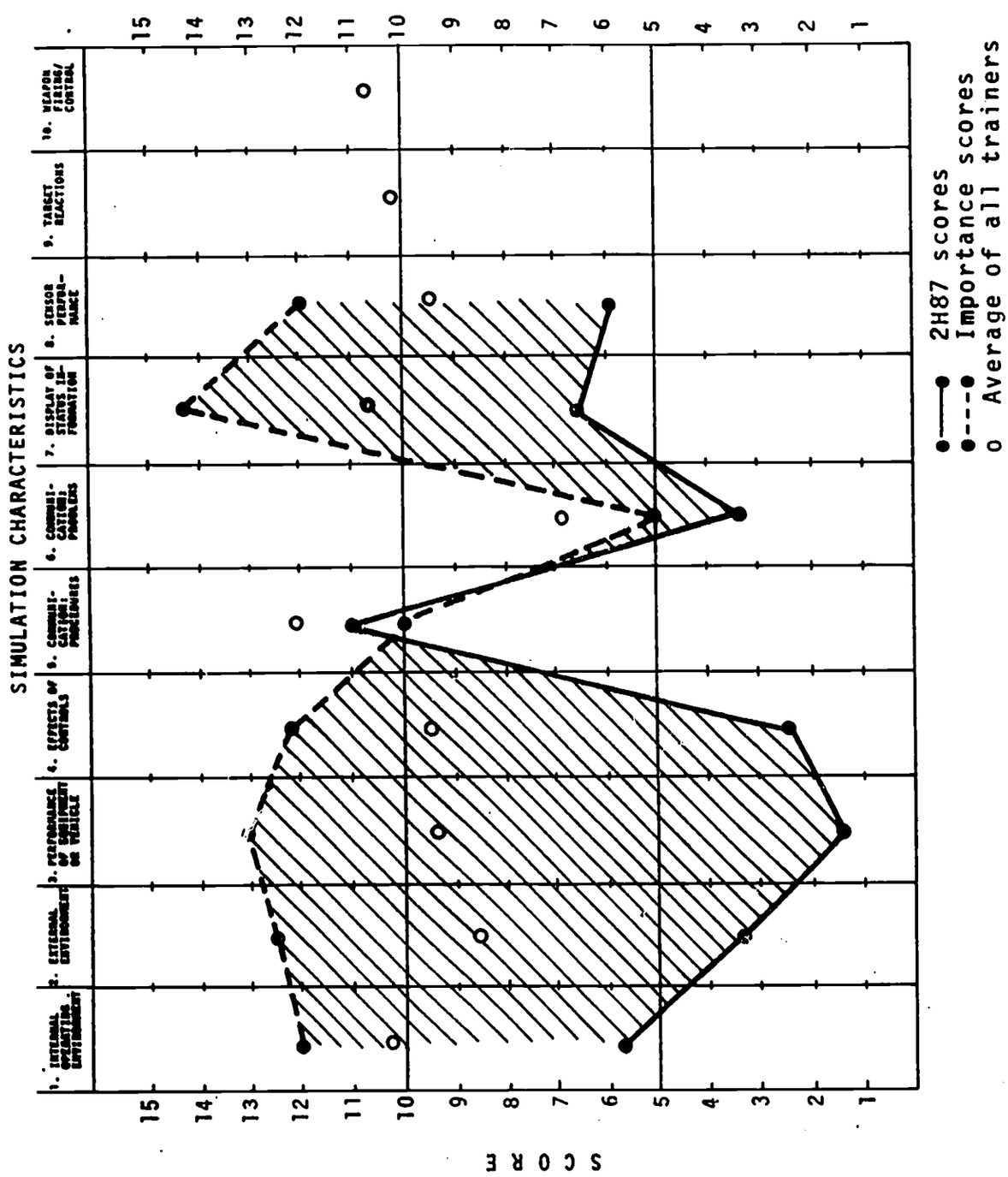

Figure 20. Profile of Simulation Scores for Device 2H87, Carrier Landing Trainer, Pensacola.

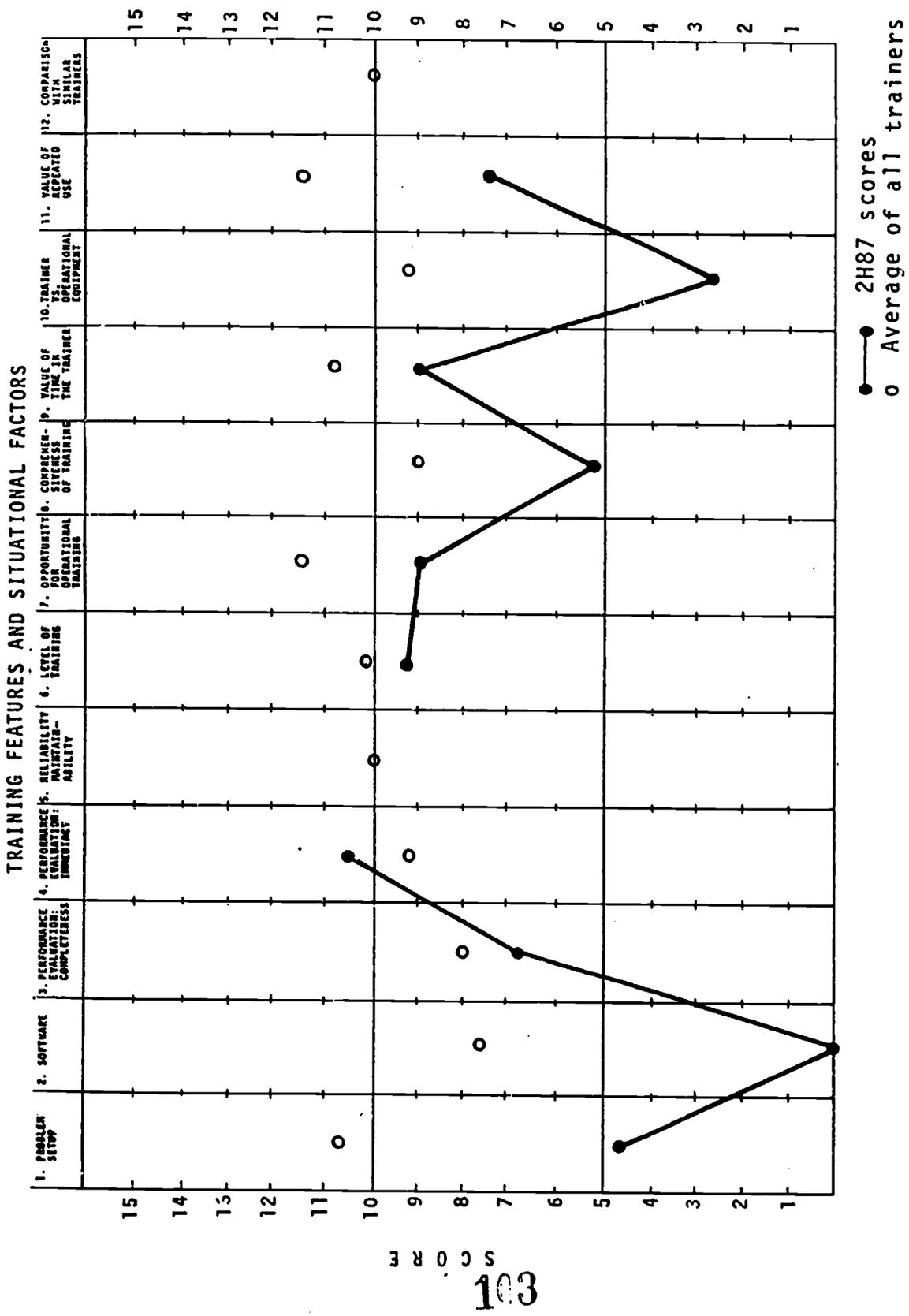

Figure 21. Profile of Training Effectiveness Scores for Device 2H87, Carrier Landing Trainer, Pensacola.

procurement. Rapid turnover of project officers, infinite and ambiguous specifications, improper progress evaluations, misconception of the purpose of the device, and political sparring created chaotic results."

"Device acceptance to this day is shrouded with misunderstanding. The result was that an unsuitable device was procured at an exorbitant cost, and it could not be used for student training. It lay idle for a year. After a suggestion that the device be either utilized or turned over as excess, the present concept of use was developed. It is felt however that the device will soon be lost since it is a poor substitute for its original concept."

"The trainee cannot manually control this trainer due to differences between performance of the trainer and the aircraft. It doesn't fly like the aircraft."

"Instructors cannot handle the trainer. It would do more damage than good to the student in its present state. The instructors are not qualified because they are trainer operators not trainer aviators. Qualified LSO's should serve as instructors or at least oversee the flight."

"Everyone who has flown the trainer has an unfavorable opinion of it. It is too difficult to control, and the presentation is not good enough."

"At present the trainer is of limited use for students because of its poor response or feel. The only value for students is to show them limited approaches and catapult shots. The LSO instructors feel the trainer would give the student a feeling of insecurity if they did poorly in flying the trainer. This would (have) an undesirable effect on their level of confidence when it is time to go to the ship."

"Instructors are not well qualified to evaluate student performance in the trainer because they are not LSOs. Therefore they can only evaluate the computer readout which is not the same as the LSOs' analysis of each approach."

"Student personnel who have flown the 2H87 feel that the inputs generated by the student are

overcontrolled by the computer inputs, thereby giving a false and unrealistic picture of an actual carrier approach. They also feel that visual resolution is very poor."

"I would like, for once, to see the Navy utilize the opinions of the user and not rely so heavily on engineers and computer specialists who have never seen a carrier approach and landing in developing a trainer such as this one. If it would have been properly engineered, this trainer could have been a tremendous aid in training students."

"As far back as 1967, VT4 sent pilots to the contractor's plants to help the engineers work out the problem areas. My pilots reported to me when they returned from seeing the mock-up that such information as glide slope and so on were all wrong. This problem was a consequence of not having an LSO, who knew what these parameters should be, serving as a project manager. It was no fault of the contractor; they were only going on what specifications were given to them by NTDC."

"A new high resolution camera that is now available through advancement of the state-of-the-art would increase the use of the trainer 99%. Reprogramming the trainer to fly in accordance with the aircraft is a relatively simple matter I am told. The trainer would be extremely valuable to this command if it worked as advertised."

In summary, the whole history of this device is one of confusion and concern. NTDC developed the specifications for a prototype device with the apparent objective of making it versatile enough to evaluate a variety of visual systems that might be utilized. In fact, it was built with a rather inflexible visual system that is more complex than necessary. In many respects the engineering of the trainer seemed to be very good and the concept certainly was without fault. However, the failure to adequately simulate the performance of the T2 aircraft seems to have been an overwhelming influence that precluded trainer acceptance for any purpose.

Nevertheless, an interesting feeling exists concerning the value of the 2H87. With all its admitted faults, some people feel that the programmed visual catapult shots have

a positive training value. "Students can at least be given a presentation of how rapidly things change during catapult takeoffs." This feeling is related to an incident on a carrier where a student pilot was involved in a bridle breaking during run-up. When the bridle parted, he thought the catapult had been fired and let the airplane roll. Subsequently he went over the side and was killed. Everyone associated with the trainer relates this story as an example of how effective the trainer could be in at least acquainting the student with the visual changes associated with catapult operations.

Because of the nature and small number of qualified respondents, the relationship between operational experience and trainer acceptance cannot be described with confidence. It is doubtful whether any significant relationship could be shown in the absence of student pilot opinion. However, the data are shown in Table 14 in the interest of completeness. Experienced personnel tended to be particularly critical of the environmental simulation, vehicle performance, and control effects.

TABLE 14. AVERAGE RATINGS OF THE 2H87 BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=2)	Medium (N=1)	High (N=5)
Average Rating, Simulation Factors	5.6	6.6	5.1
Average Rating, Training and Situational Factors	4.5	10.2	8.4

PROFILES OF THE REMAINING TRAINERS

The remaining trainers in the sample were assigned mid-range values on the composite criterion of acceptance, representing neither outstanding examples of acceptance nor rejection. They did differ substantially in acceptance with respect to particular factors, however. Their profiles will be presented in the sections that follow roughly in the order of the level of acceptance.

DEVICE 14B40: RADAR/MAD OPERATOR TRAINER. The 14B40 was designed to train sensor operators in the problems and procedures associated with non-acoustic ASW equipments, specifically radar and MAD equipment. It is a well accepted

trainer with a composite criterion score of +3.3. As indicated by Figure 22, this trainer received quite high average ratings on the simulation factors; it was rated above average in display of information, equipment performance, control effects, sensor performance, and target reactions. However, the ratings on these factors were somewhat below the judged importance level.

With respect to training and situational factors, the 14B40 generally rated about the average of all trainers (Figure 23). However, it was rated very high in problem setup and above average in training effectiveness in comparison to operational equipment and to other similar trainers.

In general, the instructors felt that the 14B40 is a very effective training device with a few minor improvements needed such as "more realistic weather effects and radar range cutoff points due to altitude." The first class of students trained with the 14B40 (it is a new trainer) "impressed the squadron people with the amount of information they carried back with them."

There was some early concern on the part of maintenance people about the reliability of the trainer that may be reflected in the below average rating on reliability. These fears have failed to materialize according to the personnel interviewed. Part of the problem was that a large number of changes to the trainer have kept maintenance personnel uncertain concerning whether schematics, manuals, and other technical information are up-to-date. Availability of parts has been a problem, especially replacement parts for GFE items. There reportedly have been major problems with the tactical situation display.

> "The factory school for this trainer was structured for computer programming with no real help being given for practical maintenance of the systems. Preliminary manuals are still in use, having not been replaced by the final manuals by the contractor."

There was a hint of slightly greater acceptance of the 14B40 among personnel who had had considerable operational experience with radar and MAD systems (see Table 15). Experienced personnel rated the trainer noticeably higher on simulation of sensor performance than neophyte personnel but rated it lower on reliability and level of training.

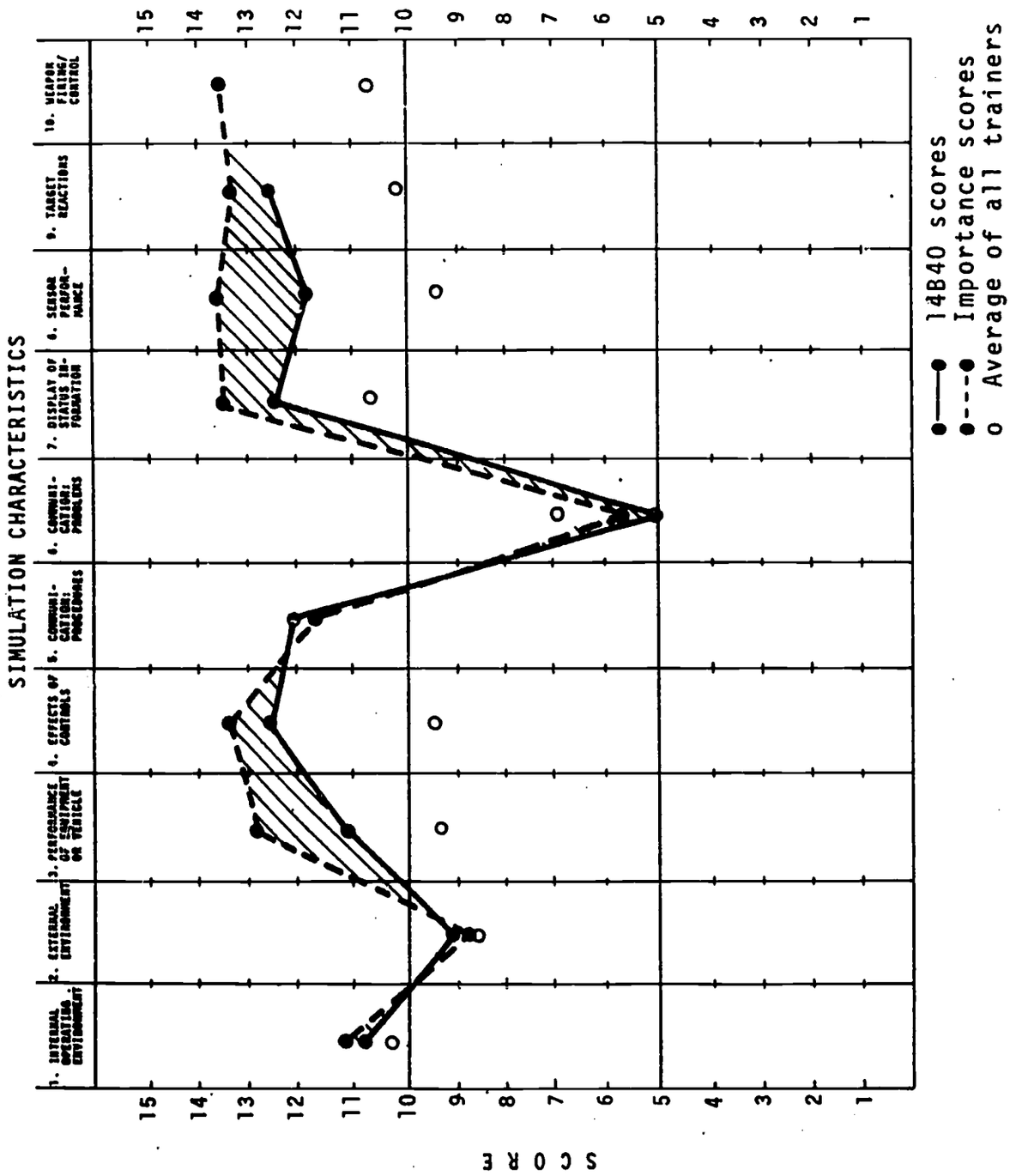

Figure 22. Profile of Simulation Scores for Device 14B40, RADAR/MAD Operator Trainer, Pax River.

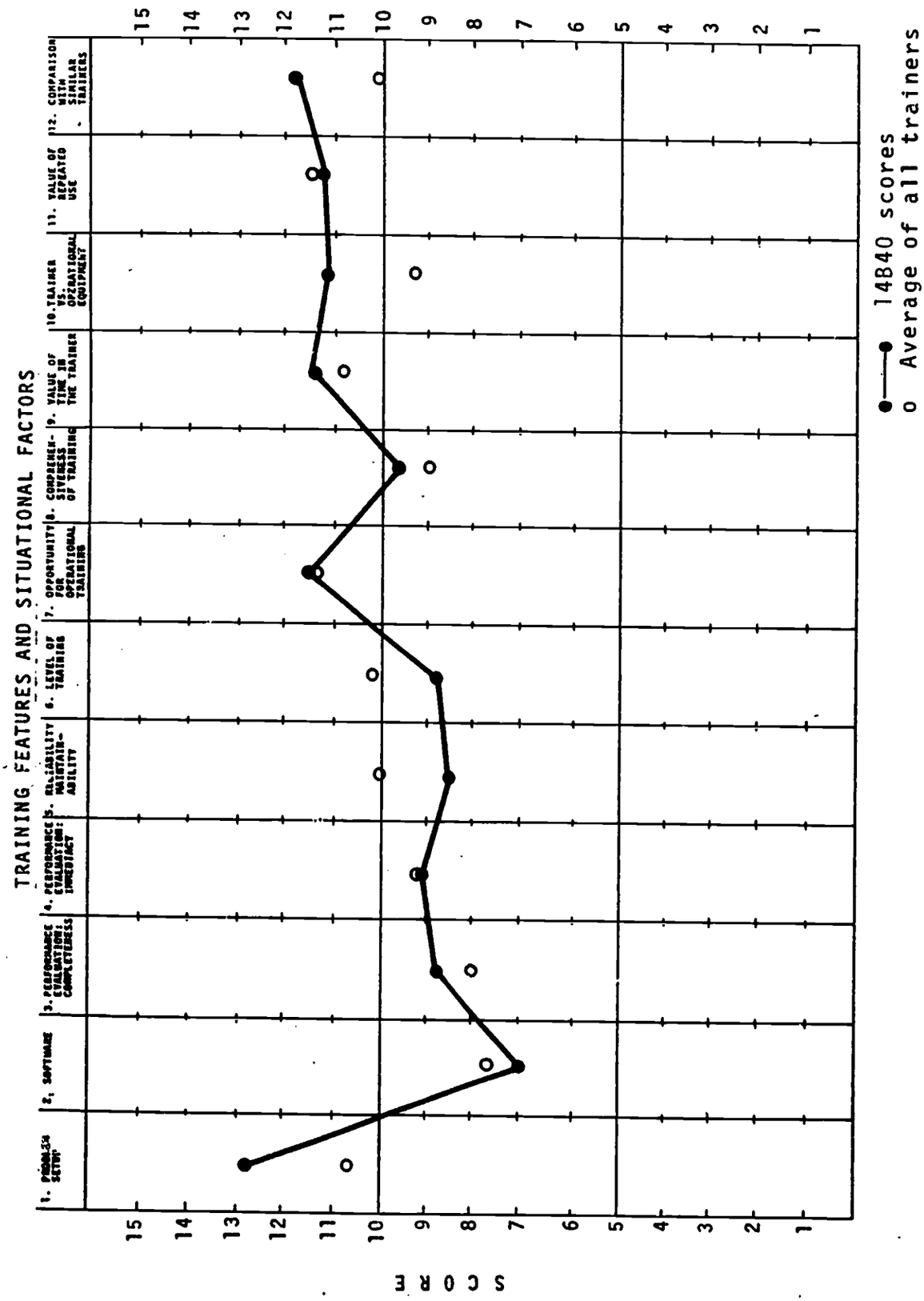

Figure 23. Profile of Training Effectiveness Scores for Device 14B40, RADAR/MAD Operator Trainer, Pax River.

TABLE 15. AVERAGE RATINGS OF THE 14B40 BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=5)	Medium (N=6)	High (N=6)
Average Rating, Simulation Factors	9.5	11.7	11.3
Average Rating, Training and Situational Factors	10.9	9.6	11.1

DEVICE 2F64A: SH3D HELICOPTER CREW TRAINER. The 2F64A is a weapon systems trainer used to train SH3D helicopter crews in ICS procedures, dipping procedures, crew coordination, knobology, and practice in tracking. It received a somewhat above average composite criterion score of +2.0.

The 2F64A profile on simulation factors is shown in Figure 24. It is apparent that the trainer approximated the the average of all trainers as a group on most factors although it was rated somewhat above average in display simulation, sensor performance, and target reactions. However, it failed to reach the judged level of importance in these areas and also shows an "importance differential" on simulation of vehicle performance and control effects.

With respect to training effectiveness (Figure 25), the trainer was also rated about average although it received a superior rating on immediacy of performance evaluation and somewhat above average scores on value of trainer time and comparison with similar trainers.

During the interviews complaints were recorded concerning the realism of the sonar displays and limited simulation of the effects of water conditions and their influence on target classification. The trainer was criticized for having no capability for raising or lowering the dome, and poor ICS communications.

A small percentage of pilots have an unfavorable opinion of the device because they feel it does not fly like a helicopter. Administrative and instructor personnel reportedly try to combat this viewpoint by pointing out that the trainer

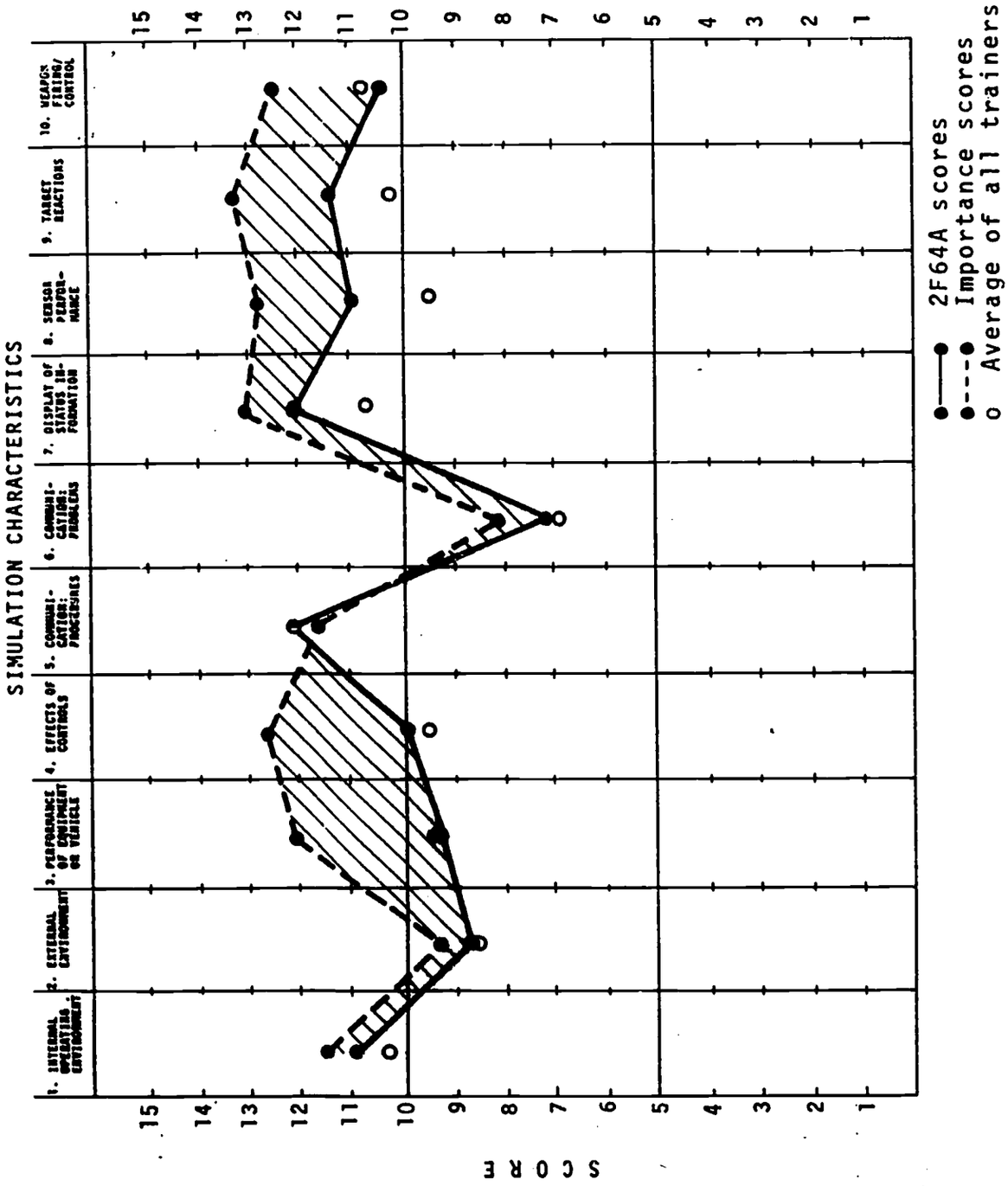

Figure 24. Profile of Simulation Scores for Device 2F64A, SH3D Helicopter Crew Trainer, Quonset Point.

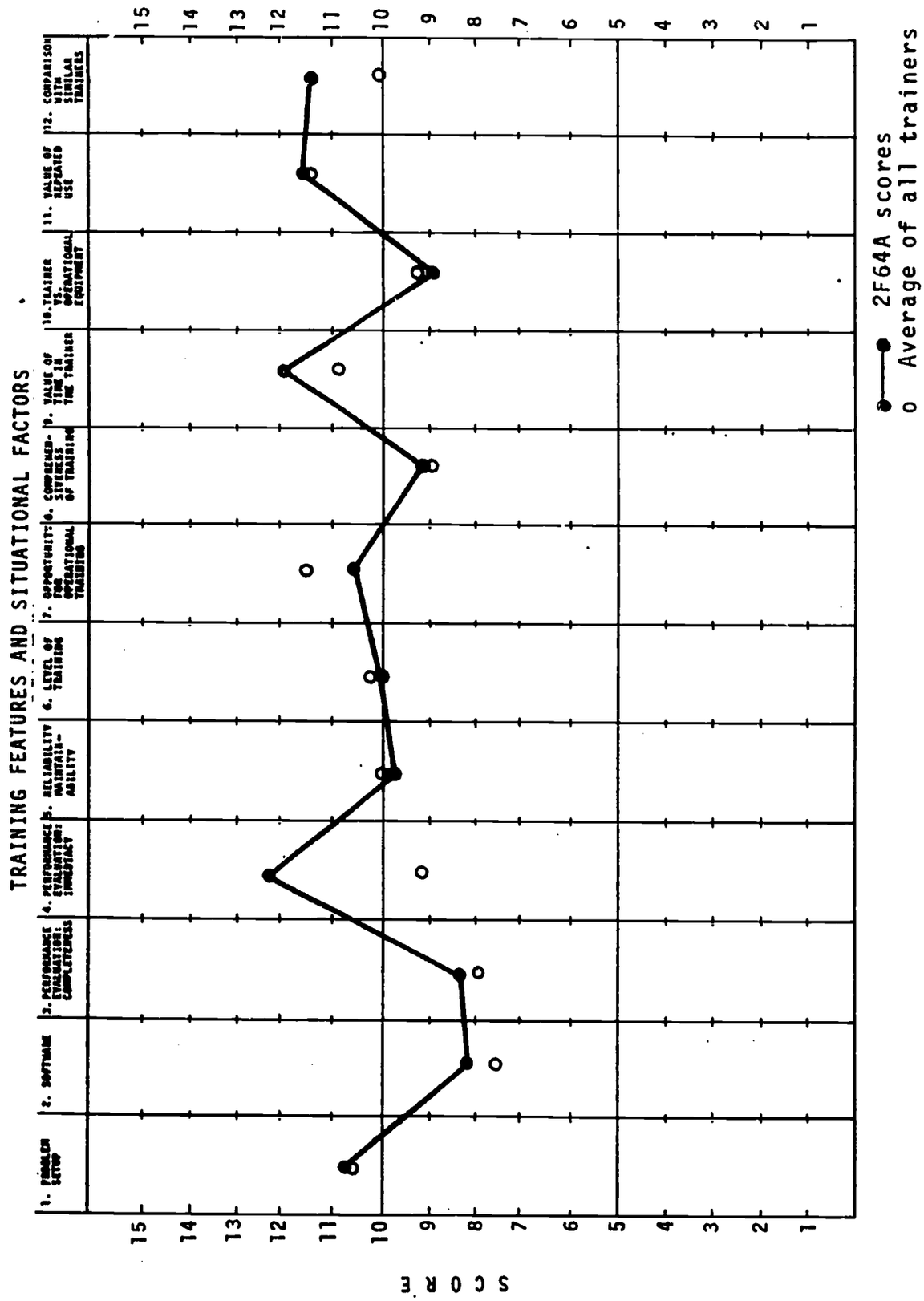

Figure 25. Profile of Training Effectiveness Scores for Device 2F64A, SH3D Helicopter Crew Trainer, Quonset Point.

is primarily for procedures training. The slow pace of updating the trainer to match the performance characteristics and other features of the actual aircraft have created some negative opinions.

> "Pilot trainees feel that the instructors are familiar with trainee reactions and the average ability of students but they are not able to judge the ability of pilots accurately since they are not pilots themselves. Pilots feel that the trainer is excellent for system NATOPS familiarization and cockpit organization and understanding. However they do *not* like to be evaluated by enlisted personnel."

> "The flight characteristics leave a lot to be desired. There is too much instrument lag in a few instruments. For instance, the remote magnetic indicator and the vertical gyro indicator. There is no rudder stick balance with the needle ball display. Gyro movement is not realistic. The trainer will not simulate hovering."

The sonar equipment is reportedly a persistent maintenance problem.

> "Due to limited use in the past, the system has not been kept up to snuff. Now that utilization has increased, increased maintenance is required. Documentation is poor and we must proceed by trial and error."

> "The GFE sonar equipment presents maintenance problems. Signal input levels are so low that infinitesimal change will foul the whole display."

> "The reputation of the trainer has improved considerably since its introduction (at Quonset Point). The primary fault of a digital computer system is that a down computer means a down trainer. Maintenance people did not know enough about the digital equipment when the trainer was new and sometimes a Chinese fire drill would ensue if a computer quit. The trouble in some instances was external to the computer. The reputation that the trainer has had for being bad (unreliable) is not necessarily a valid one."

As indicated in Table 16, there were no apparent differences in overall acceptance of the 2F64A as a function of

user experience in the SH3D. However, experienced personnel rated it significantly lower on training software and completeness of performance evaluation.

TABLE 16. AVERAGE RATINGS OF THE 2F64A BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=11)	Medium (N=7)	High (N=8)
Average Rating, Simulation Factors	10.7	9.7	10.1
Average Rating, Training and Situational Factors	10.9	10.0	9.5

DEVICE 2F66A--A COMPARISON OF TWO INSTALLATIONS OF THE SAME TRAINER. The 2F66A was developed to provide pilot and crew training for the S2E ASW aircraft. Specific emphasis was placed on pilot emergency and instrument flight procedures and on the tactical interaction between all members of the crew. Installations at both San Diego (North Island) and Quonset Point were studied for possible differential acceptance of the OFT portion. Ratings were obtained on the entire trainer at San Diego but only the OFT portion at Quonset Point.

As indicated in Table 4, neither trainer departed markedly from the overall average with respect to the composite criterion of acceptance. However, the San Diego trainer, with a score of +1.1, was rated about three units higher than the Quonset Point trainer with a score of -2.2. This was due in part to the higher utilization at San Diego but also to the fact that a greater proportion of the raters at Quonset Point were pilots. It was evident that the pilots at both locations rated the 2F66A lower than did the tactical crew members because of what they felt were serious deficiencies in its flying characteristics.

A comparison of Figures 26 and 27 indicates that the Quonset trainer was rated particularly low on vehicle performance and effects of controls. A check of the data showed that San Diego pilots rated that trainer as similarly

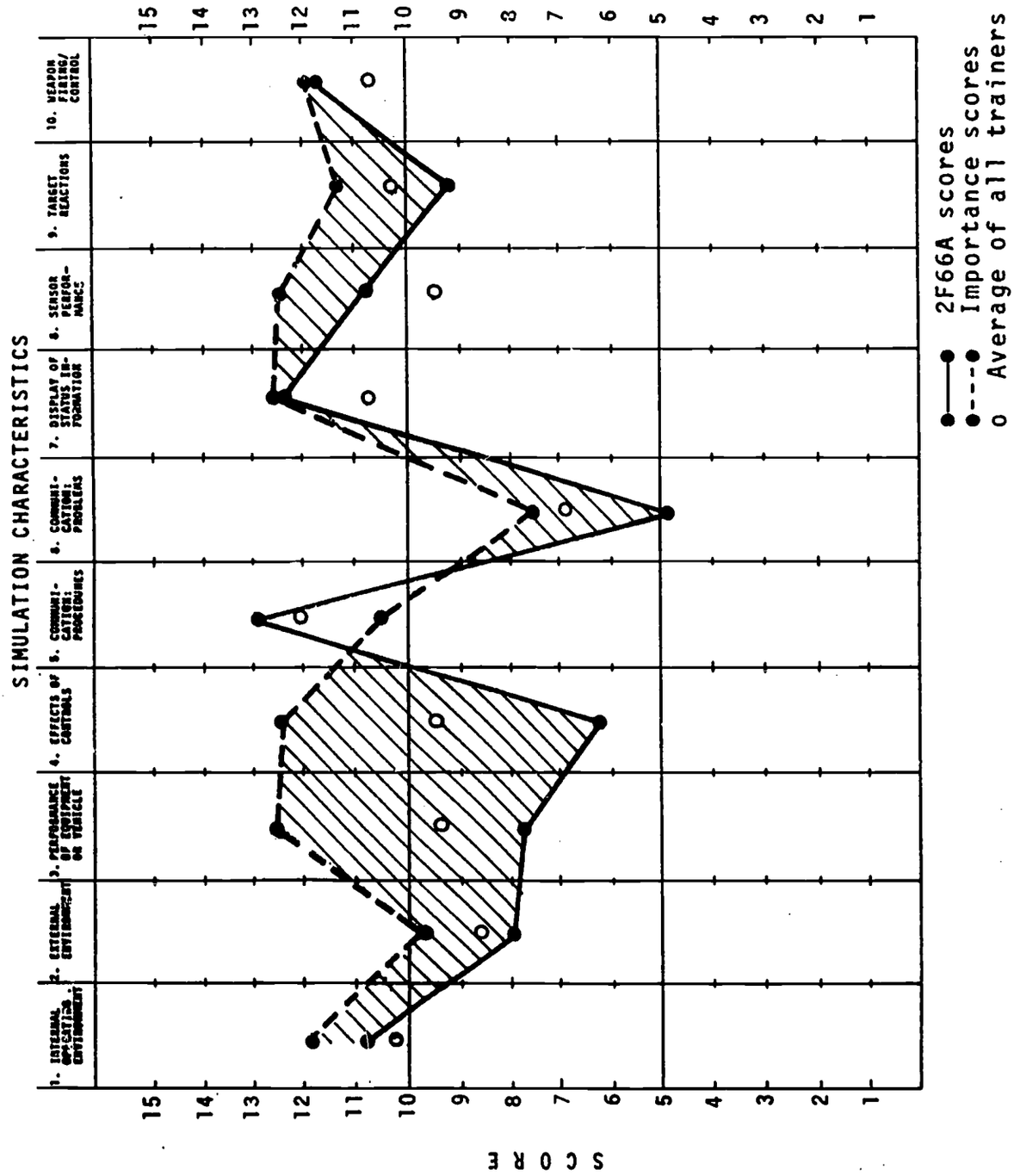

Figure 26. Profile of Simulation Scores for Device 2F66A, S2E Weapons System Trainer, Quonset Point.

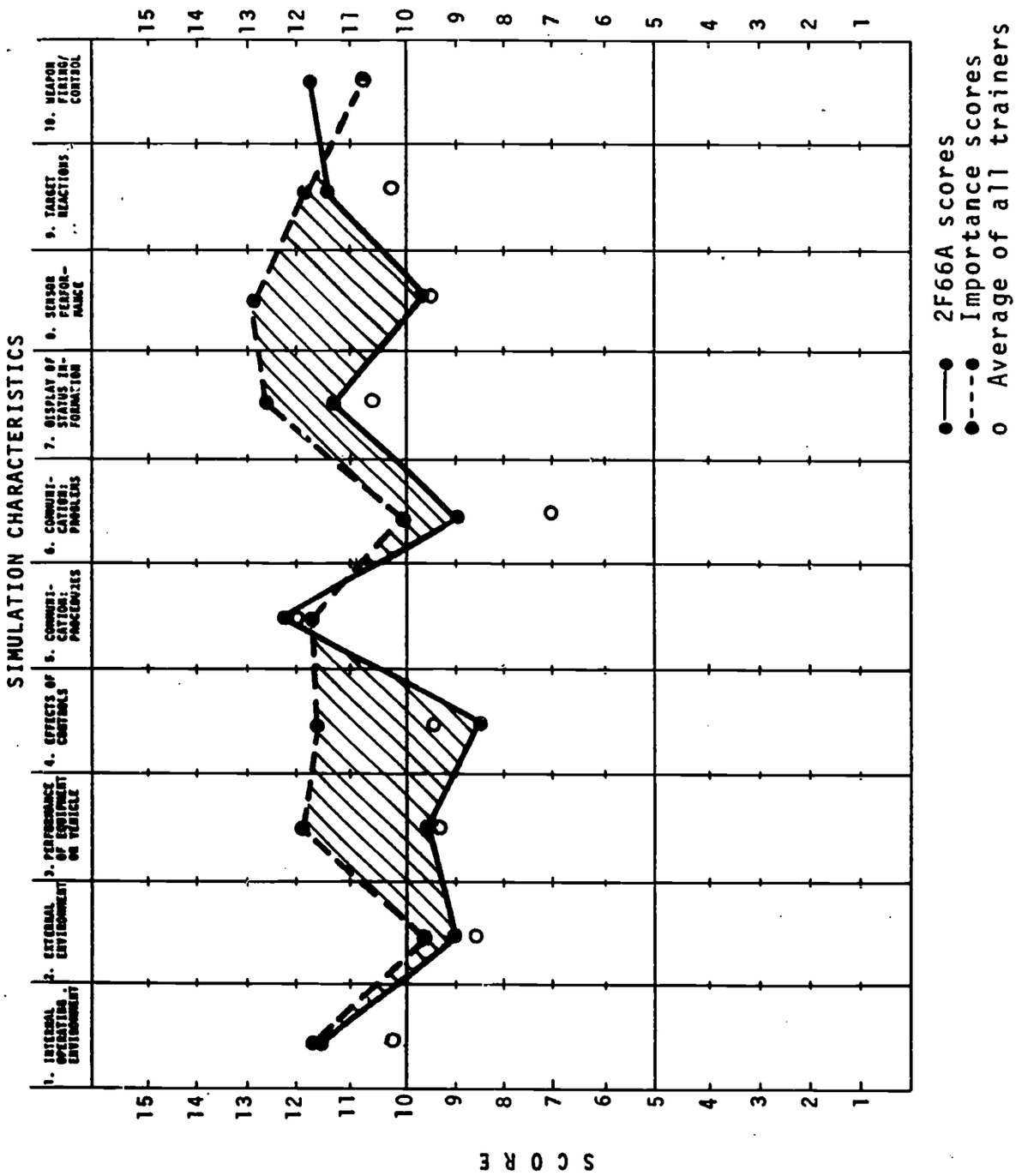

Figure 27. Profile of Simulation Scores for Device 2F66A, S2E Weapons System Trainer, San Diego.

deficient in those areas. However the higher ratings given the San Diego trainer by tactics personnel obscured the similarities. This suggests that in future studies the opinions of pilot and tactical personnel should be treated separately in analyzing the data. Unfortunately, in the present study, it was not possible to include enough personnel in each category to get reliable results for different sections of the trainer.

The other differences in the simulation profiles of the two trainers can similarly be explained. The San Diego trainer was rated somewhat lower on information displays and sensor performance. This probably reflects a more critical evaluation of those characteristics of the trainer by tactical personnel.

The profiles of the two trainers on training effectiveness factors are very similar (Figures 28 and 29). Both received average ratings in most respects although both were rated down significantly in the area of software. The reason for the unusually high rating of the Quonset trainer on level of training is not known. It may again reflect the inadequate sampling of tactical personnel at the Quonset installation.

Some typical comments concerning the 2F66A at Quonset Point follow.

> "The trainer affords good ASW tactics practice, emergency procedures practice, and practice in engine management during unusual circumstances."

> "Some instructors are not instructors at all. They merely turn on the machine and push buttons when requested to do so. It would be beneficial if they were qualified to instruct. They know nothing about ASW, flying, etc."

> "Learning to fly the trainer creates some possible negative training because of the difference in the flying techniques that must be used in mastering the trainer as opposed to those used for mastering an aircraft. Having to concentrate on the handling ability of the trainer detracts from the purpose of training."

> "I believe this trainer is the best way to train a VS crew. All aspects of the VS mission can be accomplished in the trainer short of an actual cat shot and arrested landing, excluding searchlight and camera pod hops. If you do all that is expected

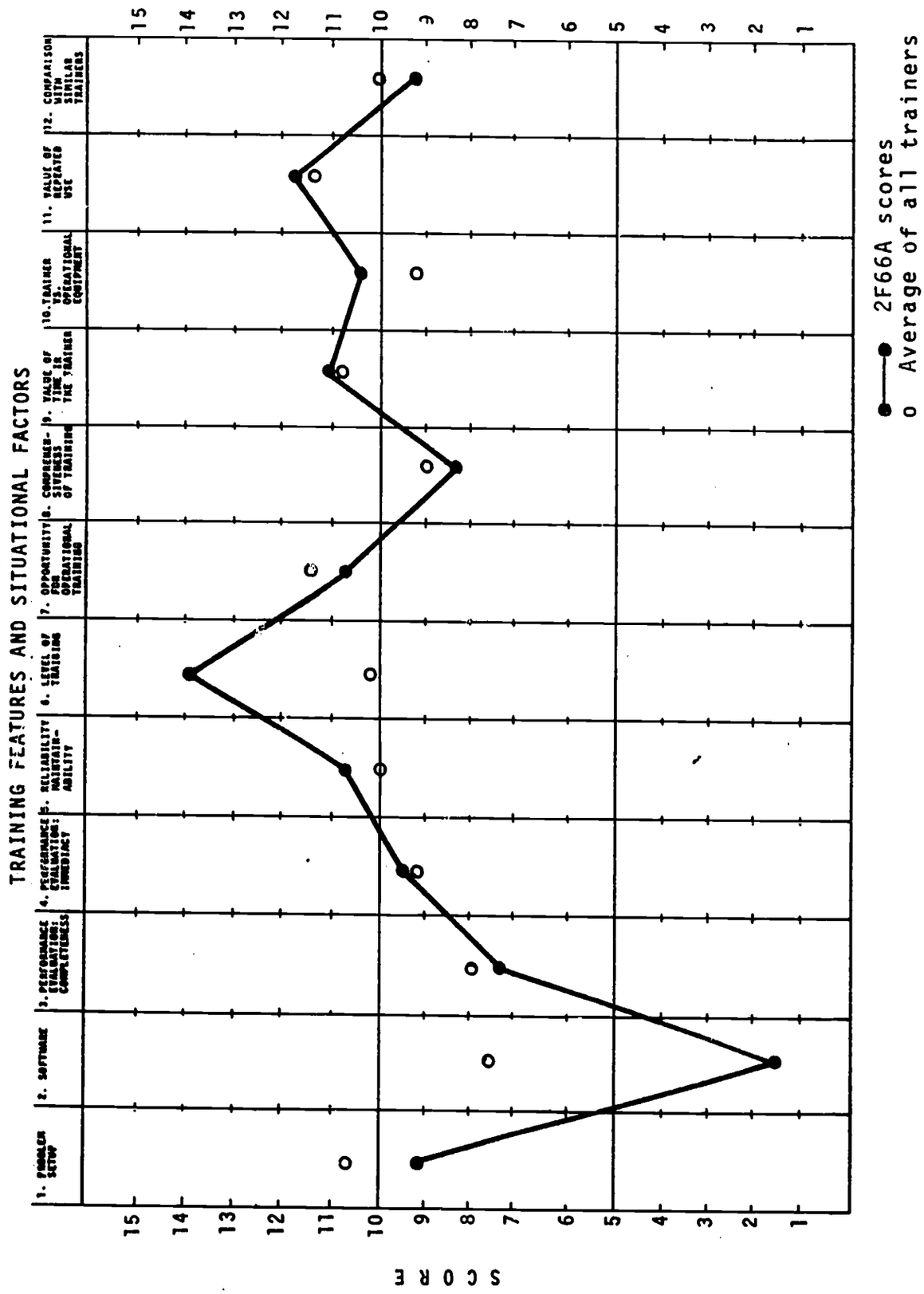

Figure 28. Profile of Training Effectiveness Scores for Device 2F66A, S2E Weapons System Trainer, Quonset Point.

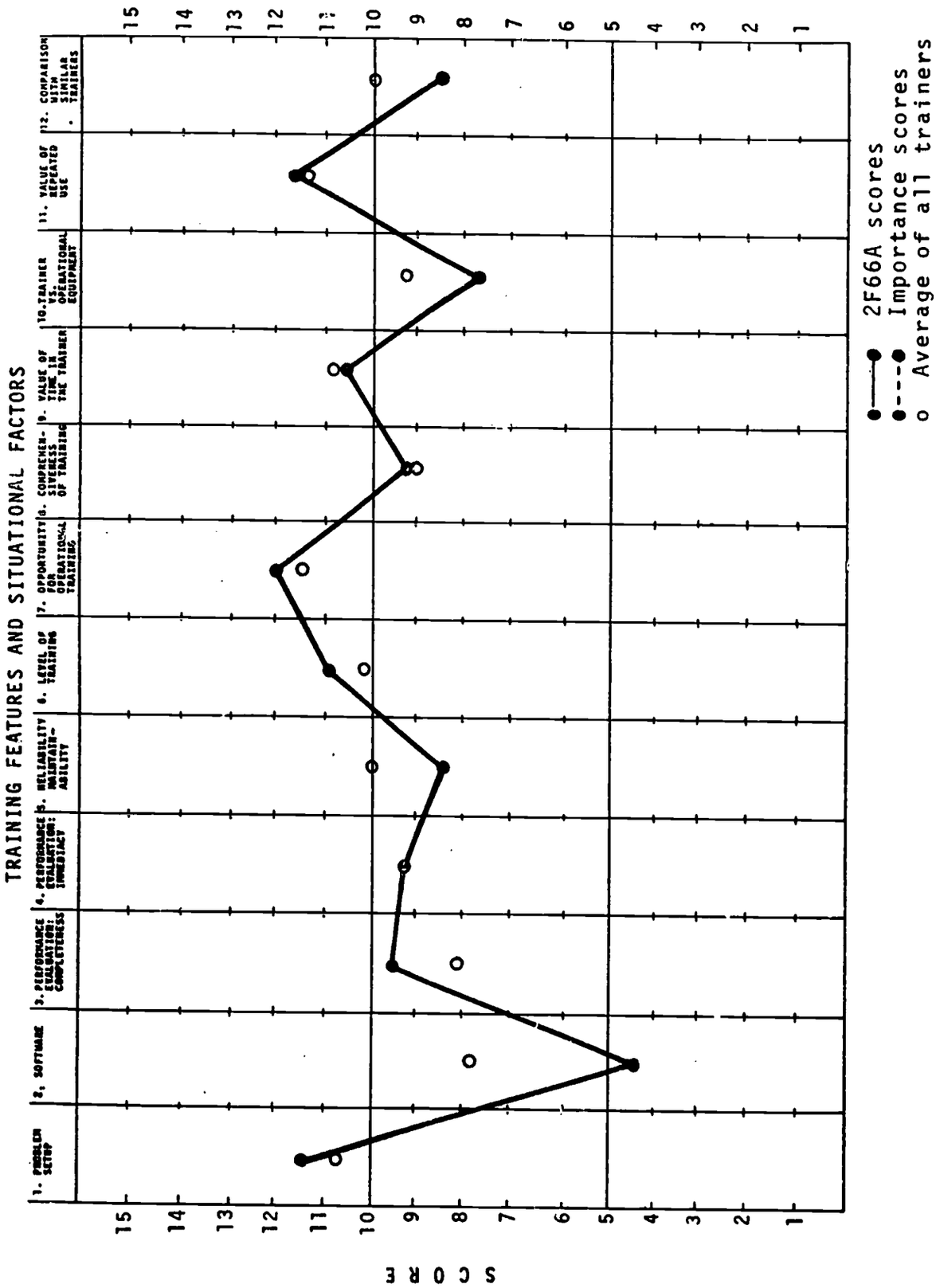

Figure 29. Profile of Training Effectiveness Scores for Device 2F66A, S2E Weapons System Trainer, San Diego.

of you in the trainer, I believe you could fly an actual mission as far as ASW goes. It is a valuable training aid to say the least."

"Aircrewmen would like to see spurious contacts for the tactics portion; there are few environmental qualities available in the tactics displays such as washover, sea return, and ambient noise."

The following are selected comments about the 2F66A made by San Diego personnel.

"The trainer is very effective if properly utilized. It simulates real conditions so well that in some instances frustrations have been induced just as if the equipment being used were real."

"Effective training is hindered by instructor capability. When they don't know enough about the trainer to simulate real world problems, the training suffers."

"Instructor techniques seem not to be standardized. Newer instructors are not as good as the older ones. A lot of time is spent in stopping the problems and resetting them."

"The device trains very well in 'knobology,' basic operator functions, instrument flight characteristics for the pilot, and ASW plotting. It is, however, limited in the scope of simulation."

"The trainer is being used to train skills other than those originally intended by the designer. It is being used in expanded tactics. The trainer is versatile enough so that the individuals who want to spend time with it can learn of new ways to incorporate it into the development of their tactical skills."

"One of the major deficiencies of the trainer is that the equipment does not keep up with the actual aircraft; therefore some negative training results. Pilots in particular are sensitive to these differences."

"The trainer is too perfect. It doesn't provide for the gray areas. It doesn't teach what to

expect in the real world. The signals are ideal; targets are easily detected."

"There is a lack of realism in the LOFAR and CODAR displays. They are much too easy to deal with. Some of the systems in the trainer are outdated such as the JULIE and gram analysis capability with the JEZ system. Students feel that tactics and conditions are changing faster than it is possible to update the training equipment."

"Schematics are very poor and a high degree of technical background is necessary to use the ones that are provided. The technical manual is no good and is not used. Drawings and schematics are lousy. They are good for general familiarization but are not reliable for any detailed maintenance work."

"Maintenance personnel had to set up their own school with regard to learning the computer and how it worked. The information provided by NTDC was much too skimpy."

"Government furnished equipment is generally poor and extremely hard to maintain. An example on this device is the ASN-30 plotter. The Packard-Bell 250 computer is (also) a problem. It is a general purpose computer but repair parts are scarce and very slow in being supplied."

"As an OFT, it (2F66A) is of value only to the new student to learn systems and some procedures. Visually it is an exact duplication of the aircraft, but control pressure and responses are not at all like the aircraft."

"As a WST, it is of value for learning crew coordination and procedures and for solving complex problems. It is of great value for improving readiness; if all training was to be obtained in the aircraft the time and expense would be prohibitive."

"I would also comment on the amount of down time. It can be infuriating to be near a solution of a long and difficult problem and have the computer dump."

"During a training session when a whole crew was working on an exercise to obtain a qual, the

computer dumps the problem destroying the time limit involved and the procedure necessary for a qual."

The results of this acceptance analysis of the 2F66A trainers appear to be entirely compatible with the much more detailed evaluation of the training effectiveness of the device recently completed by the Bunker-Ramo Corporation (12). In that study, Meister *et al.* concluded that the 2F66A was effective for training all crew members but that it was more effective for beginning students than for operational and reserve personnel. The trainer received particularly low ratings on realism of the control forces, and realism of information displayed to the sensor operators, and only average scores on "overall effectiveness."

While the instructors considered the trainer effective, problems of equipment malfunctions and insufficient fidelity "have reduced confidence and lowered the overall acceptability of the device as an integral part of air ASW training." It was further concluded that important improvements in training for all S-2E personnel could be effected through improved systematic utilization of the *existing capabilities** of the training device.

It was suggested that among the steps that could be taken to improve trainer effectiveness were "(1) more systematic variation of the nature of the training sessions; (2) increased trainer usage; (3) more systematic utilization of the trainer in both individual position and team training modes; and (4) improved trainer maintenance, enhanced fidelity, and increased trainer hardware capability."

Table 17 suggests that these trainers are somewhat less accepted by the more experienced personnel. Both trainers were rated particularly low by experienced personnel on software. In addition, the Quonset trainer was rated very low on sensor simulation and the San Diego trainer was rated particularly low on control effects.

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*Italics ours.

TABLE 17. AVERAGE RATINGS OF THE 2F66A BY LEVEL OF EXPERIENCE OF USERS

2F66A (Quonset Point)	Experience Level: Low (N=2)	Medium (N=4)	High (N=4)
Average Rating, Simulation Factors	9.2	9.5	9.6
Average Rating, Training and Situational Factors	12.6	9.6	6.8
2F66A (San Diego)	**Low (N=8)**	**Medium (N=8)**	**High (N=8)**
Average Rating, Simulation Factors	11.0	10.5	9.6
Average Rating, Training and Situational Factors	10.4	10.1	8.4

DEVICE 14A6A: ASW COORDINATED TACTICS TRAINER. The objective of the 14A6A was to provide training in coordinated ASW operations varying from a relatively simple situation involving a few ASW units, to complex exercises involving an entire ASW task group (up to 250 key people). The trainer was to be utilized to conduct demonstrations, provide for coordinated training, and evaluate tactics. It was designed to illustrate: (1) the capabilities and limitations of surface ships, submarines, aircraft, helicopters, and ASW task groups; (2) the utilization of search, localization and attack equipments and weapons; (3) the control of multi-unit forces in conducting search, localization and attack; (4) communication, plotting and recording facilities and procedures for the rapid exchange and analysis of necessary information; (5) command relationships and responsibilities; (6) realistic enemy submarine threats; and (7) offensive and defensive missions.

The trainer was to provide training for decision-making personnel in coordinated, inter-type, ASW tactical situations. The participants include aviation, surface, and submarine personnel from enlisted through flag rank. In general, it was expected that the participants would be "moderately to expertly skilled in their particular individual type functions;

however, they may be found to require practice, to varying degrees, in applying coordinated inter-type ASW tactics."

In terms of the composite acceptance criterion (Table 4), the 14A6A trainer fell almost in the middle of the distribution on the acceptance scale with a score of +0.6. Its level of acceptance can clearly be described as "modest." The reasons for this are probably most evident from the profile on simulation factors (Figure 30). It is clear that the 14A6A was rated below the average of all trainers on all simulation factors. It was rated particularly low on simulation of controls, displays, sensor performance, target reactions, and weapons firing and control. It is interesting to note, from the ratings of importance on these factors, that the participants did not regard high fidelity simulation of sensor performance, weapons and displays as important for this trainer as it was for individual ASW weapons systems trainers (for example, the 14A2). Nevertheless, the importance ratings were considerably higher than the values assigned to the 14A6A in many important respects.

In the contrast to the ratings on simulation factors, the 14A6A was rated considerably more favorably with respect to general training effectiveness factors (see Figure 31). Dissatisfaction is evident, however, with respect to the completeness and immediacy of performance evaluation. It received above average ratings in reliability and level of training. With respect to most other characteristics, it did not depart in any pronounced way from the average of all trainers.

The failure of the 14A6A to meet the levels judged as important on various simulation factors perhaps reflects a frequently mentioned criticism of the trainer, namely, that considerable time and effort must be expended learning to operate the trainer *per se*. The equipment in the trainer is "so unlike operational equipment that it is necessary to spend too much time" learning its peculiarities.

A possibly significant deficiency is that since an entire ship's team occupies a single small space, many problems in internal communications can be avoided by direct face-to-face conversation, or by looking at a plot or display not normally available. In addition, the display presents unambiguous information which makes the problems of communication unrealistic. The highest rating received by the 14A6A was in the area of communications procedures. This supports the contention of many that the 14A6A is primarily a communications procedures trainer. Nevertheless, internal communications are poorly simulated.

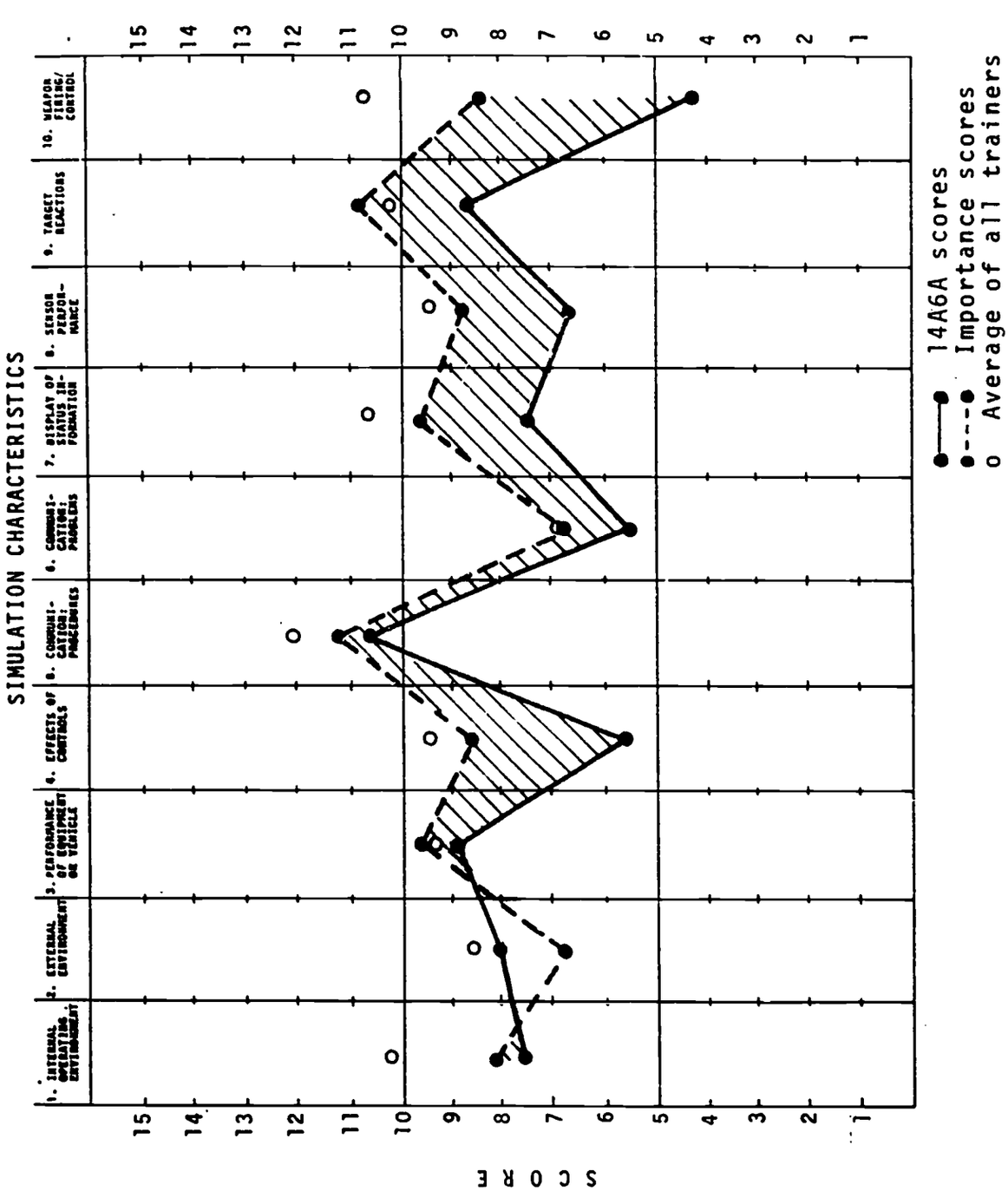

Figure 30. Profile of Simulation Scores for Device 14A6A, ASW Coordinated Tactics Trainer, San Diego.

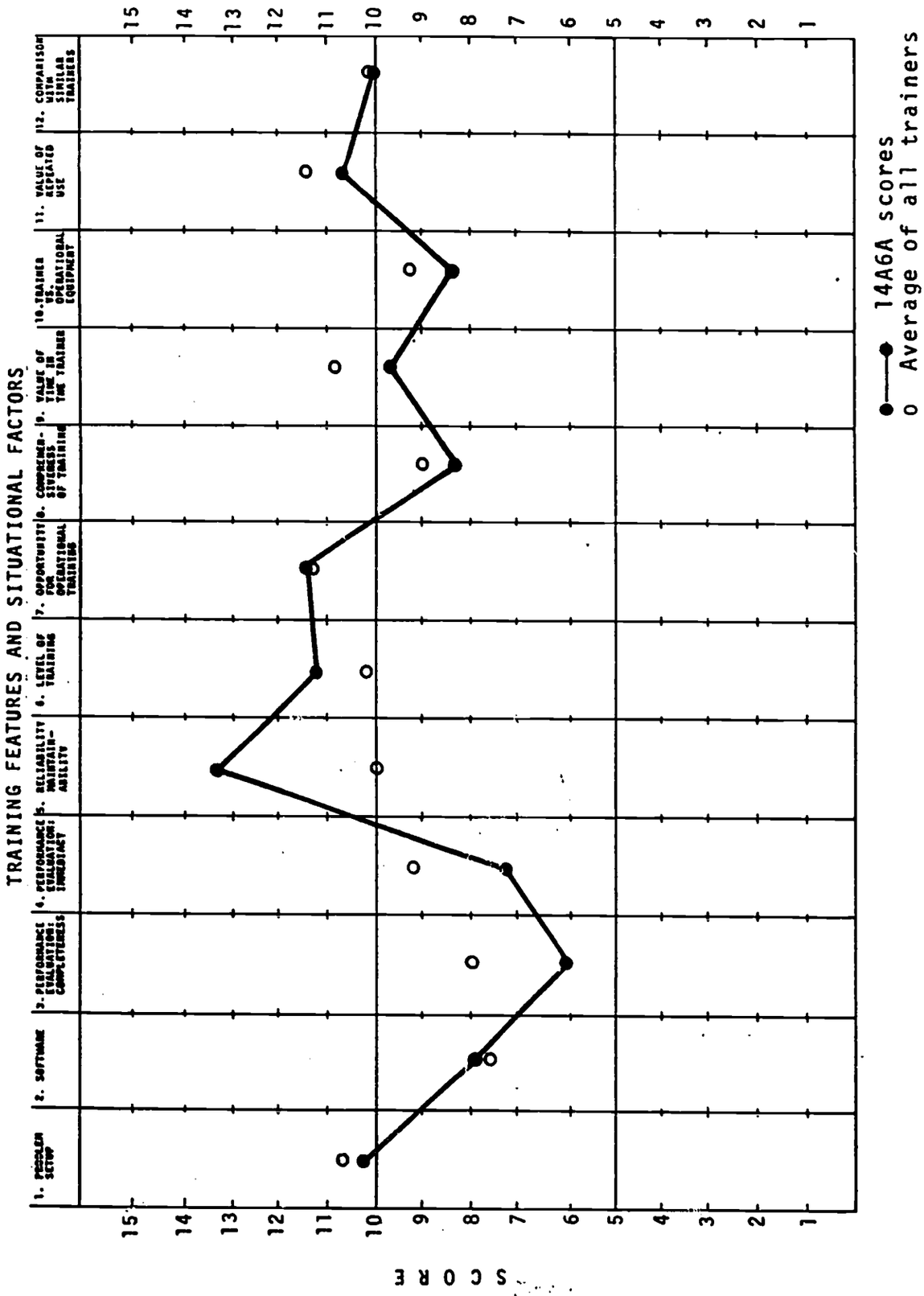

Figure 31. Profile of Training Effectiveness Scores for Device 14A6A, ASW Coordinated Tactics Trainer, San Diego.

With respect to controls, the 14A6A equipment is very unlike operational equipment. The raters accept this in principle, but nevertheless think it should be more realistic than it is.

The sensors in the 14A6A are very unlike the real sensors and they, again, provide unambiguous information. With respect to target reactions, the trainees "know that the instructors are playing games." One commanding officer commented that he very seldom heard any discussion of how foreign submarines are known or suspected to act in the various tactical situations presented in the trainer.

With respect to weapon control and firing, it is emphasized that the 14A6A was designed to carry the exercise up to the point of firing only. Evidently the assumption was that the firing phase of training would be taken care of in other trainers. The very low rating on this factor clearly indicates the opinion of many user personnel that this is not good enough. Several trainees and a few instructors commented that the ideal trainer would be one with the general capability of the 14A6A but composed of several 14A2 mock-ups with their much more detailed capabilities.

The comparatively low ratings on performance evaluation probably reflect the fact that there is no provision for immediate feedback at critical points in the exercise. Exercises typically last a full half day with problem reconstruction on a large screen at the end. During large scale exercises, enlisted personnel often take notes at individual stations; however, there is little in the way of critiques of individual ship's actions. What there is tends to take the form of "you should have done thus and so" rather than a diagnostic determination of why a particular action was or was not taken by a given unit. The performance of individual operators is not critiqued, of course, because they are not utilizing actual operational gear. An exception to these observations is the evaluation of the overall communication plan that is established for the purposes of the exercise. This is evaluated rather thoroughly.

The reliability of the trainer on the whole was rated very high. However, it is not unusual to have crews shift from one mock-up to another because of an equipment casualty. Since the trainer is rarely used to full capacity, this does not result in a significant loss of training time. The technicians complain, however, that the 14A6A was built using a line of parts left over from other projects. They reportedly often discover that the part they require is no longer in the Navy supply system or, worse, was built by a company no longer in business.

It seems likely that the ratings of the 14A6A would have been much higher in the absence of some of the simulation shortcomings mentioned earlier. However, this is little doubt that the trainer helps to recognize and correct many procedural problems before the units go to sea, particularly when used prior to a major fleet exercise. "Everyone would prefer more at sea training, but since that is not possible, the A6 is a better-than-nothing substitute."

There is evidence in the data (Table 18) that the simulation deficiencies are more strongly felt by personnel with the greater experience. This was true particularly with respect to communication problems, displayed information, and weapon firing effects.

TABLE 18. AVERAGE RATINGS OF THE 14A6A BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=3)	Medium (N=11)	High (N=15)
Average Rating, Simulation Factors	9.1	7.5	6.7
Average Rating, Training and Situational Factors	8.8	10.1	9.3

DEVICE 2B21: T-28 INSTRUMENT TRAINER. The 2B21 is an instrument flight trainer with multiple cockpit installations. It is designed for basic training in the (1) operation and use of individual instruments; (2) development of an instrument-scan pattern; (3) coordination of controls and instruments in basic flight patterns; (4) use of radio navigation facilities, i.e., VOR/TACAN, and ADF and ILS; (5) GCA-landing practice; (6) voice procedures, where applicable in the above areas of training; and (7) operational flight training of the T-28B aircraft.

The trainer was to simulate "normal aircraft operation with respect to flight and engine performance, flying qualities, aircraft systems operations. radio communication and navigation systems operation, and flight path." The simulation was to result in appropriate response on the part of the trainer's indicators, control reactions, and the flight

path recorder. The trainees utilizing the trainer were presumed to have no prior experience in instrument flight and navigation, and only limited flight instruction.

The composite criterion score for the 2B21 was +1.4, just slightly above the average of all trainers. It is evident that the trainer is accepted but not without some reservation. The reasons may be reflected in the profile on simulation factors (Figure 32). The trainer was rated well below average in simulation of vehicle performance and control effects. In relation to judged importance, these deficiencies are particularly severe. In contrast, the trainer was rated as distinctly above average on information displays and sensor performance.

The 2B21 was rated above average on several important training effectiveness factors. These include problem set-up, software, performance evaluation, reliability, and value of time in the trainer. However, the trainer was rated below average on level of training, comprehensiveness of training, and on use of the trainer versus operational equipment. It was also rated somewhat below average in comparison with other trainers of this type. (See Figure 33.)

Some possible reasons for the mixed attitudes of acceptance and rejection are reflected in the following comments.

> "The trainer does not fly like the real aircraft. It's a poor basic air trainer but a very good scan procedures, basic instrument, and radio work instrument trainer. Without it, students' progress would be slow."

> "Some instructors feel that the device hurts scan and some basic procedures and also basic air work for trim, rudders, etc. Making the trainer resemble the T28 aircraft may have been a mistake. Students expect the trainer to respond like the aircraft and it was not designed to do that. Lack of realism in the control responses of the trainer is a continuing problem for the instructors."

> "Rudder pedals in the trainer are oversensitive. Students transmit information to each other to the effect that they should fly the trainer with their feet on the floor. Some negative training occurs because of this condition. They forget or have negative carry-over and try to fly the aircraft in the same way."

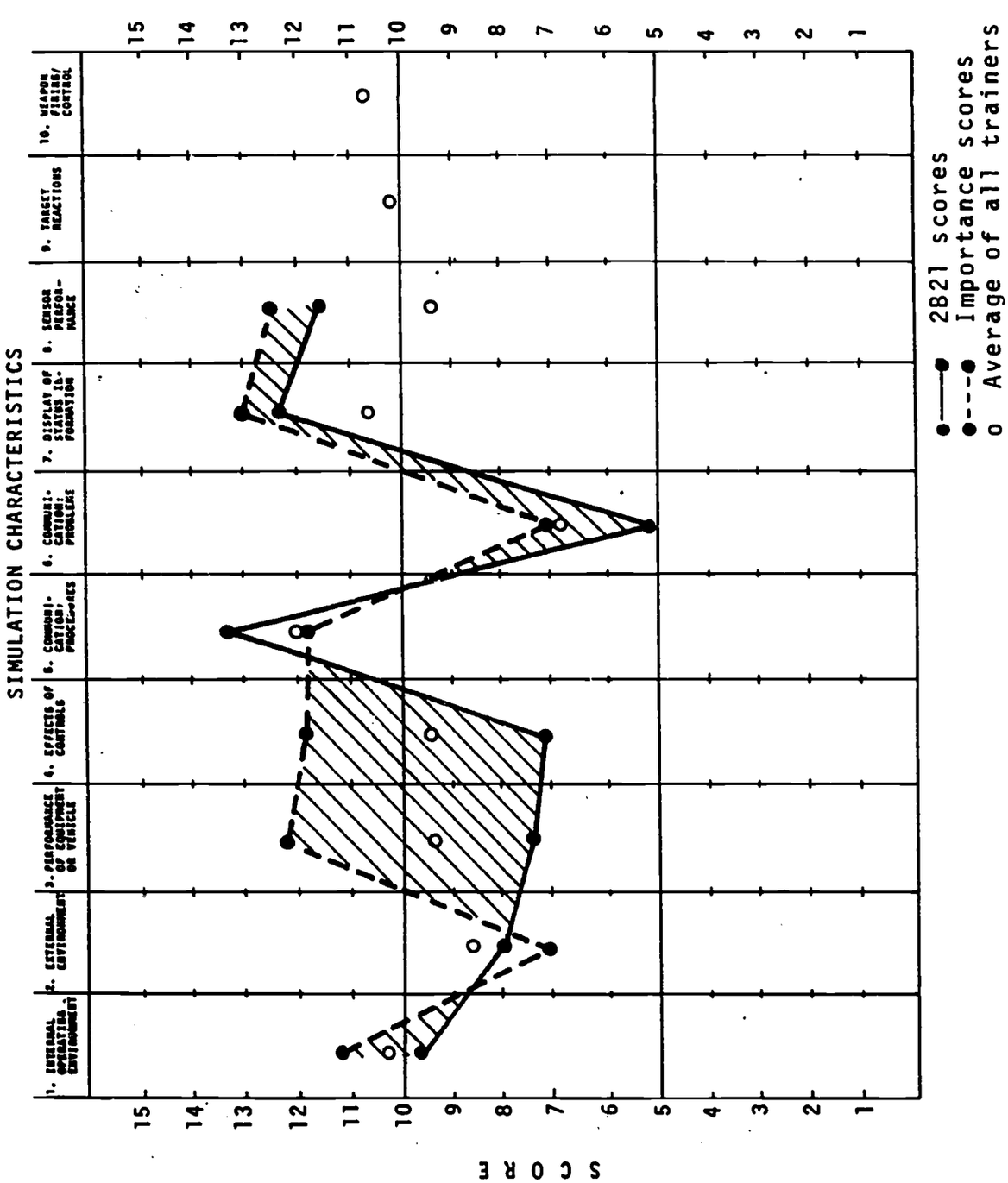

Figure 32. Profile of Simulation Scores for Device 2B21, T-28 Instrument Trainer, Pensacola.

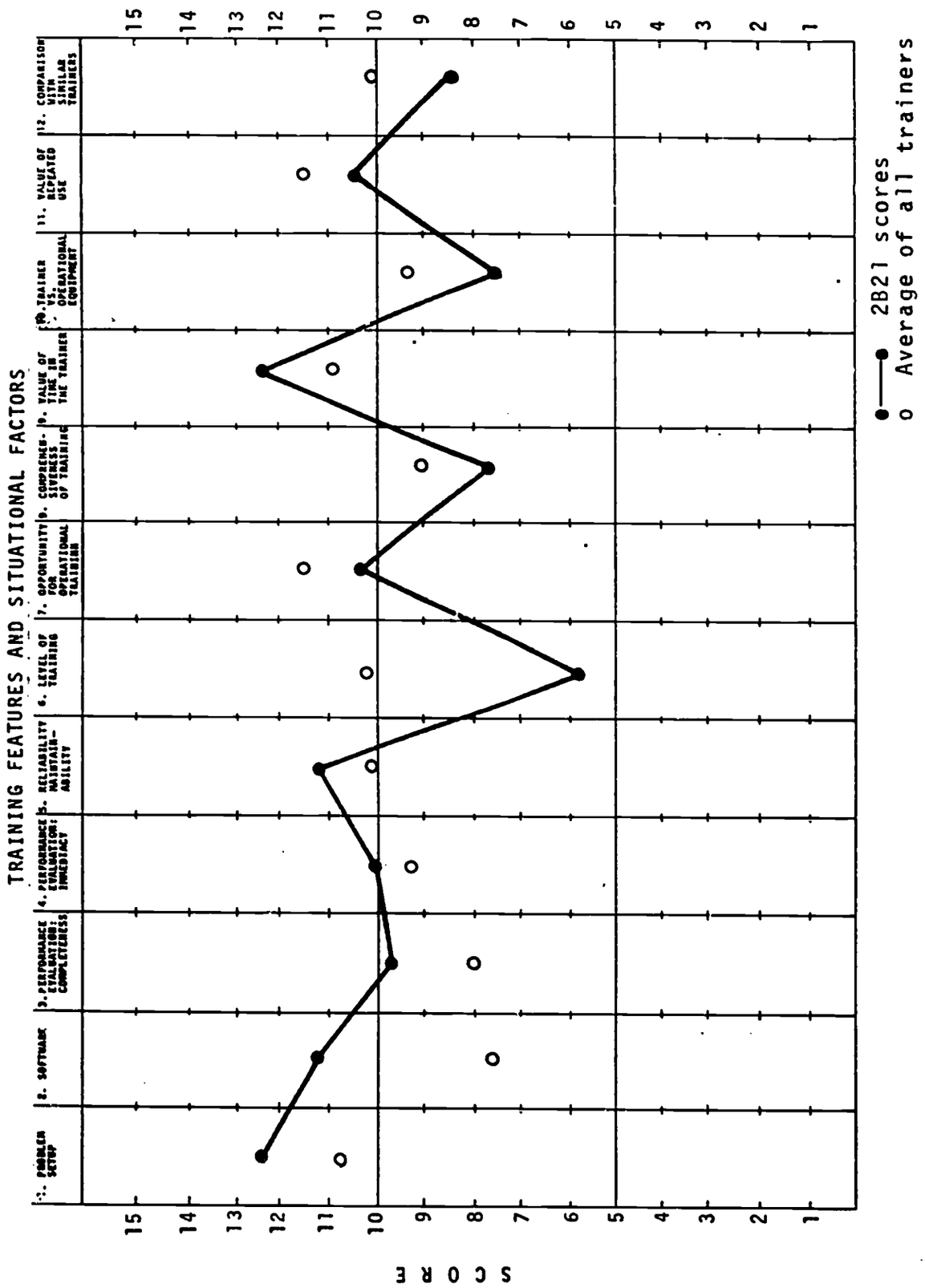

Figure 33. Profile of Training Effectiveness Scores for Device 2B21, T-28 Instrument Trainer, Pensacola.

"The turn and bank indicator does not react to the application of power. Control sticks are not smooth, seem to bind, and cause the trainee to over-control the trainer."

"No status accrues to the student as a result of flying the trainer. They are still playing the "hours game" for status and therefore time in the trainer only detracts from the time they have available to accumulate hours in the air."

"The more intelligent students appreciate the intent of the trainer and benefit more from the training time. They recognize how the trainer satisfies training needs in the area of instrument scan procedures, and voice reports, but they recognize also that it is certainly no good for basic air work. Flying the "Link," as they refer to it, is not at all like flying the aircraft. Some students feel that flying a Link can be detrimental to flying in the aircraft because of great differences in control pressure and trim."

It is noteworthy that student responses to the questionnaires in this study were very similar. They expressed disappointment that they could not increase their airmanship proficiency in the trainer and were concerned by the unreliability of the internal communications system between instructor and student. The trim and rudder problems were very distracting to them. Since this was their first exposure to air trainers, it is possible that the deficiencies noted will have a lasting effect on the opinion of some students with regard to air trainers in general.

There were no large differences in acceptance of the 2B21 as a function of level of experience (see Table 19). However it is interesting that the more experienced personnel rated the trainer *higher* on level of training and value of time in the trainer than did those with low experience. On the other hand, they rated it lower in comparison with similar trainers.

TABLE 19. AVERAGE RATINGS OF THE 2B21 BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=18)	Medium (N=3)	High (N=6)
Average Rating, Simulation Factors	9.3	9.9	9.6
Average Rating, Training and Situational Factors	9.7	9.6	10.8

DEVICE 2F65: E-2B WEAPONS SYSTEMS TRAINER. The 2F65 was designed to simulate the tactical mission of the E-2B weapons system. The E-2B is an all-weather airborne early warning and control airplane. It has a tactical crew consisting of an ECM operator (copilot), CIC officer, air control officer, and radar officer who are responsible for the operation and control of all avionics equipment. The copilot doubles as ECM operator when the aircraft is on station and provides ECM inputs to the avionics system computers.

The tactics system of the E-2B performs the following functions: detection, acquisition, automatic tracking and identification of targets, report of target positions, and control of interceptors.

The device was intended for the use of carrier based AEW squadrons, to train fleet pilots and AEW/CIC crews under the direction of qualified instructors. The device was to provide training in all of the necessary cockpit techniques, flight planning, emergency procedures, instrument flight procedures, and tactical procedures associated with the weapons system.

On the composite criterion (Table 4), the 2F65 received a somewhat below average overall rating (-2.2). In the profile on simulation factors (Figure 34), it is evident that deficiencies were felt in the areas of vehicle and equipment performance, control effects, communication procedures, and information displays. In addition, the trainer was rated distinctly below the importance ratings with respect to sensor performance, target reactions, and weapons control.

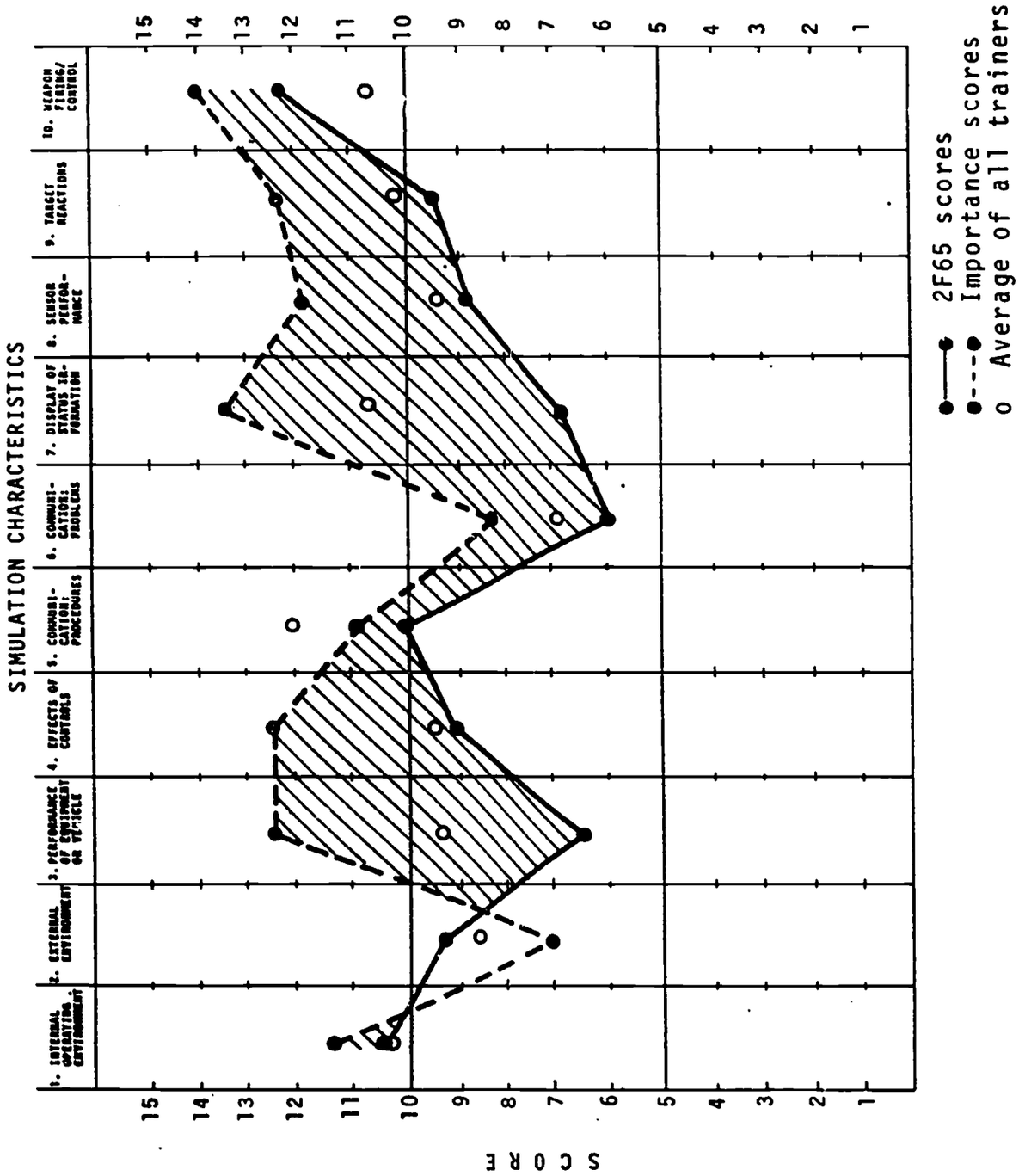

Figure 34. Profile of Simulation Scores for Device 2F65, E-2B Weapons Systems Trainer, San Diego.

With respect to training effectiveness factors, the device fared much better (see Figure 35). The trainer was generally rated average or better in all respects with the exception of software. Despite any of the felt deficiencies already mentioned, the value of time spent in the trainer was rated as above average.

It was clear to the study team that the 2F65 had two distinct levels of acceptance. The OFT portion was generally regarded not acceptable because of the problems associated with simulated flight, particularly aircraft control and response. Evidently the analogue simulation of these functions has proven very unsatisfactory, and changes in aircraft performance parameters are not easily incorporated in the trainer. Reportedly, "many pilots lose sight of the effectiveness of the trainer for emergency and procedural training because of these deficiencies."

The tactics section of the trainer has a much higher level of acceptance than the OFT. This appears to be because it can be used to develop problem solving ability and performance skills by NFO's. Acceptance is not unqualified, however. NFO's feel they would derive more from the training sessions if "greater realism at different levels of complexity" could be incorporated into the video displays.

Squadron personnel are not always as clear as they might be concerning the potential value of the trainer and the training personnel are not considered fully responsive to their training needs. No one seems completely happy with the trainer. Major updates have been made and are ongoing but the consensus seems to be that the effort is futile. Because of original inadequacies, it is felt that little can be accomplished to make the 2F65 into an entirely acceptable training aid. Early unrewarding experiences seem to have carried over and projected into future expectations.

Some verbatim responses from the questionnaires follow.

"This trainer satisfies needs for training in voice reporting and manual tracking; exposes students to data link operations; acts as an interface between the classroom and the real world; and provides a base for performing and experimenting with tactics."

"The trainer does not realistically simulate video modes, no side lobes, etc. Radar interpretation is lacking and communications net background noise is also lacking."

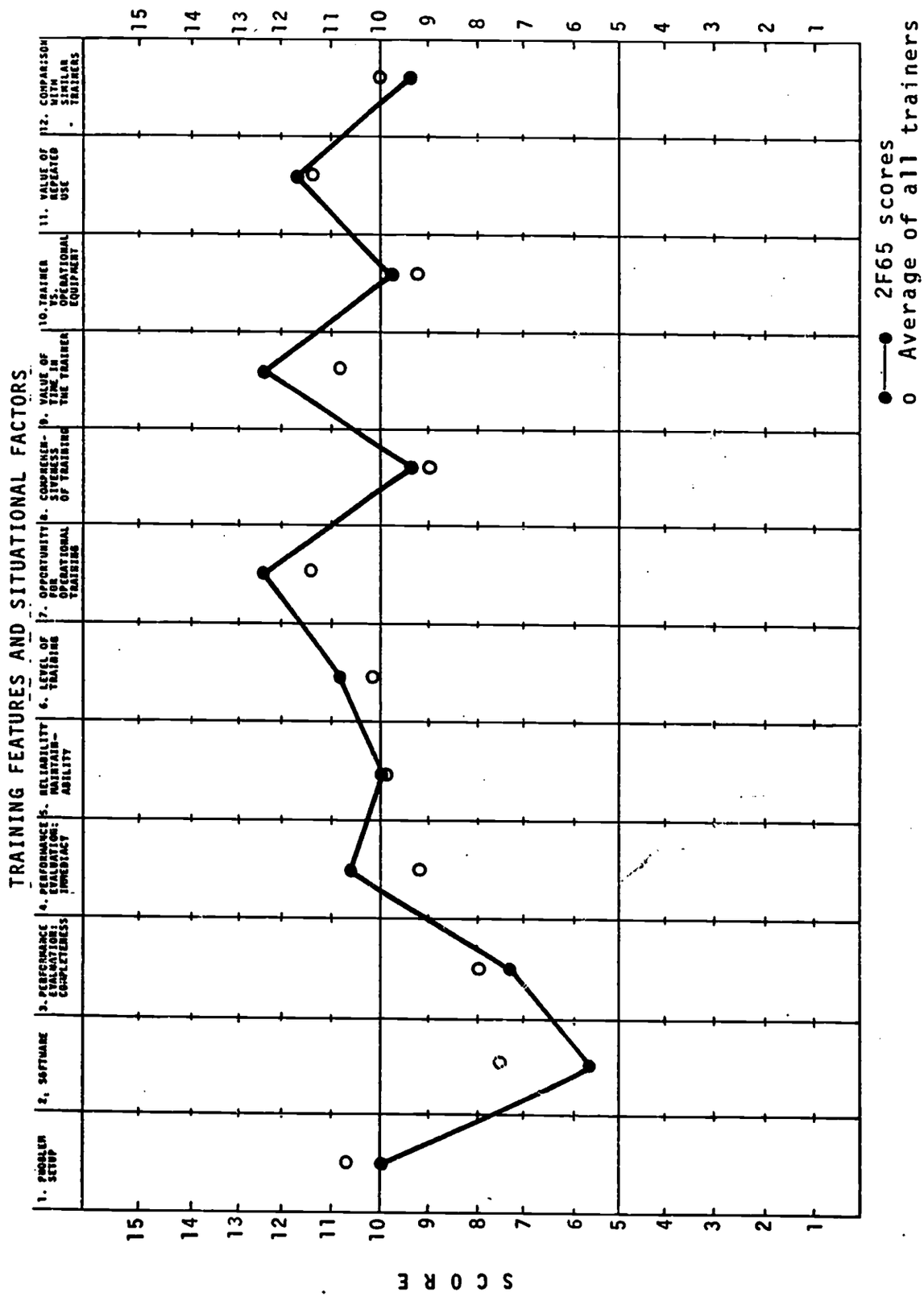

Figure 35. Profile of Training Effectiveness Scores for Device 2F65, E-2B Weapons Systems Trainer, San Diego.

"More tactics problems are needed, such as carrier controlled approaches, strike controlled fleet exercises, and war games."

"Radar and IFF simulation are not worthwhile."

"It is felt that the trainer could benefit from a Navy man as the primary coordinator for all activities related to the trainer...a managing director who can better relate the use of the trainer to the operational world, a real Navy NFO/E2B type with sufficient expertise to ramrod this show and keep on top--this would be his primary duty."

"Instructors at some activities do not thoroughly know the operations and limitations of airborne equipment. Some instructors have not been checked out in operation of the trainer when they are assigned to it. Occasionally both of these conditions apply to the same instructor."

"The operators and other people associated with the trainer have no general flight experience in the type of aircraft they are trying to simulate. It would be invaluable to have these people experience familiarization flights in the aircraft itself."

"More rapid, frequent and direct contact is required with project personnel both at NTDC and the Naval Air Systems Command. These support personnel have the most current information on trainer status, use and need and are at the end of the chain of decision. They are the last to know concerning the many items affecting the ability of the trainer to meet its mission. There is no wish on the part of the lower people to usurp power; they would just like to be provided with a method for making valid inputs for trainer changes and improvements and they would like to be informed of what the training requirements are going to be."

"Problems occur in troubleshooting because of the way the schematics and other parts of the manuals are laid out and these cause considerable confusion and wasted time. The trainer has undergone extensive updating which has required a lot of revision of the technical manuals. Schematics and drawings

are for the most part insufficient. Some are too brief or vague to be of much help; some are so full of errors they are useless. Technical manuals appear to be written by people who take an awful lot for granted, for example, engineers. Parts of some systems are scattered over many sections of the manuals."

"Training manuals are not used regularly because the individuals are familiar enough with the equipment. Write-ups in the manual are weak and don't necessarily relate to the training equipment. Scuttlebutt has it that the documentation was subcontracted and developed from engineering notes."

"There needs to be a more responsive method for getting aircraft changes incorporated into the trainer quickly. The decision to include aircraft changes (in the trainer) are too far removed (in time) from operational (changes). Negative training occurs because of this."

Some observations from trainees:

"The trainer is good for cockpit familiarization, normal pre-starts, starts, takeoff and landing procedures, and eye scan development. The students are generally left on their own. Some come to the trainer very well prepared; others come with a lackadaisical attitude, sometimes fostered by previous troubles in the trainer. The students feel that the trainer doesn't simulate conditions well enough to do much training. This applies to the OFT portion. The opinion is that the trainer bears no resemblance to the E2 aircraft. It is good for emergency procedures within limitations and it makes a good cockpit familiarization trainer. But it doesn't fly too well and the navigational aids don't work. Very frequently it fails during flight."

"Many instruments are too imprecise to give accurate simulation. Many programs were not included or were erroneously installed and reprogramming is difficult and expensive. Flight curves, etc., would need rescaling to make them match the performance of the aircraft. The original design information was inaccurate and since these features are hard-wired into the trainer, there is little opportunity for change."

"It is felt that direct liaison between squadron NATOPS people and NTDC is necessary. At present many inputs (suggestions for change) are received at widely separated periods of time. What is needed is continuous liaison; also, most necessary changes are beyond the capability of NTDC representatives. Much effort was expended by NTDC to fix the OFT portion of the trainer. But most of what was initiated was inconsequential insofar as training was concerned. The present trainer is beyond the scope of changes necessary to bring it up to date."

One respondent had had experience previously with a commercial airlines simulator. He felt the difference was startling between the commercial simulator and the 2F65 and that the Navy could benefit by incorporating some of the features used in commercial simulators. Quite a few trainees were aware of what the airlines were doing with simulators. They felt that trainers can be made to do the job but that this one was not. Their question was, "Why?"

The more experienced personnel were definitely less accepting of the 2F65 than neophyte personnel (see Table 20). This was particularly true in the areas of vehicle performance, communication problems, displayed information, problem setup, training software, completeness of performance evaluation, level of training, and value of trainer *vs.* operational experience.

TABLE 20. AVERAGE RATINGS OF THE 2F65 BY LEVEL OF EXPERIENCE OF USERS

	Experience Level		
	Low (N=3)	Medium (N=5)	High (N=6)
Average Rating, Simulation Factors	10.9	8.5	8.4
Average Rating, Training and Situational Factors	11.8	10.4	7.6

SECTION VI

A POST HOC APPRAISAL OF THE RATING SCALES

One of the objectives of this study was to develop a methodology which could be used in the future by NTDC to assess the acceptance of training devices. It is felt that the acceptance profiles presented in the preceding section are clearly useful and diagnostic. Nevertheless, it would be surprising if the rating scales from which they were derived could not be improved. Those familiar with the use of rating scales, particularly by personnel who are not trained in their use, will be well aware that the judges do not necessarily discriminate effectively on all of the characteristics (i.e., trainer features) described.

Undoubtedly, many of the characteristics are correlated, i.e., they are not logically independent of one another. It is also possible, however, that the ratings of training devices could suffer from a sort of generalized "halo" effect, a commonly observed phenomenon when supervisors rate their personnel on performance effectiveness. The "halo" effect occurs when one salient feature of a device (or individual) produces a generalized reaction, either negative or positive, such that the rater's judgments of all other characteristics are biased in a similar direction by this feature. In the limiting case, the judgment of a single characteristic "colors" the judgment of all others, and only a single dimension is required to extract all of the information obtainable from the rating scores.

In the case of training devices it would be hoped that the users would judge each characteristic relatively independently of the others. This would be reflected by comparatively low correlations among the ratings assigned to different features of the trainer. On the other hand, if there were a strong "halo" effect, the correlations would be very high.

Throughout this report we have portrayed the results as if the simulation and training effectiveness factors were truly independent in the minds of the participants even though we knew that "halo" effects might have effectively reduced the number of dimensions on which the trainers were being judged. In the interest of improving the methodology, and the definition of the composite criterion of acceptance, a detailed statistical analysis was therefore performed in an attempt to better identify the nature and number of underlying dimensions on which the trainers were actually judged.

Pearson product-moment correlations were computed for the scores of all trainers on the 22 simulation and training characteristics. The resulting correlation matrix was subjected to factor analysis, a technique for identifying the smallest number of common factors (dimensions) that account for all of the common variance in the matrix. Varimax rotation to oblique simple structure was performed in an effort to maximize the interpretability of the results.

The oblique primary factor loadings resulting from this procedure are shown in Table 21. For convenience, 10 factors were extracted which the computer program clearly indicated was more than enough to account for the common variance. Not all of the factors met conventional statistical criteria but it was evident that 7 of the 10 were clearly interpretable on logical grounds. Each of these factors or underlying dimensions is briefly described below.

Factor 1. *Recognized Value*. The rating scale variables that loaded heavily on this factor were as follows:

Importance of training opportunities provided	.76
Value of repeated use	.69
Level of training	.68
Use of trainer versus operational equipment	.59
Comprehensiveness of training	.49
Value of time in the trainer	.38

It seems evident that this factor is a rather direct reflection of the felt value of the training device in the overall scheme of training. It is a clear reflection of the fact that training devices are recognized as fulfilling a highly important need in addition to the opportunities for practice with operational equipment. This is undoubtedly a basic underlying consideration in the acceptance of any training device.

TABLE 21. OBLIQUE PRIMARY FACTOR LOADINGS RESULTING FROM ANALYSIS OF 22 RATING SCALE CHARACTERISTICS

TRAINER CHARACTERISTIC	FACTOR									
	1	2	3	4	5	6	7	8	9	10
Internal Oper. Environment	-.12	.13	-.05	.07	-.02	.06	-.51	.02	.03	.04
External Oper. Environment	-.12	.06	-.04	.13	.08	.09	-.43	-.09	-.12	.04
Vehicle/Equip. Performance	-.24	-.12	.08	.67	.07	.00	-.07	.02	.19	.03
Control Simulation	-.19	-.04	-.03	.75	-.08	-.04	-.02	.04	-.02	-.06
Communication Procedure	.04	-.07	-.00	-.03	-.12	.66	-.07	.08	.06	.07
Communication Problems	-.13	.19	.00	-.05	-.03	.58	.07	-.04	.04	-.04
Display of Information	.04	.48	-.05	.07	.18	.15	.06	.01	.41	.02
Sensor Performance	-.03	.76	.05	-.10	.05	.07	-.10	-.13	.19	-.07
Target Reactions	-.08	.71	.00	-.16	.01	-.07	-.02	.04	-.01	.10
Weapon Firing/Control	.19	.58	.01	.20	-.05	.05	.03	.15	-.01	-.02
Problem Set-Up	-.06	.14	-.11	.01	.57	-.11	.00	.09	.01	-.08
Software	.14	-.09	-.06	.14	.49	.09	.09	-.02	-.00	.07
Compl. Performance Evaluation	.02	-.00	-.77	.03	.03	.08	-.03	-.01	.05	-.02
Immed. Performance Evaluation	-.04	-.03	-.80	-.04	.04	-.06	-.04	-.00	-.01	.01
Reliability/Maintenance	-.03	-.01	.06	-.15	.69	-.09	-.02	.04	.09	.04
Level of Training	-.68	-.20	-.01	-.09	.17	.12	-.01	.11	-.04	-.06
Training Opportunities	-.76	-.04	-.02	.08	-.11	.02	.06	-.04	-.09	.08
Training Comprehensiveness	-.49	.03	.08	.08	.25	.05	-.17	.09	-.09	-.02
Value of Time	-.38	.04	.02	-.10	.03	.09	-.09	.04	.03	.32
Trainer vs. Oper. Equipment	-.59	.19	.00	.16	-.03	-.06	.01	-.15	.01	.01
Repeated Use	-.69	.09	-.07	.04	-.01	-.11	.09	.09	.12	.07
Comparison With Others	-.22	.01	-.00	.08	.29	.06	.04	.33	.02	.02

Factor 2. *Tactical Realism.* The features of a trainer that loaded most heavily on this factor had to do with simulated sensor performance, representation of targets, and weapon performance. All of the rating scale variables comprising this factor relate to the adequacy with which the tactical problem is presented.

Simulation of sensor performance	.76
Simulation of target evasion	.71
Simulation of weapon firing	.58
Simulation of displays	.48

Factor 3. *Provision for Evaluation.* This factor was defined by only two rating scale characteristics:

Immediacy of performance evaluation	.80
Completeness of performance evaluation	.77

Although the definition of a "common" factor technically requires high loadings by more than two variables, these two characteristics clearly logically identify a basic dimension of trainers that is well defined in the minds of evaluators of training devices. No other characteristic of the trainer showed even a modest loading on this factor.

Factor 4. *Performance "Feel".* This factor was also a "doublet" with heavy loadings on two characteristics that are logically related in training devices. These were:

Simulation of controls	.75
Simulation of performance	.67

There were no other significant loadings on this factor. It is clearly a factor that is of major concern to users of operational flight trainers and other devices, such as submarine diving trainers, which are characterized by extensive feedback to the operator through the controls and apparent motions of the vehicle.

Factor 5. *Operational Readiness.* The trainer characteristics loading on this factor included both maintenance and operational considerations. Those with the heaviest loadings were as follows:

Reliability and maintainability	.69
Problem setup	.57
Training software	.49

This factor appears to reflect the "readiness" of the device to meet training needs from both a reliability and training convenience viewpoint. It undoubtedly reflects an important dimension in acceptance, both by students and by the personnel who must keep devices operational.

Factor 6. *Communication Provisions.* The only rating scale variables loading heavily on this factor were the two items describing provisions for communications in the trainer. The loadings were as follows:

Simulation of communication procedures	.66
Simulation of communication problems	.58

Factor 7. *Environmental Simulation.* This is another example of a doublet that is logically well defined. In this case the only rating scale variables with heavy loadings had to do with environmental simulation. The loadings were as follows:

Simulation of internal operating environment	.51
Simulation of external operating environment	.43

Factors 8, 9, and 10 showed appreciable loadings by only a single rated characteristic so no attempt at interpretation was made. It is interesting to note that all of the trainer characteristics included in the rating scale loaded heavily on at least one common factor with the exception of the last scale, "Comparison with Similar Trainers." The reasons for this unexpected result are not clear. This particular scale was intended as a kind of summary evaluation after all of the

other trainer characteristics had been considered. However, it loaded only .22 on Factor 1 (Recognized Value) and .29 on Factor 5 (Operational Readiness). Its loadings on other factors were negligible with the exception of Factor 8 (.33) which could not be defined. Possibly this overall comparison scale led to a complex set of considerations on the part of the raters which did not produce much reliable variance. Or, perhaps a major difficulty was that many of the respondents, being relatively new to the weapons system which the trainer represented, had insufficient past experience in comparable trainers. In either case, the value of this particular scale seems in doubt.

In effect, the results of the factor analysis were to reduce the original 22 trainer characteristics included in the rating scale to just 7 basic dimensions:

1. Recognized Value
2. Tactical Realism
3. Provision for Evaluation
4. Performance "Feel"
5. Operational Readiness
6. Communication Provisions
7. Environmental Simulation

If the rating scale were to be revised for future use, it could be argued that it need include only the 7 factors listed above since, generally speaking, those are all the dimensions that were discriminated by the raters. We would argue against this procedure except in the case of Factor 1, Recognized Value. It would seem that some combining of the six variables loading on this factor could occur without serious loss of information. From the viewpoint of trainer acceptance, the three variables loading heaviest on this factor probably reflect the most important considerations.

With respect to the other factors, however, it is doubtful whether combining could occur without serious loss of diagnostic information. For example, although four trainer characteristics loaded heavily on Factor 2, Tactical Realism, elimination or combining of any of those characteristics with any others might result in obscuring important deficiencies (or advantages) of a particular trainer.

SECTION VII

SUMMARY AND CONCLUSIONS

Factors influencing the level of acceptance of 16 complex training devices representing air, surface, and subsurface operations were studied by means of specially developed rating scales and questionnaires. A total of 326 Navy personnel, representing students, instructors, administrators, and maintenance technicians, participated in the study.

A composite criterion of trainer acceptance was developed that was comprised of ratings of trainer effectiveness, judged adequacy of simulation, volunteered statements concerning the merits and shortcomings of each trainer, percent utilization, and ratio of hours-used to hours-requested. On the basis of this composite criterion, both highly accepted trainers and trainers with acceptance problems were identified.

The value of training devices to the overall training process is widely recognized by Navy personnel. Training devices are particularly well accepted with respect to the opportunity they provide to supplement operational training, especially the training they provide in certain procedures that are too costly or too hazardous to be practiced in the operational environment. They are appreciated for the efficiency they represent with respect to the time required to achieve skills initially, and for maintaining acquired skills through a program of repeated use.

However, it is to be emphasized that no trainer is totally "accepted" or "unaccepted." There is little doubt that the acceptance of training devices can be increased, with the consequence of both improved training and greater cost effectiveness. The following general findings of the study are offered with these objectives in mind.

SIMULATION FACTORS THAT INFLUENCE ACCEPTANCE

1. Using the composite criterion of acceptance described earlier, highly accepted trainers were rated systematically higher than those with acceptance problems on 8 of the 10 simulation characteristics studied.

2. Highly accepted trainers were rated as particularly superior on simulation of vehicle performance, effects of controls, display of information, and sensor performance.

3. The trainers as a group, whether highly accepted or not, were rated below the considered level of importance on

three simulation characteristics: displayed information, sensor performance, and target reactions.

4. All trainers were rated high on communication procedures but almost all were rated low on communication problems. However, the simulation of communication problems was not considered highly important by the participants. This may reflect an overly restrictive definition of communication problems in the rating scale used for the study.

5. "Unaccepted" trainers were judged poorest in simulation of the external environment, vehicle or equipment performance, control effects, sensor performance, and weapon firing and control.

6. Flight trainers appear to experience acceptance difficulties, regardless of their other merits, if they are rated low on simulation of vehicle performance and/or control effects ("feel").

7. Weapons systems trainers appear to experience acceptance difficulties, regardless of their other merits, if they are rated low on simulated information displays, sensor performance, or target reactions.

8. Some acceptance problems appear to have developed because the simulated performance characteristics of the trainer have not kept pace with changes to the operational equipment. In some cases the trainer appears to have been programmed on the basis of "theoretical" performance curves that are different from those achieved in the operating environment.

9. Operational personnel tend to be very sensitive to the specific response characteristics of the vehicle that is simulated by the trainer. If the trainer does not react in a fashion very similar to the operational equipment it simulates, it is considered non-acceptable regardless of whether the trainer was intended to be a high fidelity simulator or not. Although it may be argued that important skills can nevertheless be acquired in such a trainer, the attitude of "response-specificity" is a major obstacle to acceptance.

OTHER TRAINER FEATURES THAT INFLUENCE ACCEPTANCE

10. The highly accepted trainers as a group were rated systematically higher than trainers with acceptance problems on all 12 training characteristics and situational factors studied.

11. Highly accepted trainers were rated superior particularly with regard to problem setup, training software, and reliability. Trainers with acceptance problems were rated particularly low on training software, reliability, comprehensiveness of training, and the advantages of the trainer as opposed to the use of operational equipment for training.

12. Considered as a group, the trainers in the study tended to be rated lowest in the areas of training software, completeness of performance evaluation, and immediacy of performance evaluation.

13. The trainers as a group were rated highest with respect to the opportunity they provided to supplement operational training, value of time spent in the trainer, and value of repeated use.

14. In several cases trainer acceptance appeared to have been greatly reduced by inadequate (or totally lacking) training software. In contrast, in a few cases, exceptionally good training software apparently had greatly enhanced trainer acceptance.

15. Trainers with which serious maintenance problems were associated tended to be unaccepted. There are four sources of maintenance problems frequently mentioned:

a. Inadequate technical documentation;

b. Long delays in obtaining spare parts;

c. Difficulty in maintaining government-furnished operational components (GFE);

d. Severe problems of access, particularly in trailer-housed trainers.

It is generally recognized that trainer maintenance personnel have done an exceptional job of coping with these problems.

CHARACTERISTICS OF USERS THAT INFLUENCE ACCEPTANCE

16. The level of user experience in the area of operations represented by a trainer is a factor in the acceptance of some trainers. In general, if a trainer is seen as having simulation deficiencies, the more experienced personnel will be more critical than the less experienced personnel. In addition, some inexperienced personnel depreciate the value

of a trainer because, in their view, its use conflicts with the opportunity to do the "real" thing.

17. Important capabilities of some trainers are not fully appreciated because of the assumption that "the fleet knows best" what its training needs are and how to use the trainer to meet them. A related problem is the lack of technical qualifications (and often inferior rank) of those who are called upon to critique performance in the trainer.

18. The "not invented here" phenomenon, often seen as a symptom of resistance to hardware and procedural innovations, appears to have its counterpart with respect to training devices in the form of a "not consulted here" reaction. Specific deficiencies, particularly in the area of simulation, are often considered the result of a failure to consult operational personnel. The magnitude of any felt deficiencies may be exaggerated by this reaction.

A related problem is that NTDC and the various systems commands are frequently seen as unresponsive to perceived deficiencies, the need for updating or modernizing, the requirements for improved documentation, etc.

CHARACTERISTICS OF INSTRUCTION THAT INFLUENCE ACCEPTANCE

19. Quality of instruction (including evaluation of performance) is a major problem in trainer acceptance. In some cases this stems from the fact that the instructor's role is relegated to training devicemen who are not technical experts in the area of operation represented by the trainer; in others, it is due to the assignment of the instructor's role to operational personnel who are not fully knowledgeable concerning the trainer's capabilities and/or the learning process.

20. The absence of standard syllabi and graded series of problems is an obstacle to effective use of some trainers and therefore to acceptance.

21. A problem in some trainers is that the instructor simply has too many stations to observe and cannot possibly evaluate the performance of all students adequately. This has a negative influence on acceptance.

22. Many personnel responsible for trainer operation feel out-of-touch with what operational personnel feel to be their training needs.

23. There appear to be no standard qualifications for instructor personnel for most trainers. In some cases,

personnel who are trained primarily in maintenance serve as instructors. There appears to be no well-defined program for training in device *operation*.

24. Training devicemen have, in many instances, done a remarkable job of self-instruction in learning how to operate the trainer. However, serious problems can occur when they are transferred and their responsibilities assumed by less experienced personnel. This can produce acceptance problems for appreciable periods of time.

25. Unrealistic programming of problems (for example, illogically correlated malfunctions or the failure to program sequentially related ones) has an adverse effect on trainer acceptance.

PATTERNS OF USE THAT AFFECT TRAINER ACCEPTANCE

26. Acceptance (or rejection) of a trainer is frequently in conflict with the original design objectives of the trainer. Most often, the trainer is used in a manner that is considerably less sophisticated than its designed capabilities. However, such trainers are often well "accepted." In other cases, particularly with flight trainers, greater sophistication is expected by the users than was apparently intended by the designers. Such trainers experience considerable rejection by a significant proportion of users.

27. When some characteristics of the problems presented in trainers (for example, tactical problems) are "too easy" as judged by experienced personnel, the trainer tends to regress towards the status of an elementary procedures trainer, regardless of the fact that it may have some very sophisticated capabilities.

28. The full capabilities of many trainers are not appreciated by a substantial proportion of users (or potential users) because of the lack of knowledge among operating personnel of what the trainer can do. In a few cases, highly motivated administrative personnel have effectively promoted the trainer's use. In others, no one has assumed this responsibility. In many cases, the two-way communication link that should relate fleet training needs to trainer capabilities is in need of considerable strengthening.

RECOMMENDATIONS

In the interest of improving the acceptance and utilization of training devices, the following actions are recommended.

1. The acceptance profiling technique developed for this study should be applied periodically to all complex trainers. Data on simulation, training characteristics, and situational factors influencing acceptance should be accumulated so that a body of knowledge is developed that will be useful for design decisions. Longitudinal studies should be conducted to determine how sensitive the technique is to *changes* in the level of acceptance. The reactions of Navy personnel to this survey indicates that they would readily cooperate in such a program.

2. Effort should be made to increase acceptance and methods of utilizing complex trainers by increased investments in training software. Detailed instructional guides, prepared by personnel who are both operationally knowledgeable and sophisticated in training methodology, should be a standard item for delivery with all complex trainers.

3. Corresponding efforts should be made to ameliorate the acceptance problems generated by inadequate technical documentation, spare parts, and troublesome GFE items that adversely influence trainer maintenance.

4. Research should be conducted into the general problem of trainer acceptance as a function of the "feel" of the simulated vehicle. The fundamental issue, of course, is the transferability of responses from the trainer to the operational equipment. Rightly or wrongly, Navy personnel feel the need for a high level of specific response realism in operational trainers (i.e., they feel the trainer should react like a specific model of an aircraft, submarine, etc.). Their reactions clearly reflect a concern for the possibility of negative transfer. Probably this concern is justified for some types of trainers and not others. Research should be conducted to define design guidelines in this area and to better relate them to the phenomena of transfer.

5. Similarly, research should be conducted into the necessary fidelity of simulation for tactics-related training such as sensor capabilities, information displays, target behavior, and weapon reactions. The problem is to decide what levels of simulation are required for effective training of *different members* of the tactical team for such tasks as target detection, classification, tracking, localization and attack.

6. The problem of developing uniform and high standards of qualification for instructors needs to be solved, along with effective ways to train these personnel. The Navy should seriously reconsider its traditional policy of assuming that

operational personnel can identify their own training shortcomings and act as their own instructors in solving them.

7. For every training device representing a major investment, consideration should be given to the development of a "trainer advocate" who, by virtue of his related operational experience, knowledge of the trainer's capabilities, limitations, and design objectives, and understanding of good training practice, can effectively close the communication gaps between trainer users, designers, operational commands, and systems commands.

REFERENCES

1. Berger, P. K., Matheny, W. G., & Newmiller, C. E. The role of trial in the acceptance and adoption of new equipment (A review and summary). *Life Sciences, Inc.*, 1966.

2. Chambers, A. N. Affective and acceptance factors in selection and utilization of training aids and devices. *NAVTRADEVCEN Tech. Rept. 9-11-1*, 1958.

3. Chin, R. Basic strategies and procedures for effecting change. *Designing education for the future, No. 3: Planning and effecting needed changes in education.* E. L. Morphet and C. O. Ryan (eds.). Citation Press, New York, 1967.

4. Edenborough, R. A. User Opinion of RAF Flight Simulators. *RAF Institute of Aviation Medicine*, Farnborough (England), 1968.

5. Edgerton, H. A. The acceptability and effectiveness of the casual use of auditory training aids. *NAVTRADEVCEN Tech. Rept. 373-1*, 1960.

6. Finch, C. R. *et al.* Instructional resources for vocational-technical education: Teacher attitude, resource availability and resource utilization. *Pennsylvania State University*, University Park, Dept. of Vocational Education, 1970.

7. Krumm, R. L., & Buffardi, L. Training effectiveness evaluation of naval training devices, Part I: A study of submarine diving trainer effectiveness. *NAVTRADEVCEN 69-C-0311*, 1970.

8. Mackie, R. R. *et al.* Factors leading to the acceptance or rejection of training devices. *NAVTRADEVCEN 70-C-0726-1*, (in prep.).

9. Mathews, J. B., Whittenburg, J. A., Barnes, B. P., Cheek, F. V., & Wise, J. E. A pilot study to investigate non-utilization of Navy equipment. *Human Sciences Research-RR-65/9-Rn* (CONFIDENTIAL).

10. McClelland, William A. The process of effecting change, *Human Resources Research Organization*, George Washington University, Alexandria, Va., 1968.

11. Mecherikoff, M., & Mackie, R. R. Attitudinal factors in the acceptance of innovations in the Navy. *Human Factors Research, Inc., Tech. Rept. 784-1* (in prep.).

12. Meister, David *et al.* Training effectiveness evaluation of naval training devices, Part II: A study of device 2F66A (S-2E Trainer) effectiveness. *NAVTRADEVCEN 69-C-0322-2*, 1971.

13. Niehoff, Arthur H. Planned change in agrarian countries. *Human Resources Research Organization*, George Washington University, Alexandria, Va., 1969.

14. Prophet, Wallace W. The importance of training requirements information in the design and use of aviation training devices. *Human Resources Research Organization*, George Washington University, Alexandria, Va., 1966.

15. Quesada, Gustavo M. On the diffusion of innovations research tradition. *Office of Research Analyses*, Holloman AFB, New Mexico, 1969.

16. Rogers, E. M. (with F. F. Shoemaker). *Communications of Innovations: A cross-cultured approach.* 1969: New York Free Press.

17. Rogers, E. M. *Diffusion of innovations.* New York: Free Press of Glencoe, 1962.

18. Simpson, H. K., & Parker, E. L. Maintenance status and fleet acceptance of ASPECT target classification equipment. *Human Factors Research, Inc., Tech. Rept. 206-33*, 1965 (CONFIDENTIAL), for ONR.

19. Toye, M. A rethink on basic skills (with comments on the deterioration of training schemes after installation). *Industrial Training International*, 1969, *4*, 3, 112.

20. Use of the operational flight trainer. *NAVTRADEVCEN Tech. Rept. 1734-00-1*, 1966.

APPENDIX A

SAMPLE RATING SCALES AND QUESTIONNAIRE

NAME OF RATER: _____

FACTORS IN TRAINING DEVICE ACCEPTABILITY

PART I: RATING SCALES

INTRODUCTION

Human Factors Research, Inc., is under contract to the Navy to determine why some training devices are highly accepted by those who use them, and others develop an unfavorable reputation. This can be a very serious problem, since a trainer typically represents a large investment of money, and since the effectiveness of the trainer might be influenced by its acceptability.

One approach we are using to study this problem is to get information *directly from the users* of several training devices. For purposes of comparison, some of these trainers we are studying are highly accepted, while others may not be.

The data we wish to obtain from you will require two stages. First, this set of rating scales will allow you to give evaluations of several important characteristics of the trainer in a quick and easy form. Second, there is a questionnaire for you to record some detailed reactions to the training device, its effectiveness, and its acceptance. In addition, a member of the research staff may contact you for further detail or clarification.

In order to match up the rating scales, questionnaires, and interview notes, you are asked to put your name above, on the line which says "NAME OF RATER." Please feel free to answer the questions honestly and frankly. Our report to the Navy will be in terms of trends and averages; only our company research staff will see the actual rating scales and interview notes.

(Sample page from rating scale illustrating format)

SIMULATION OF SENSOR PERFORMANCE

How realistic is the simulation of sensor equipment in the trainer? Consider such factors as the physical appearance of objects in the environment and the environment itself as displayed to the eyes or ears; the number and variety of objects simulated; how detectability is affected by the surrounding environment. If applicable, consider how well different *classes* of targets are simulated.

15	[ ]	The simulated presentations cannot be distinguished from the way objects or targets appear in the operating environment.
14	[ ]	
13	[ ]	
12	[ ]	
11	[ ]	
10	[ ]	The simulated presentations are somewhat different from operational equipment, but training is not seriously limited.
9	[ ]	
8	[ ]	
7	[ ]	
6	[ ]	
5	[ ]	The simulated presentations are sufficiently different from operational equipment that some functions cannot be trained effectively, or training is generally impaired.
4	[ ]	
3	[ ]	
2	[ ]	
1	[ ]	
0	[ ]	The simulated presentations are so different from operational equipment that what is learned in the trainer could have a negative effect on operational performance.

[ ] NOT APPLICABLE [ ] INSUFFICIENT KNOWLEDGE OR EXPERIENCE

(NOTE: The questions on the following pages were asked of all qualified respondents. In the interest of saving space, the format of the questionnaire has not been reproduced.)

FACTORS IN TRAINING DEVICE ACCEPTABILITY

PART II: QUESTIONNAIRE (TRAINEES)

Please fill out PART I: RATING SCALES, if you have not already done so, before going on to this questionnaire.

The form of this questionnaire is intended to encourage somewhat detailed responses to the questions, without taking a great deal of time. Try to give enough detail so that the research staff can clearly understand your answers.

If you wish to make comments about the trainer or about your reactions to it, but these comments do not fit any of the questions specifically asked, please write them on the last page of this questionnaire. We welcome such comments, since they can point to unexpected factors in trainer acceptance and effectiveness.

Please notice that there are questions on <u>both</u> sides of each page. Experience indicates that the questionnaire can be completed in about an hour.

INTERVIEW SCHEDULE
(ADMINISTRATIVE AND INSTRUCTOR PERSONNEL)

Name _____

Rank/Rate_____ Length of Service: ____ Yrs. ___Mos.

Present Billet _____

_____ How long? ____ Yrs. ___Mos.

Educational level--highest grade in school:

7 8 9 10 11 College degree? [ ] Yes [ ] No

12 13 14 15 16 Graduate study? _____ (Years)

Navy schools related to present billet: _____

_____

Area of specialization in the Navy:_____

_____

Relation to this training device:

[ ] Administration [ ] Instructor [ ] Trainee

[ ] Maintenance [ ] Other

Details: _____

How long have you been involved with this device?

_____Yrs. _____ Mos.

1. Are the personnel scheduled into this trainer all essentially the same in background, experience, previous training, and so forth, or are there important differences among the trainees?

2. What are the differences?

3. In what ways is the trainer used differently for different types of trainees?

4. Is student use of this trainer voluntary or is it scheduled by authority?

5. Do you think the amount of time scheduled for individual students or teams is too much, too little, or about right?

6. Why do you feel this way?

7. How often do students use it or try to use it?

8. Is this often enough to satisfy student training needs?

9a. Why don't students use the trainer enough to satisfy their training needs?

9b. What particular training needs do you feel this device satisfies?

10. In general, when students come into this trainer, are they adequately prepared to get maximum benefit from using the trainer?

11. For personnel who would benefit by using this trainer, are the administrative procedures for gaining access to it easy?

12. What are the administrative obstacles?

13. Do you know of any administrative obstacles at all?

14. Is the number of trainers or their physical location a factor in utilization?

15. Do problems in getting a team together influence its use or its effectiveness?

16. Approximately what is the utilization rate for this trainer?

17a. What would you say is the biggest hindrance to maximum utilization?

17b. What other factors interfere with maximum utilization?

18. In general are the instructors who operate the trainer well qualified to operate it?

19. Why do you say that?

20. Are they well qualified in the skills which the trainer trains?

21. Why do you say that?

22. Do you think it's important that they be skilled in these skills?

23. In general do you think the instructors feel that the trainer does an adequate job of training?

24. Do you know why they feel that way?

25. Are the instructors well qualified to evaluate student performance in the trainer?

26. Why do you say that?

27. On what kind of data is the evaluation based; for instance, does it depend on the instructors' memory, informal notes, a checklist, a computer read-out, or what?

27a. What kind of information does the trainee get, and at what points during his training is he evaluated? Do the evaluations pertain to team performance or individual performance?

27b. Is the evaluation of performance in the trainer reported to anyone other than the students being trained? If so, to whom is the report made, and what is done with the information?

28. How could the evaluation be improved to be more useful to the students?

29. We're trying to find out what people are likely to hear about this trainer before they use it. What favorable or unfavorable comments did you hear before you had direct experience with it?

30. From whom, and where?

31. Based on your experience with the trainer, what would you be likely to say to someone else about it, both pro and con?

32. As far as you know, does the trainer have any kind of a reputation with regard to maintenance or reliability? For instance, is it regarded as a generally reliable or generally unreliable machine? I'd like to know if the trainer has a reputation in this respect, even though it might be different from your own opinion.

33. What reputation does it have with regard to maintenance or reliability?

34. With whom does it have this reputation?

35. To your knowledge, has it ever been necessary to cancel or delay scheduled training due to equipment casualties?

36. How many times has this happened to <u>you</u>?

37. How long were these delays?

38. Are there any <u>particular</u> maintenance problems that you're aware of from your own personal knowledge?

39. Are there any particular maintenance problems that you've become aware of through scuttlebutt?

40. Do you know of any person or group of people at the present time who are actively promoting the use of this trainer?

41. Who are they?

42. What are they doing to promote the trainer?

43. What positive or negative effects would you say these efforts are having on the use of the trainer or on peoples' attitudes or knowledge about the trainer?

44. To your knowledge, are there any people now, or have there been any in the past, with an <u>unfavorable</u> opinion of the trainer?

45. Who are they?

46. Why do they feel this way?

47. To what extent and in what ways has this negative opinion spread to other people?

48. During the development of this trainer, did the designers obtain or try to obtain information from the users of similar devices (either instructors, trainees, or other Navy personnel) to assist them in making design decisions?

49. Considering all the characteristics of this trainer, the various features that were designed into it, the way it operates, etc., would you guess that users of similar devices were consulted to assist in making design decisions?

50a. With regard to the development of this trainer, do you know where and how the requirement for it originated?

50b. What are the training purposes for which this trainer was originally designed? I'd like to know what the designers' original purposes were, even if the trainer is being used differently now.

50c. Considering the training needs of the trainees, what limitations are there in what this device was designed to do?

51. Would you say that the present uses of the trainer are exactly the same as what you've said the designers intended, somewhat different, or very different?

52. Are there some skills that cannot be trained in relation to the training requirement it was supposed to fulfill?

53. Is the trainer being used to train skills other than those originally intended by the designers?

54a. Could the trainer be used effectively to train skills other than those for which it's presently being used?

54b. Should it be used in these other ways, either instead of the way it's being presently used, or in addition to its present uses?

55. Consider the present uses of the trainer. Could the same training be accomplished with a less complex device?

56. To your knowledge, have any hardware modifications been made, either official or unofficial, since the installation of this trainer?

57. What modifications have been made?

58. By what agency or group were they initiated?

59. Have these modifications affected the training capabilities of the trainer?

60. Have these modifications allowed more functions to be trained, restricted the original range of functions, or had some other effect?

61. In what specific ways have the training functions of the device been changed by the modifications?

62. Would you judge the overall effect of the modifications to be good or bad, as far as training effectiveness is concerned?

63. What other effects have these modifications had, for instance, on reliability and maintenance, problem set-up, and operation?

64. Are there any channels of communication that you can use to make suggestions for improving this trainer?

65. What are they?

66. Does anything effective happen if these channels of communication are used? In other words, do you feel anything is done about legitimate complaints and suggestions?

67. Have <u>you</u> ever registered any such complaints or suggestions?

68. Do you ever feel frustrated about the way suggestions or complaints are handled?

69. What would you like to see in the way of new lines of communication or improvements in existing lines of communication?

70. Have you had experience with <u>other</u> trainers in this area of operations? Which ones?

71. On the whole, how worthwhile do you think trainers of this type are? Why?

72. Overall, in terms of actually accomplishing effective training, what would you say are the most serious deficiencies of trainers of this type? Please start with the deficiency you think is <u>most</u> serious, and give me some indication of why you feel that way.

73. If you were in a position to suggest design changes for a new model of this trainer, what design changes would you suggest to improve training effectiveness?

74. What design changes would you suggest to make the trainer more cost-effective?

75. What design changes would you suggest to make it easier to provide students with more complete or more meaningful evaluations?

76. In order to provide better evaluations to the students, what kind of information would you like the trainer to provide you with?

77. This is the end of the interview, but before you go I'd like to give you a chance to make any comments you'd like to about the trainer. Perhaps we didn't cover something that you consider important, or perhaps something we talked about needs further explanation. Do you have any comments you want to make?

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Human Factors Research, Incorporated
6780 Cortona Drive
Goleta, California 93017

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

FACTORS LEADING TO THE ACCEPTANCE OR REJECTION OF TRAINING DEVICES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Report (June 1970 - April 1971)

5. AUTHOR(S) (First name, middle initial, last name)

Robert R. Mackie with Gene R. Kelley, Gary L. Moe, Michael Mecherikoff

6. REPORT DATE
August 1972

7a. TOTAL NO. OF PAGES
166

7b. NO. OF REFS
20

8a. CONTRACT OR GRANT NO.
N61339-70-C-0276

b. PROJECT NO.
NAVTRADEVCEN Task No. 8346

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
NAVTRAEQUIPCEN 70-C-0276-1

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Approved for public release; distribution is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

Naval Training Equipment Center
Orlando, Florida 32813

13. ABSTRACT

The use and acceptance by Navy personnel of 16 major training devices were studied in relation to: (1) situational factors affecting training; (2) simulation characteristics of the trainer; (3) instructional characteristics of the trainers; reliability of the trainers; formal and informal communications regarding trainer capabilities; and level of experience of the users in the systems simulated by the trainers. Trainers representing air, surface, and submarine systems were selected for study; the participants included students, instructors, administrative, and maintenance personnel.

An acceptance profiling technique was developed that appears to be highly diagnostic of the reasons for acceptance or rejection of particular trainers. It was evident that both highly accepted and seriously rejected trainers were represented in the sample. Methods for increasing trainer acceptance are outlined in terms of improvement in specific areas of simulation; improved software; greater qualifications for instructors; improved evaluation of performance; and improved understanding of the purpose, capabilities, and limitations of trainers by the users. The merits of continuing studies of trainer acceptance and the role of a "trainer advocate" are discussed.

DD FORM 1473

UNCLASSIFIED

Security Classification

14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Training						
Training devices						
Acceptance/rejection						
Human factors						
Acceptance profile techniques						
Criteria of effectiveness						

DD FORM 1 NOV 65 1473 (BACK)
(PAGE 2)

UNCLASSIFIED

Security Classification

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Mailing labels are prepared, when needed, as a computer listing, the source of which is updated on a weekly basis. It is not practical to prepare distribution lists each time labels are prepared. Therefore, such lists are prepared semiannually, and a slight discrepancy may exist between the addressees on this list and those appearing on the labels used to distribute this publication.

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FACTORS LEADING TO THE ACCEPTANCE OR REJECTION OF TRAINING DEVICES. 1971, 166p, 35 illus., 21 tables, 20 refs.

The use and acceptance by Navy personnel of 16 major training devices were studied in relation to: (1) situational factors affecting training; (2) simulation characteristics of the trainer; (3) instructional characteristics of the trainers; reliability of the trainers; formal and informal communications regarding trainer capabilies; and level of experience of the users in the systems simulated by the trainers. Trainers representing air, surface, and submarine systems were selected for study; the participants included students, instructors, administrative, and maintenance personnel. An acceptance profile technique was developed that appears to be highly diagnostic of the reasons for acceptance or rejection of particular trainers. It was evident that both highly accepted and seriously rejected trainers were represented in the sample. Methods for increasing trainer acceptance are outlined in terms of improvement in specific areas of simulation; improved software; greater qualifications for instructors; improved evaluation of performance; and improved understanding of the purpose, capabilities, and limitations of trainers by the users. The merits of continuing studies of trainer acceptance and the role of a "trainer advocate" are discussed.

KEYWORDS

Training
Training devices
Acceptance/rejection
Human factors
Acceptance profile techniques
Criteria of effectiveness

Human Factors Research, Inc.
Mackie, R. R. and others
N61339-70-C-0276
NAVTRADEVCEN
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