TRAINING EFFECTIVENESS EVALUATION: PAST AND PRESENT

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ABSTRACT

Training effectiveness should be the driving force behind the procurement and use of training systems. However, there are major difficulties to overcome in the evaluation of aircraft training systems effectiveness. The main difficulty stems from the complexity of the issue, which results in a lack of clear operational definitions. The Naval Training Equipment Center has initiated a research program in Training Effectiveness Evaluation (TEE), an initial part of which is to develop a model of the TEE process. The main objective of the initial phase of the program is to define the elements needed in TEE and to specify the interrelationships among critical elements. Another objective is to foster better communications within the training and operational community.

INTRODUCTION

One early attempt at aircrew training was a device known as "pin ball." The objective of "pin ball" was to train "live fire" sortees against other aircraft (Air Force, 1945). This was accomplished by gunners firing special "frangible" bullets which would not damage the armored target aircraft. The target aircraft had 110 microphones mounted on the fuselage. Any "hit" was registered through a microphone connected to a counter located in the cockpit. A hit also activated a red light in the nose of the target aircraft which would blink on for a short time (Figure 1).

"Pin ball" contained many aspects which remain as issues in contemporary training. The fidelity and realism of the device were high; and complete visual, motion and aural cues were supplied to the gunner. The device also provided immediate feedback to the trainee as well as objective performance measurement.

Contemporary training issues revolve around the levels of fidelity required for simulation and the costs associated with such fidelity. In ground-based aircraft simulation, for example, the requirement for motion cues has not been addressed satisfactorily. This issue is of great economic interest since platform motion bases are expensive and have a great impact on engineering design and facility requirements. Other contemporary issues that require attention are illustrated in the technical development of a 360° visual display and/or advanced means to substitute color in a monochromatic presentation. A crucial consideration is the question of how much more effective a training system could be with the addition of such technical achievements.

The effectiveness of a training system directly affects the performance of the output (i.e., the graduates) in post-training environments. Thus, the evaluation of training effectiveness is a critical link in the design and

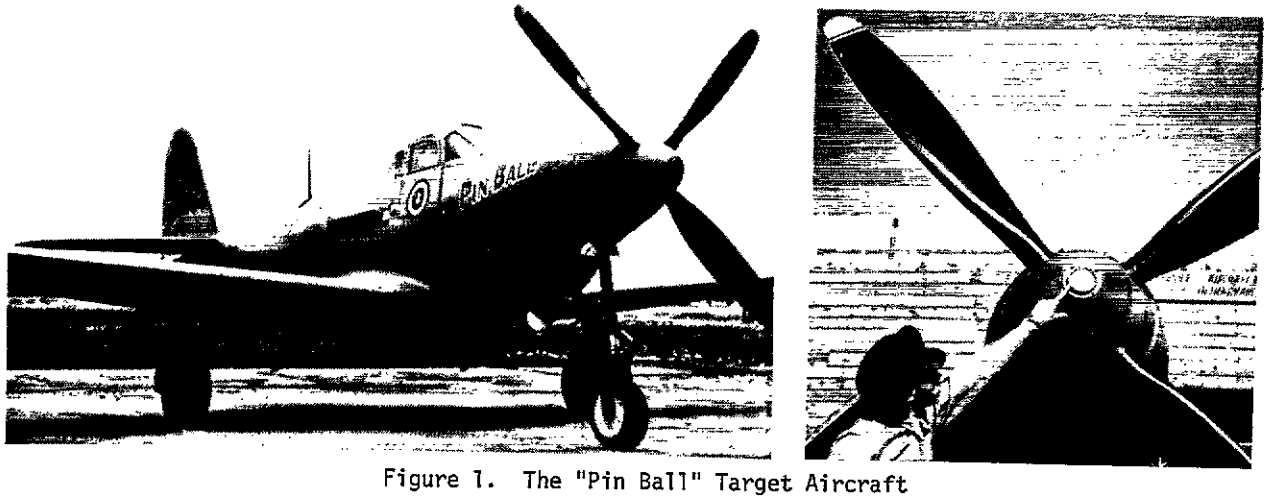

Figure 1. The "Pin Ball" Target Aircraft

use of simulators and training devices. It is clear that training effectiveness has a direct impact on combat readiness.

Contemporary TEE Difficulties

One of the major difficulties in the area of TEE is the lack of agreement on definitions for appropriate terms. For example, Johnson (1976) noted that no one can provide a precise definition of training effectiveness. Other investigators have questioned the basic validity of simulator training programs. "The effectiveness of almost all military simulator programs is being assumed, and, in many cases, these assumptions may be in error by significant amounts. There has been virtually a total absence of controlled tests designed to validate military simulator training programs" (Caro, 1977, p.11).

TEE at NAVTRAEQUIPCEN

The Naval Training Equipment Center (NAVTRAEQUIPCEN) is involved in research programs, as well as applied efforts to understand both the methodological and practical considerations underlying TEE. The program has taken on increased significance due to:

- Advances in the state of the art in simuation technology.
- Heavy emphasis on determining the costs related to simulation.
- Requirements to train personnel to perform increasingly complex aircrew tasks and tactics.

Elements of TEE

The objective of TEE in aircrew training is to assess how wella training system imparts skills and knowledge to a trainee, and how well the skills and knowledge are demonstrated in real world task performances. The process depends upon three interdependent elements:

- The trainee.
- The training environment.
- The operational environment.

Training system development has concentrated on the optimum interaction between the trainee and training environment; TEE concentrates on the interaction between the training and operational environments.

A vital requirement in training effectiveness evaluation is that there must be a match between what is required in the operational environment and what is trained. The match requires a clear specification of operational requirements, and the development of pertinent training criteria and related performance measures. The development of criteria must occur through a systematic process which examines longitudinal effects to ensure that all relevant operational factors are included in a TEE. Goldstein (1974) stated the issue succinctly. "Evaluation is only one part of a long-term systematic approach; therefore, it is necessary to pay particular attention to developing relevant criteria of learning and transfer performance" (Goldstein, 1974, p.213).

Another important requirement in TEE is the need for effective two-way communication and feedback between the operational and training communities. Unfortunately, such communication links appear to work ineffectively in many cases. Without such links, training will tend to be divorced from operational inputs. Further emphasis must be placed on developing *more adequate communications.*

An effective TEE requires that consideration must be given to the methods by which TEE's are conducted. TEE often has been conducted through the transfer of training (TOT) paradigm. TOT consists of comparing training performance to performance which can be observed and measured in an operational setting (Blaiwes, et. al., 1973). The comparison is difficult, as many divergent operational requirements must be integrated to develop criteria. Another specific method used to measure training effectiveness is the incremental transfer effectiveness function (ITEF) which deals with the time savings in a training situation based on the utilization of successive increments of training in another usually less costly, training situation (Povenmire and Roscoe, 1973). This is a useful measure to express time savings, but, it, like many other measures does not integrate training costs into its formulation. The usual assumption is that it is less costly to use a simulator for training. Yet Caro (1977) stated that no one knows which simulator programs are cost-effective since it is difficult to determine all the variables that affect costs.

Other considerations for a TEE include the attitudes of personnel (trainers, trainees, operational personnel) and the impact other variables in a total training system have on TEE. The variety of considerations make training effectiveness evaluation a complex effort. A useful way to view the many variables and their interactions is through the development of a multidimensional TEE model.

A Model of the TEE Process

A model of the TEE process is being developed to provide guidance for the determination of how well a training system meets operational requirements. The preliminary TEE Model (TEEM) is depicted in Figure 2.

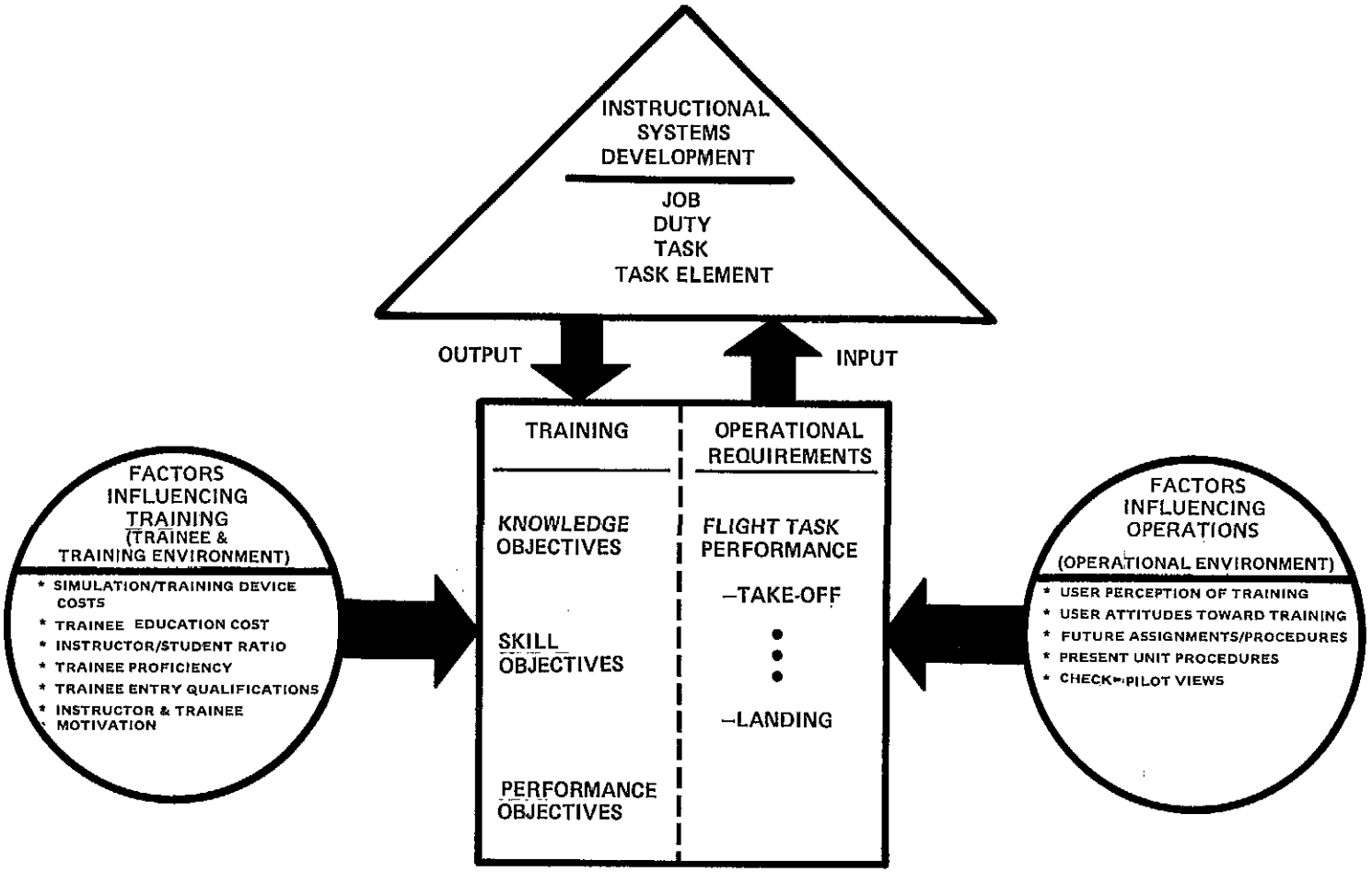

FIGURE 2 – TRAINING EFFECTIVENESS EVALUATION MODEL (TEEM)

The TEE Model was designed to examine the connection between operational requirements and training system components as shown in the central portion of Figure 2. For example, an operational task such as a take-off must be broken down into knowledge objectives and skill objectives which serve as the basis for the evaluation. The breakdown procedure is accomplished by means of the Instructional Systems Development (ISD) process. Through this process, necessary task analyses of job, duty, task and task elements are performed to specify training requirements.

The model also provides guidelines to develop factors that are not in the central portion, but are very important considerations in a TEE nonetheless. For instance, the model considers the influence from diverse subjective factors including personnel perceptions, attitudes and views; or objective factors such as influences from unit procedures. Factors such as future trainee duty assignments and experiences (longitudinal factors) must enter into the definition of operational influences.

Influences on the central portion of the model also occur from training factors (left hand area of the model). Resources, training personnel, facilities, devices and trainee ability all enter into training evaluation from the trainee and training environment. While most of the influences are objective, subjective attitudes of the trainee and training personnel must be factored into a TEE.

The major benefits of the model are that it can serve as a communication tool between operational and training groups, and that it provides an analytical tool for examining the TEE process in detail. Both of these aspects of the model are vital to the increased utilization of simulator outputs which include trained personnel as well as advances in simulation state of the art. The model is a necessary first step to define issues and problems related to TEE and to guide future research efforts.

The model may also be used to develop a checklist of the elements for a TEE including the following:

a. From the operational environment element --

- Have the operational requirements been fully identified?
- Have personnel perceptions of the requirements been analysed?
- Have actual and future squadron practices been considered?

b. From the training environment element --

- Have training device and simulator costs been properly identified?
- Have training personnel attitudes been determined.

c. From the trainee element --

- What are the trainees' views of the training program?

d. and from the model --

- Have valid performance criteria been developed?
- Have all relevant costs influencing the training been identified?

The model also can serve as a means of integrating on-going research results and attempts at developing performance measurements. One Air Force effort will attempt to apply automated performance measurement techniques within a C-5A aircraft. The objective of this effort will be to compile operational data which can be compared directly to a simulated system. Another effort, which is reminiscent (in objectives) of the "pin ball" system described earlier, is the Fairchild TOW Helicopter Installed Television Monitor and Recorder (HITMORE) developed for real-time monitoring and assessment of aerial gunnery performance. This system provides immediate post-mission playback and analysis of gunner aim-point during live or simulated firings of the AN-IS-TOW COBRA Weapon System (Ayral and Chandler, 1978).

Additional Research in TEE

The model as developed requires validation and improvement, but it can form a basis for defining TEE problems and solutions. In almost all endeavors it is important to define elements of a problem before attempting to specify solutions. This is especially true with TEE since it is a complex topic. The methodologies to address many of the elements have not been completely specified and need additional research. Some methodologies that might be beneficial to TEE are:

- Multidimensional scaling for performance measurement may offer a promising way to assess crew proficiency.
- The measurement of longitudinal variables such as retention must be addressed; transfer of training to the operational environment must show retention, otherwise the training program may not be worth the cost

- Cost-effectiveness analysis has not been successfully applied to TEE; relevant costs must be determined.

With the increasing role that TEE now plays and will play in the future of Naval aircrew training, a comprehensive research plan must be developed to address issues such as these. TEE must, therefore, be included as an integral part of all training systems.

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