EFFECTS OF TRAINING SITUATION ANALYSIS ON TRAINER DESIGN

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One of the major branches of military training is maintenance training. In formal schools for aircraft maintenance training it is seldom practical to train personnel in flight line and hanger procedures on line aircraft. To aid in providing these skills, many training devices are employed. These devices each simulate portions of the real maintenance environment the student will encounter in his future work.

The form in which the maintenance task is simulated depends upon the particular training situation or the "use requirements" of the trainer in supporting the overall training course. The training situation therefore determines the general design of the device. Trainers may take many forms, from elaborate mock-ups of major portions of the airframe or its electronic systems, to a simple practice stand where a student can perform a maintenance task until the skills become automatic.

Ideally, flight-line and hangar maintenance training would take place in a real environment utilizing the aircraft, tools, test equipment, and procedures the maintenance man would encounter in actual practice. Unfortunately this is impractical in formal schools where numbers of students in many different specialities must be trained simultaneously and in a short training cycle. In the crowded confines of the aircraft, only one or two students at a time can work on any one operation. The maintenance tasks of the various specialities to be trained either conflict with each other or cannot be performed safely together. Additionally, many operations simply cannot be performed safely until the student has previously practiced and understood the principles. Since the aircraft is not an effective training tool for formal maintenance schools, other types of training devices are needed to expedite and enhance the training program.

A typical formal training program may be divided into two major parts; the lecture phase and the lab phase. The lecture phase provides first a general understanding of the principles involved, and then the how-to-do-it details. The lab phase of training follows much the same pattern of "principles" followed by "applications". The training situation, however, has now moved from the large group, motivated and force-fed by the instructor, to the individual or small group in a self-learning situation, where the principles and the how-to-do-it logic and skills are made their very own.

Training devices may be used effectively in both the lecture and the lab phases of the program. They can assist by adding a visual and tactile focus to the points of the lecture or by illustrating the principles presented. Training devices may be exceptionally useful in the lab phase of training in providing a place to practice how-to-do-it problem solving with tactile, visual, and audio reinforcement of the training.

Visual and audio aids of many kinds are available to assist the training program: films and tapes, projected or permanent graphics, programmed instruction devices, and plain old fashioned texts. In fact, the single most valuable aid is the aircraft maintenance manual itself. Each of these classes of aids can be of great value to the training program, and it would be very interesting to explore the effects of changing training situations on the design and use of these aids. However, none of these aids provide the student with tactile reinforcement of the lecture or with the opportunity to practice procedures until lecture theories become personal skills.

Student-operated training devices which simulate portions of the aircraft maintenance environment do provide this combination of theory reinforcement and tactile practice. It is our purpose here to explore the effects of changing training situations on the design of these devices for the Naval Air Maintenance Training Detachments (NAMTRADETS) and the Air Force Field Training Program.

The maintenance trainer of 20 years ago was aimed at the training-in-grade of already skilled personnel to maintain a basically familiar system, such as hydraulics, on a new model aircraft. Since the people were already skilled in their speciality, training cycles were short and aimed primarily at understanding the functions of the overall system rather than skills such as rigging or installing a hydraulic cylinder. As a result, maintenance trainers tended to emphasize overall system operation, relationships, or principles. These functions are best shown and taught graphically. The typical hydraulic system trainer of the period was an animated schematic on which system relationships could be demonstrated, isolated, or repeated at will, emphasizing the point of the lecture. Manual skills training and fault isolation practice using real hardware were not requirements for the maintenance trainer, and consequently, were seldom provided.

As the average time in service of the maintenance personnel decreased over the past 20 years, and the number of operating squadrons increased, the training load increased correspondingly. The operating squadrons were faced with increased training requirements to upgrade personnel, as well as transition training for improved models of aircraft. From this evolved the Air Force's Field Training Detachment (FTD), as well as an enhanced Naval Air Maintenance Training Group program.

The FTD's and NAMTRADETS, groups of full-time instructors equipped with maintenance trainers, are assigned to a base for a long period of time to assist operating squadrons with maintenance training. Instead of "transition-training" skilled personnel in grade, emphasis is placed on upgrading the skill level of the personnel. As a result, the design requirements for maintenance trainers changed to meet the increased emphasis on skills training. The animated schematic style trainer was typically replaced by an operating hardware mock-up of the system in the airplane, and graphic aids took over the task of illustrating system theory and function during the lecture phase of instruction. The maintenance trainer, therefore, became the primary training tool in the lab phase of instruction. The requirements for a typical maintenance trainer became: Provide familiarity with the equipment as it is installed in the aircraft; provide applied practice in maintenance operations, parts replacements, rigging, adjustment, and safety practices; and provide trouble shooting and fault isolation practice.

We have examined the general role of training devices in the maintenance training program today and the resulting requirements the trainers must fulfill. Let us now look in more detail at the process whereby the maintenance trainer is fitted to that role.

Before any requirement exists to design a trainer, the need for the trainer must be established. Aircraft system maintenance procedures are analyzed to define the skills needed by the maintenance personnel. Training requirements to provide these skills are defined and reviewed to determine which kinds of aids will best promote these skills. If a maintenance trainer is needed, the general nature of the trainer is determined. For example, would an operational mock-up, a static display, or an animated display best fulfill the requirements?

The next step is establishment of detail design requirements. If an operational trainer is to be provided, the requirements for operating the system in the classroom, isolated from the rest of the aircraft systems, must be determined. What input signals or output displays must be provided synthetically to allow a navigation system to function normally? What safety hazards exist around a radar system in a classroom? What security problems will an operating counter-measures trainer present?

Some general considerations in setting detail design requirements are:

- Accessibility to students.
- Maximizing the number of student training stations.
- Generating student enthusiasm.

- Good transfer of training to the aircraft environment.
- Transportability.
- A short engineering and delivery cycle.

When the detail design requirements have been fully developed, potential solutions to these requirements must be evaluated and the general configuration established. The proposed configuration is then submitted to the customer for approval.

With customer approval to this point, detail design or engineering can now begin. Designing is basically an iterative process. The general design is subdivided into functional components, and again requirements are established with alternative solutions sought and evaluated. Eventually a preferred design will be selected for each of the components. This process proceeds in ever greater detail until the design is complete.

Consider the effect a change in training requirements can have upon maintenance trainer design using two different training situations applied to two versions of RF-4 camera system trainers. The RF-4C camera trainer, shown in Figure 1, was designed to meet mobile training detachment requirements for "transition-training" personnel already experienced in their specialty. It consisted of an operational mock-up of the camera installations on two open panels. The viewfinder, cockpit equipment, and camera parameter control unit were mounted on an electronic workbench. The trainer featured transportability, easy access for system troubleshooting and maintenance practice, and numerous training stations. The trainer did not attempt to present realistically the conditions surrounding the performance of maintenance tasks in the aircraft. That form of "finger-dexterity" was not a requirement for the experienced personnel being trained.

The RF-4B camera trainer, shown in Figure 2, was designed for a permanent school to provide training for both skilled personnel transitioning to the new aircraft, and for personnel fresh from basic school who had yet to work on their first aircraft. In this case, transportability was not a prime requirement; thus the panels could be heavier and larger. Training in camera installation and removal, the use of camera hoisting equipment, camera door rigging, and system trouble-shooting was required. To provide these mechanical skills, as well as trouble shooting practice, a complete operational camera installation within the confines of a mock-up of the interior of the aircraft nose was mounted on one panel. The viewfinder and aft cockpit controls were mounted on an electronic work bench. Within the confines of the nose, all installations, clearances, and encumbrances provided realistic conditions in which to practice the desired skills under flight-line conditions. Since the trainer was designed for the Marines, some thought was given to adding rain and mud for utmost realism. After some consideration, this requirement was waived. This greater emphasis on "finger-dexterity" and realism of practice had a price. Easy transportability was sacrificed, the number of available student training stations was reduced, and ease of access for both lecturing and practice was lost.

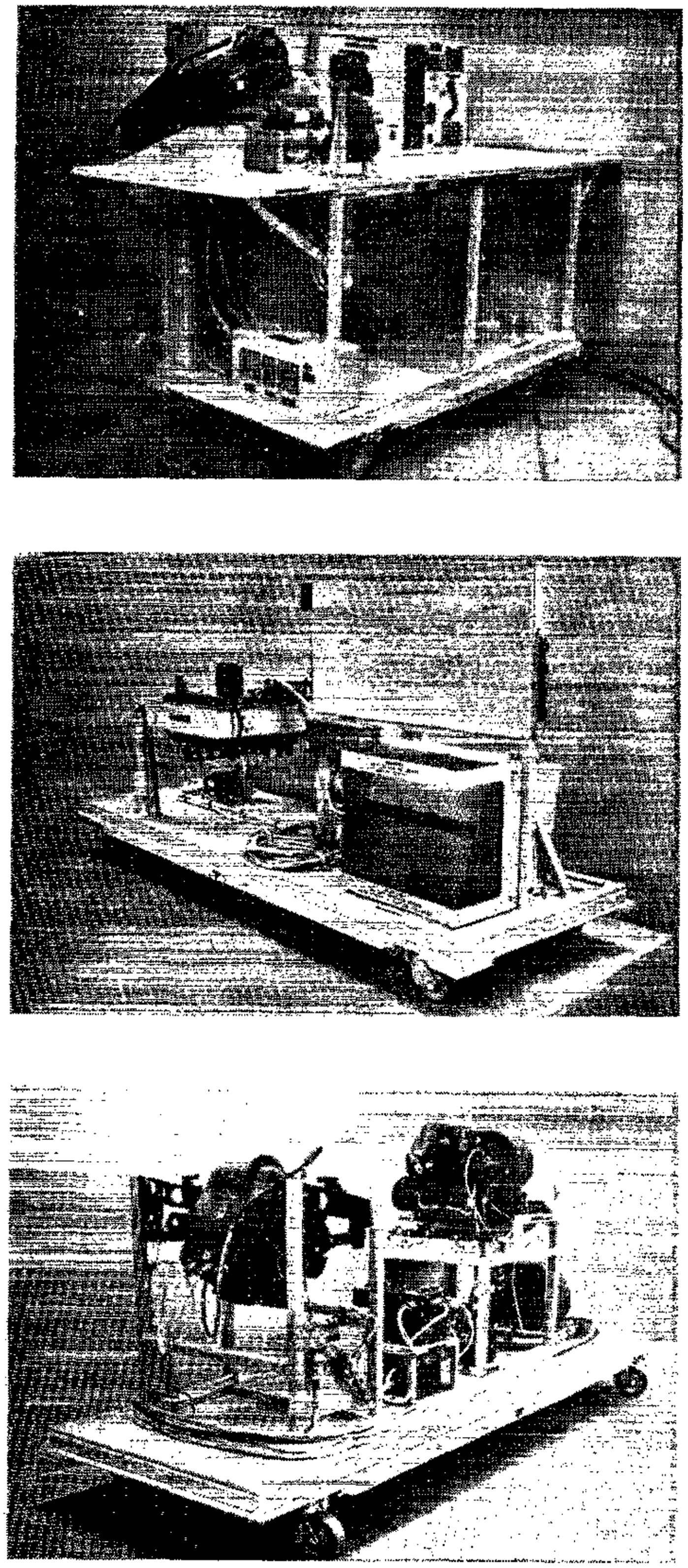

Figure 1. RF-4C Camera Trainer

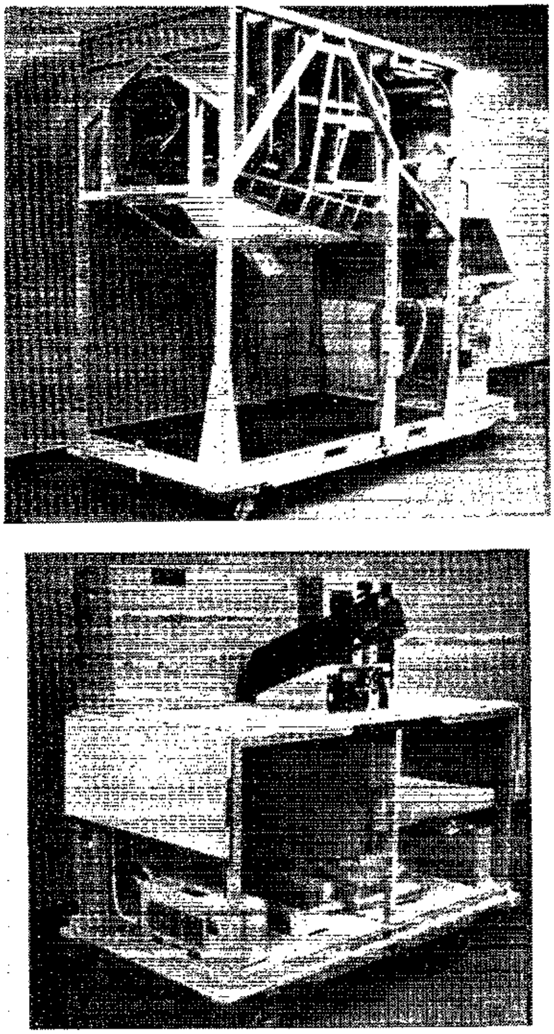

Figure 2. RF-4B Camera Trainer

In the above example, the final skills requirements of the maintenance people were the same for both schools. The RF-4B school expected to receive a greater percentage of students with little experience in maintenance of photo systems in aircraft and consequently additional requirements for applied skills training had to be satisfied. As a result, it became a design requirement to provide a greater degree of realism in simulating the aircraft maintenance environment in the RF-4B camera trainer. The changing training situation was reflected in the change in design described in the example.

In summary, economics of use require that formal schools use training devices to simulate the aircraft maintenance environment rather than use the aircraft itself. Individual trainers, of necessity, simulate only selected portions of that maintenance environment. Because of the economics of use, each trainer is a compromise satisfying only the most urgent training requirements which cannot be more economically fulfilled in some other way. Careful analysis of the projected training situation is required to establish and evaluate the training requirements to be met by the training device. Only with careful training situation analysis can the design of the trainer be guided to meet the needs of the training program and provide the customer with the best possible training capability for the money spent.