THE NAVAL TRAINING DEVICE CENTER RESEARCH PROGRAM

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The research organization at the Naval Training Device Center was formed in March 1964. It was formed because it became apparent that, with the ever increasing demand for training devices and the need to provide training for more complicated tasks, the inventory of technical know-how had to be expanded in at least the same ratio as the requirement for new training devices.

It would be well to call your attention to the fact that research at the Center is applied, not basic research. We are not trying to extend man's fundamental knowledge for its own sake. Our effort is that which draws from other research the tools, materials, techniques, and methodologies which can be directed toward training devices and, by selective study and experiment, demonstrate their applicability.

There are a few occasions when it is necessary to conduct more fundamental research, but this comes about only as the result of a void in information required to assist in our research effort.

To best fulfill our goals the research laboratories are divided according to disciplines rather than operational objectives (See figure 20).

We have presently five laboratories and a Laboratory Services Department. The laboratories are engaged in a number of endeavors, including a variety of research projects, both in house and contract, as well as providing consulting services to other segments of the Center's organization.

It can be seen from figure 21 that the research directorate has functions other than just research. As a matter of fact, less than half of our total time is spent on research presently. This will increase some by phasing out the contract portion of our development work. These are the projects carried over by the engineers who were transferred into our group from the engineering department when the research directorate was formed. With this 10% shift of our effort from development to research, we will be over the 50 % level for direct work in research.

We consider that an important aspect of the measure of the research directorate is the consultation services provided by our scientists and engineers to other Center departments. This "indirect research" tends to insure that the research results will eventually be applied to developmental projects. In addition, the organizational role of the "consultant" in the research lab assures that he is under the supervision of a technical expert in his own field. Also, the participation of some of our personnel in the analysis of training ramifications in operational requirements, further assures that our research is appropriately oriented.

The Physical Sciences Laboratory, Code 51, is responsible for conducting research and providing consulting services in a range of physical sciences such as optics, photo-optics, photo-chemistry techniques, photogrammetry and cartography, geophysics, oceanography and meteorology as applied to display techniques, and materials and components for training devices. They also conduct research and provide consulting services in the synthesis of displays.

Some work presently underway includes the study of space frequency filtering techniques for image enhancement, the utilization and application of lasers in training devices, the application of holography in training, the simplification and improvement of the transparencies used in radar landmass simulation, and the near completion of a study which examines the factors to be considered in the training for deep water

navigation.

The Electronics Laboratory, Code 52, is responsible for conducting research, providing consulting services and evaluating simulation components and techniques of electromagnetic, sonic and magnetic detection and transmission equipment. They also are responsible for developing various techniques which use the physical properties of projectiles in motion to determine the projectile's location.

This laboratory is presently engaged in the determination of the electrostatic and electromagnetic properties of bullets in an effort to make use of these properties for student gunnery scoring by means of a non-material target. Other avenues of investigation being followed in this effort include active optical illumination of the projectile as a means of obtaining the same information.

The Electronics Laboratory is also conducting experiments which investigate the use of several properties of electro-magnetic transmission for application to the simulation of a training environment.

The Visual Simulation Laboratory, Code 53, is responsible for conducting research and providing consulting services in real world visual simulation systems and integral components thereof. Present endeavors include the improvement of the controls of the Point Light Source (basic motion device). Heretofore the Point Light Source has been used as a research tool in the development of flight simulators. The dynamics associated with low frequency control phenomena such as is necessary in the development of a ship control trainer dictates this improvement.

The laboratory is in the process of evaluating several techniques for ship control presentations to establish a payoff for training effectiveness vs sophistication. Future Visual Simulation Laboratory work includes investigation into several, hiterto unexplored areas, where real world displays may be useful.

The Computer Laboratory, Code 54, is responsible for directing and operating the Center's computer facility; conducting research in computer mathematics and programming especially for the development of mathematical models for simulation purposes, conducting research in computer applications, analog and digital simulation, computer components, computing systems and computational techniques as related to training systems; providing consulting services in computer, computational, and mathematical technology and applications.

This laboratory is in the process of developing the characteristics of a replacement for the Universal Digital Operational Flight Trainer Tool (UDOFTT). This research tool was the first real time digitial computer and has been in operation since 1960. It will be released to GSA for appropriate disposal, and its replacement will be installed here in Orlando. The Laboratory is also engaged in developing methods for the control of several flight trainer cockpits simultaneously; the development and analysis of the dynamic equation of the hydrofoil (especially in the transition mode); and the establishment of a hybrid computing facility. The laboratory is studying the optimization of training device mechanization through the use of suitable math models. This involves experimentation in a hybrid computing facility to determine the best interface or interfaces for analog and digital computation in several classes of training devices. Associated with this effort is the attempt to examine and test various classes of simulation equations to determine which terms can be eliminated.

The simplified equations can be tried out on a hybrid facility and, if adequate, can be used in simpler, less expensive training devices because refinements have been minimized without jeopardizing training effectiveness. In conjunction with the Psychology Laboratory group, the Computer Laboratory will be working on the programming for adaptive training experiments with primary emphasis on application to motor skills.

The Psychology Laboratory, Code 55, is responsible for defining, developing, and conducting research, and incorporating a human factors input to a support program for present and future training devices. This laboratory operates and maintains specialized psychological research equipment and conducts human factors research studies, investigations and evaluations in human factor problems in such fields as electro-oculography, tracking and control, feedback and transfer of training. The laboratory also provides consultation and assistance in the analysis of training device problems, man-machine system environment interrelationships, and in the consideration of training device designs in terms of compatibility with human capabilities, limitations, training, learning and maintainability.

The laboratory is presently engaged in a variety of studies which include biopotential signal processing, training and performance as a function of stress, computer aided instruction, adaptive systems, the systematic examination of factors which can function as a measure of training device effectiveness and alternate approaches to weapon system trainers.

In this last area we have been, for the most part, trying to train men in WST's that provide an environment similar to that which exists under actual operating conditions. We now plan to develop approaches to weapons systems trainers which are man oriented rather than equipment oriented. These studies shall emphasize the obtaining of desired responses rather than the simulation of operational equipment.

The Laboratory Service Department is responsible for planning, operating, and maintaining research oriented facilities to fabricate, repair, or modify various types of experimental electronic and electro-mechanical devices for use in research and on-station engineering projects; for maintaining and calibrating measuring equipment to determine and analyze basic electrical and electronic values, frequencies, stability, and waveforms; for providing specialized services not available in the laboratories; and for providing consulting services regarding instrumentation on in-house projects.

The classification of research for training devices can be approached from several viewpoints; for example, by scientific discipline, or by potential operational utilization, or by hardware components. Each of these tabulations has been used at one time or another to give us a better look at our work and our problems. We find one of the more useful of these classification schemes to be as exhibited (see figure 22). Most people are surprised to learn that a large percentage of our research work at NTDC is not the simulation of operational equipment but rather environmental simulation. By environmental simulation I mean the representation of the world in which training is expected to be accomplished. It includes such things as terrain models and factored transparencies and constitutes 45% of our work. On the other hand, the simulation of operational equipment constitutes only about 20% of our work. The third area, involving 35% of our effort, is devoted to an examination of generalized training applications. These include techniques such as the utilization of biopotential information in the design of training equipment, e.g., a slowly varying current is generated by the motion of the eye. This signal could be used to establish and correct the sequence of viewing instruments in a cockpit; and perhaps ultimately as a control signal for visual missile guidance training. I feel that the total research effort that I have described may conjure up a picture as to numbers of personnel that are far in excess of our existing organization. Therefore, I would like to indicate that at present we have approximately 50 professional personnel in the research laboratories plus another 60, the majority of whom are shop people and whose efforts encompass both research and development work.

Even more important than numbers of personnel is the problem of establishing an environment conducive to creativity. Emphasis is on originality and imagination. In addition to participation in professional society symposia, internal seminars and profitable brainstorming sessions are held periodically. We are seeking not only improvement in present training device techniques but also completely new approaches.

RESEARCH ORGANIZATION

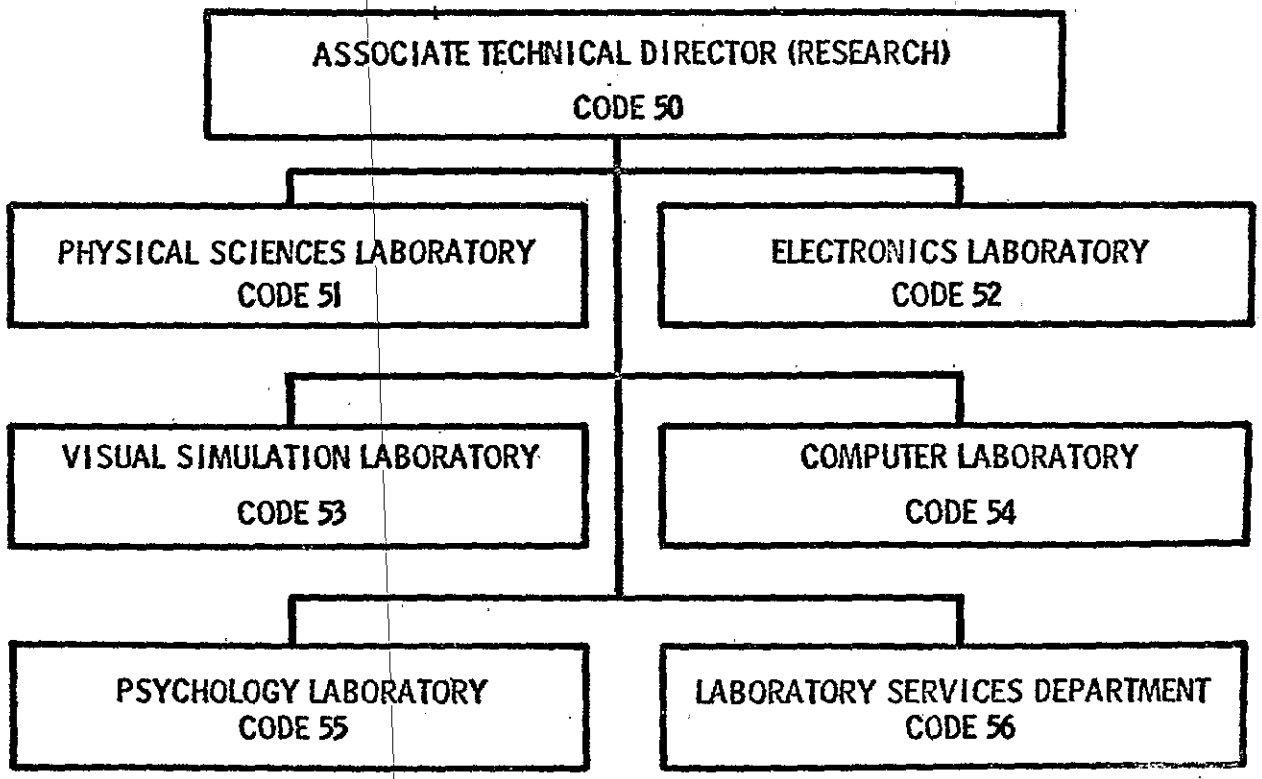

Figure 20. Research Directorate Organization Chart

MAN-HOUR DISTRIBUTION OF RESEARCH DIRECTORATE

RESEARCH	45%
IN-HOUSE	30%
CONTRACT	15%

DEVELOPMENT	30%
CONTRACT	10%
CONSULTATION TO OTHER CENTER DEPARTMENTS	10%
PARTICIPATION IN MILITARY REQUIREMENT STUDIES	10%

GENERAL	25%
TRAINING AND SYMPOSIA	10%
LEAVE	10%
ADMINISTRATIVE	5%

Figure 21. Research Directorate Functions

CLASSIFICATION OF TRAINING DEVICES

ENVIRONMENTAL SIMULATION	45%
GENERATORS	
SENSORS	
DISPLAYS	
OPERATIONAL EQUIPMENT SIMULATION	20%
VEHICLES	
PROCESSORS	
DISPLAYS	
TRAINING APPLICATIONS	35%
TRAINING TECHNIQUES	
DECISION MAKING	
TRAINING EFFECTIVENESS STUDIES	

Figure 22. Research Classification of Training Devices