THE MODERN APPROACH TO TRAINING

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The modern approach calls for the use of techniques and devices that will reduce training costs, and at the same time;

- √ *train the most students*
- √ *cover the most material*
- √ *promote retention of learned material*
- √ *not endanger equipment or personnel*
- √ *free operational equipment for operational use*

TRAINING in the chemical industry is moving forward at an accelerated pace with the profitable application of training devices scientifically designed to meet current training needs. As increased production is achieved by means of more complex process equipment and automation, one of the major operational problems is the man-machine relationship; and underlying this relationship is the problem of how best to transmit information about a process to operators and maintenance personnel, and then how to get the most out of the equipment by having personnel use this information correctly. Obviously, the problem is basically one of training.

Origin of the Modern Approach

The origin of modern training occurred when Hitler, before World War II, was not allowed to use actual weapons in his military training program and resorted to "ersatz" or synthetic equipment. Next, when Great Britain was denied the use of air space over the British Isles for training of air personnel, she was forced to train her air crews, air gunners, and radar men on the ground.

Early in World War II, this synthetic training as it was called, was introduced into this country on a rather elaborate developmental scale. A War Department press release of April 4, 1946, gives some idea of the extent to which this type of training equipment was used and the results which were provided:

"At least 524 lives, $129,613,105, and 30,692,263 manhours were saved in one year through the Army Air Force's use of *eleven* synthetic training devices, according to a survey conducted by independent research analysts. The survey also states that the use of these eleven devices actually freed 15,043 men for other military duties. It appears clear that synthetic training devices have been of tremendous value to the Air Force's training program during the war."

During the postwar period, the military agencies of the government developed and expanded the use of training devices in their various training programs. Devices ranging all the way from small part-task trainers to large, complex procedure trainers and simulators were found to be valuable tools for effective training.

Simultaneously, the increase in complexity of all types of manufacturing equipment and processes increased the urgency of the training problem in industry, and the modern approach to the problem began to be used to solve it.

Briefly, the modern approach deals effectively with a training problem by using the following method of attack:

Analyzing the Training Problem. A highly trained member of the training device company makes a thorough study and analysis of the customer's over-all training problem. In accordance with the findings of this analysis, the type of trainer best suited to the customer's need scientifically is designed and produced. Part-task trainers, which are usually smaller and less complex than simulators and consequently are low-cost, high-utility devices, are recommended whenever possible.

Capitalizing on Part-Task Trainers. A part-task trainer is designed to aid training in a critical area of an over-all training task. For example, a particular over-all chemical process may not call for concentrated training except in one or two areas. In such cases, a complete process simulator may be inefficient, unnecessary, and costly. A part-task trainer, however, provides for concentrated training in the critical area, does not tie up or endanger expensive operational equipment, and is economically attractive.

Using Simulators When Neces-

sary. When the analysis of the over-all training task indicates that an over-all process trainer, or simulator, is the best solution to the problem, the vendor's training personnel, engineering staff, and production department combine their skills to design and produce the most effective simulator possible.

Applying Sound Training Principles. Whether a part-task trainer or an over-all simulator is decided upon, the design and construction of the trainer is based on sound, established training principles.

Advantages of This Training Method

Four important advantages stem from the use of this type of training device as a teaching tool:

Orientation and Emotional Conditioning. Since panels, controls, and instruments of the trainer are arranged and activated authentically according to the arrangement and activation of the operational equipment, the trainee is placed in a training situation that duplicates the actual operating situation. He thus becomes oriented and emotionally conditioned to the operational task. Sometimes there is failure to understand how important this is. Companies make a major capital investment in new equipment and entrust it to operators unaccustomed to the new process. Any damaging of equipment or spoilage of product jeopardizes the operator's position. Thus, fear is coupled to lack of knowledge with a resultant slowing up of the learning process. It has been found that nothing dispels fear and mystery as fast as knowledge and practice. Training on a scientifically designed trainer allows simulation of critical operating conditions and guided practice in complete safety, free from the danger of equipment damage or product spoilage. Learning by doing in the absence of danger and fear speeds the learning process.

Learning by Guided Doing. By this it is meant that the instructor passes information on to the trainee and at some stage in the instruction, the trainee gets up and performs on the simulated piece of equipment. This forces the trainee to take an active part in the learning process by performing actions that are directly transferable to the actual control panel. Difficult or troublesome procedures can be repeated as much as necessary.

Development of the Trainee's Judgment and Responses. The provision for the introduction of critical and emergency situations into a normal procedure conditions the trainee's responses and develops his judgment in taking corrective action. This seems to be a critical role that humans play in the man-machine relationship.

Evaluatory Aspects. The provision for setting up both normal and emergency situations likely to arise in the operation of a procedure, as well as the "play-back" feature of this type of trainer, provides means by which the instructor can determine whether or not a trainee has sufficient capability to serve as an operator. The instructor can do this by having the trainee perform on the trainer—play back the procedure in which he has been instructed. The instructor can also determine how the trainee will perform under emergency operating conditions—again without danger to equipment or personnel.

Chemical Process Trainer

The Du Pont Co. was the first chemical concern to grasp the significant potential in the modern approach to training applied to the chemical industry and, in 1954, negotiated a contract for the world's first chemical process trainer. At the time, Du Pont had developed a new process for producing Hylene. The company's pilot plant was shut down and a substantial capital investment was being made in the construction of a new plant. Meanwhile, the Du Pont management was most anxious to get the new plant on stream at the earliest possible moment. An analysis of the over-all training task indicated that the device best suited to fill the need would be a chemical process simulator.

Crews were trained and operators were ready to put the equipment on stream as soon as the plant was completed and the instrument mechanics were ready to maintain it.

Successful application of the trainer was emphasized when the Du Pont Co. ordered another trainer for a different process. Figure 1 shows the second trainer—a Carmody Integrated Process Trainer which duplicates the complete central control panel for the plant in question. The trainer is 8 feet high and 40 feet long. All instruments, symbols, alarms, and recorders appear on a one-to-one scale just as they do on the actual control panel. Instrumentation critical to training is activated from the instructor's console or from the operation of other controls on the panel itself. Important effects of a variable change are interlocked to appropriate instruments throughout the process. Noncritical instruments are dummied on with manually movable indices and recorder pens. Assemblies on the back of the trainer panel contain the activating mechanism for the instrumentation. Graphic panel representations are accurately reproduced.

The instructor's console is movable, but is designed to be placed as shown in Figure 1. The instructor can have the trainee demonstrate his knowledge of operations by setting up various conditions and having the trainee take required action at the control panel.

Control panel sections are provided with quick disconnects for ease of erection and disassembly. Installation and maintenance can be handled by the customer.

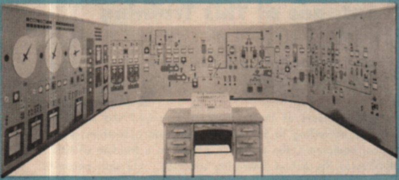

Figure 1. Carmody Integrated Process Trainer

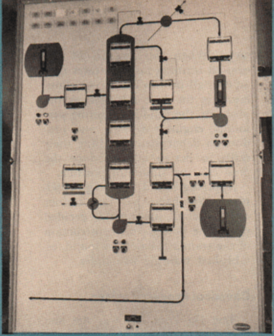

Figure 2. Carmody Fractionation Column Trainer

Fractionation Column Trainer

Still another trainer developed for the chemical and petroleum industries is the Carmody Fractionation Column Trainer, Figure 2. This is a portable unit with which the operational principles of a typical fractionation column can be demonstrated. It is 8 feet high and 5 feet wide and can be folded into a compact unit, 4 feet × 5 feet × 2 feet. The instrument interlock and alarm features of the integrated process trainers are included on this trainer. The instructor's console, shown mounted on the right side of the panel, has a 20-foot control cable and is detachable for remote (rear of room) operation. This trainer can be used for teaching principles common to other types of columns and towers. As shown in Figure 2, the product is brought in at A and is run through the column. The alarm system, telltale lights, and instructor's console are all essential features of this trainer. The trainer can be folded into the shape of an oversize suitcase, making it easy to move from place to place.

Fluid Catalyst Cracking Trainer

Another company that has found the modern approach to training profitably applicable to its training problem is the Standard Oil Co. of Ohio. Some time ago, this company laid plans for the construction of a new $40 million integrated plant. Members of the company in charge of the planning had a great deal of experience with most of the process involved in the new plant, but the fluid cat-cracking process offered certain problems in personnel training. They were aware of the need for equipment to augment their classroom training program.

A training analysis conducted by the trainer manufacturer indicated that a trainer was needed that would:

Provide for setting up, through simulated instrument functioning, variable conditions associated with the process and encountered during operation of the plant.

Permit trainees to run through the various steps used in controlling the process under normal operating conditions.

Permit the introduction of upset or abnormal conditions in the process and thus, in turn, permit trainees to practice handling these abnormal conditions.

Through the above three items, develop the operator's confidence in his ability to handle these controls.

Reduce the time necessary to use the assistance of the contractor's operators in the refinery.

Reduce the training time for operators initially and in the future.

Physical Characteristics of the Trainer

The Carmody Fluid Catalyst Cracking Trainer, Figure 3, is made up of three separate panels joined into one panel which is 6 feet, 9 inches high, 14 feet, 8 inches long, and 9 inches deep. The trainer operates on 110-volt, 60-cycle power with components of the electrical system within the trainer, such as alarms and interlocks, being operated on 24 volts. The maximum power requirement is only 550 watts, and the cost per hour of operation is negligible.

The trainer duplicates the operational control panel accurately, and this duplication has been achieved inexpensively. The critical instrument pens have been activated and many are interlocked automatically. Others are manually movable by the instructor or trainee. A few are simply static photographic reproductions of instruments. In all, the trainer has 24 activated instruments, three interlock systems, and four alarm systems. The alarm systems have been designed for both high and low conditions. A white light only indicates a normal process. A red flashing light with a warning sound indicates an abnormal process which has been acknowledged but not corrected. An important feature of this trainer was the fact that the instruments on the panel could be controlled either by the instructor from a remote location, or by the trainee at the face of the panel. This was the first process trainer that could be operated like the plant itself.

Interlock, as the term is used, means that a number of different instruments will respond automatically to activation of a key instrument by the instructor or operator. In this way, the interrelationships among process variables are programmed into the instrument responses of the trainer. For example, when the instructor increases fresh feed to the reactor, the feed

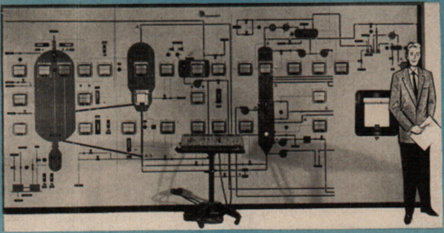

Figure 3. The Carmody fluid catalyst cracking trainer

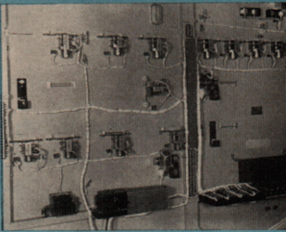

Figure 4. Rear view of Carmody fluid catalyst cracking trainer showing relay rack, power, and instrument activation mechanisms

control recorder No. 302 begins to rise. This, in turn, affects the temperature within this reactor, the temperature recorder controller begins to decrease, and at the same time the reactor slide valve opens as does the generator slide valve.

The next interlock falls into the emergency condition category. It is programmed through the emergency cut-off valve, and this activates seven other instruments. This cuts all feed flow to the reactor, and the interlock illustrates the dependent effects of this action.

The Instructor's Console

In the center of Figure 3 is the instructor's console. It is 14 inches wide, 23 inches long, and about 5 inches deep. On its face is a photographic reproduction of the entire panel with the switches for activating instrument pens sitting right in the miniature vessels. Along the top of the console is a row of trainer operation controls.

The first is the main power switch which controls all power to the trainer. The second is a horn silencer which is tied into the alarm system so that if the instructor is repetitively going through a problem, he is not bothered by the continual horn which may be sounding. Next is a circuit breaker for protection of the activating circuits. And fourth, is an acknowledge switch which allows the instructor to acknowledge alarms easily from his position at the console when he is demonstrating procedures to trainees. The last switch is a programming switch which has three positions. In the *up* position, it cuts out all programming so that if the instructor wants to show step-by-step instrument reaction on a portion of the process, he can do so without affecting any of the other instruments. In the *center* position, the program switch activates the interlocks as described previously. As soon as the demonstration or the instruction is over, he merely pushes the programming switch to the *down* position and all the instruments that are in the electronic interlocks are automatically returned to a normal operating condition.

To give some idea of the electromechanical equipment that is operating the trainer, the motor cam assemblies which activate the pens are shown in Figure 4 and are discussed briefly.

The illustration shows standardized components powered by motors driving the pens and activating the alarm systems. The panel sections are provided with jumper strips at adjacent edges so that it is easy to break these connections, dismount the panel sections, and move the trainer readily. In previous trainers, packaged alarm systems were used and they were satisfactory, but it was found that cost could be reduced by designing a special alarm system. This chassis houses both the alarm system and the power pack. The relay rack folds up during shipment into a very neat, thin package. All relays are of the dust-proofed type. The components are standard and easily obtainable through any electrical supply house. One other point is the portability of the trainer. Although it is not designed primarily to be moved from place to place, this can readily be done by a semiskilled mechanic.

Summary

Of the many advantages, tangible and intangible, to be obtained from the application of the modern approach to training, the most pertinent is that, through its application, profits can be increased. Operational equipment kept in service, more competent operators and maintenance personnel, better end products—all spell greater efficiency and reduced operating costs.

All in all, the future for this new method of gaining knowledge appears full of promise. More and more complex equipment and processes are being developed and sold both at home and abroad, and ways are being devised to prevent the language barrier from affecting the effectiveness of trainers sent overseas.

Automation is also contributing to the need for more and better training, and many different types of personnel are seeking ways to improve their proficiency at various tasks. Training is a dynamic, evolving activity and the modern approach is still in its embryonic stage. The future will see still greater developments in methods of transferring knowledge and inculcating skills.