# TRAINING: AN ENGINEERING PROCESS

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The Training Specialist has historically found himself in the predicament of Mark Twain's Juggler, peddling an act at which almost everyone considers himself an authority and critic. Everyone has extensive experience with the process; everyone understands the task; sooner or later everyone tries it for themselves. Simply keep several items in motion -- all at the same time.

Juggler and Training Specialist share another method of operation: The system approach. Based on experience with Training Specialists, it would be no surprise to find that a good portion of the discussion among Jugglers, when and if they gather at meeting and conventions, would center on charts and models of their chosen or proposed system of keeping more and more moving faster and faster.

The Juggler however is "one-up" on the Training Specialist. Once the Juggler has designed his system and implemented it, before an audience, he has resolved all his responsibilities to his patrons and to his art. His system is in fact contained, and while it might be blended into a total circus, the juggling activity is distinct, with a starting point and a conclusion that are of no particular consequence to the performance of those appearing prior or subsequent. In short, the system is not part of a larger system.

The event of the components of the Training System being put into motion simply marks a point in a process whose beginnings are entwined in larger systems, or non-systems, and whose conclusions cannot be accurately determined.

The Training Specialist, who has accepted the System Approach to training, has already accepted the concept that training is or should be an Engineering and Production Process, designing and producing modifications in human behavior through calculated application of techniques, methods and procedures to meet predetermined standards. The purpose of this paper is to echo Skinner's call for a Behavioral Technology, to move beyond the Jugglers Stage and organize and structure the process for its "own sake", to develop the Total System, a Total Training Environment.

Consider for a moment the Engineering Process, simplified.

First enter--the engineer: Consumer of the scientist's research, he is concerned with the practical application of science. He is able to communicate with the scientist, with other engineers and with Technicians through a common language established for definition, for measurements, description and physical law.

He has been trained to use the tools of engineering, tools, such as the micrometer, designed by other engineers and furnished to the technology. He is bonded to other engineers by the Technological Contract known as the Engineering Process. Whatever his particular field he conforms to drawing systems, standards and processes, and automatically serves the Technology as he serves his own endeavors.

Enter--the engineering drawing: Through an engineering order system, our engineer has received a requirement to design a tool for the production testing of an actuating cylinder. He studies a blueprint, which is a standard size and format and could be understood by any engineer or person trained to read blueprints anywhere in the world.

If our engineer chose, and he probably will not, he could trace the application of the actuator to its next assembly (or next assemblies) and trace that assembly to its next assembly, until eventually he would come to a "Top Drawing". This top drawing could be traced to a specification, the specification to an operational requirement and so on, until he could trace all the strands of the web of technology involved in his requirement to design, and cause to be produced, a test tool.

Having studied the requirements, the engineer proceeds with the design process. He starts by creating an engineering drawing or set of drawings, in a generally universal format, relating it to its next assembly. He is soon listing parts, selected from catalogs; he checks standards to see if parts meet requirements; he indicates procedures, processes and criteria by a number rather than by long pages of text.

Leaving our engineer to design his tool, the point is that the Engineer, unlike the Juggler, is functionally in contact with the "Total Circus", his actuator will become another strand in the web of technology. The tool that he designs will be produced and used by people he will never meet, and his design will forever be available to those who in the future face similar requirements.

So much for the worlds of the Juggler and Engineer; the present world of the Training Specialist is all too familiar. The more he attempts to talk the precise language of the engineer, the more the Training Specialist finds himself standing up in that hammock, juggling more and more objects because he is forced to assume personal responsibility for more and more strands of the technological web.

Generally, Training Specifications have guaranteed that the contractor will conduct a 40 (or multiples thereof) hour course, in depth, in detail, or in general. In other words the contractor specifies that an Instructor will show up at a certain place, at a certain time if the students do.

More recently Training Specifications are addressing student-terminal performance. Guarantees of student output behavior, of course, requires specification of input capabilities, and the Training Specification writer finds himself deeper into the larger system or non-system. He can travel the uncharted strands of that network just so far, depending on his own endurance and courage. Unlike the engineer, he has no "Technological Contract". His systematic approach to training is as broad but no broader than his individual reach and grasp.

A recent set of fortunate circumstances placed the Douglas Aircraft Company's Military Training Department in a position to view "things that never happened in a place that never was". And while this paper will present more questions than answers, it will, hopefully, convince "Training People" that it is feasible to have visions of Training (Behavioral Technology) as an industry-wide, indeed worldwide, Engineering Process, with an organized body of knowledge systematically nurtured by the Behavioral Scientist, applied by the Behavioral Engineer and implemented by the Behavioral Technician through Standards, Specifications, Engineering Drawings and virtually every facet of the Physical Engineering field.

A detailed discussion of the "fortunate circumstances" mentioned above is unnecessary and would result in one more Training Specialist back up in the hammock juggling and touting his system approach models. Suffice to say the circumstances referred to were a set of related projects which placed the Training group in a sort of mini-world where they were able to grasp the entire network affecting the behavior of the target population.

Also, for purposes of discussion, the training system employed by Douglas is similar to those employed by all Aircraft Training groups. Like most Training Systems, it contains the Aircraft System/Equipment Analysis which provides a list of the aircraft equipment classified and divided into its lowest functional groupings. This analysis provides the structure on which the Training Requirements Analysis is based and on which the complete Training System is constructed.

When the Navy adopted AR-19, which, among other requirements, called for the application of a new code number for training aids, the most expeditious and economical approach to a Training Manager with a 15-year-old training program was to code all the equipment in the Aircraft System/Equipment Analysis.

Since each item of the Aircraft System/Equipment Analysis had been coded to correspond with AR-19 using only the code and first two of four digits, it was realized that the skill/knowledge requirements could be applied to the code by extending the number to have the last two digits of the four-digit ID number represent the skill or knowledge involved; i.e., per AR-19 code, AAG signifies "Radome"; on the A-4 Aircraft System/Equipment Analysis AAG01 signifies "Nose Radome"; by extension of number to the AR-19 requirement for four digits using the skill/knowledge sequence number, AAG0102 signifies "Nose Radome Removal and Installation"; AAG0104 - "Nose Radome Adjustment"; AAG0106 - "Nose Radome Inspection"; AAG0110 - "Nose Radome Cleaning"; AAG0114 - "Nose Radome Location" etc. As a result of the coding, a complete set of potential training requirements is established for the aircraft. (Figure 1)

Consequently, a system which had been designed to classify graphic aids evolved into a classification system for potential Training Requirements. For each of these potential training requirements, a Training Instruction Specification was established. The Training Instruction Specification specifies behavior criteria for a unit of instruction (i.e., remove and

SHEET 1

# TRAINING REQUIREMENTS ANALYSIS

MOS NEC: AD

| EQUIPMENT | EQUIP. ID No. | LEVEL | 1 ASSEMBLE-DISASSEMBLE | 2 REMOVE-INSTALL | 3 CONNECT-DISCONNECT | 4 ADJUST-ALIGN-CALIBRATE | 5 OPERATE-CONTROL | 6 INSPECT | 7 SERVICE | 8 TEST-CHECKOUT | 9 HANDLE-TRANSPORT | 10 CLEAN-FLUSH-PURGE-PAINT-I | 11 SUPERVISE-COORDINATE | 12 RECOGNIZE | 13 LOCATION | 14 RECORD | 15 PURPOSE | 16 THEORY OF OPERATION | 17 OPERATION CHARACTERISTICS | 18 TASK-INTERFACE | 19 SAFETY PROCEDURE | 20 REFERENCE SOURCE | 21 MODEL DISTINCTION | 22 CUES / CRITERIA | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AIRFRAME (GENERAL) | AAA | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| A-4 AIRPLANE | AAA 00 | B | | | | | | X | X | | X | X | | X | | | X | | X | X | X | | X | | | | |
| | | I | | | | | | | | X | | | X | | | X | | | | | | X | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| AIRFRAME STRUCTURE | AAA 01 | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| COUNTING ACCELEROMETER SYSTEM | AAA 02 | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| COUNTING ACCELEROMETER INDICATOR | AAA 03 | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| TRANSDUCER ASSEMBLY | AAA 04 | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| FUSELAGE | AAB | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| FUSELAGE STRUCTURE | AAB 00 | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACCESS DOORS | AAB 01 | B | | | | | | X | | | | | | X | X | | X | | | | X | | X | | | | |
| | | I | | | | | | | | | | | X | | | | | | | | | | | | | | |
| | | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |

Figure 1. Training: An Engineering Process

install the Nose Radome) to fill a potential training requirement. It provides the following information to the Instructor/Course Planner: (1) Method to be used; (2) Media to be used; (3) Prerequisite Training Instruction Specifications; (4) Time Estimate; (5) Objective of Instruction (in course planning context, i.e., "This Instruction will--"); (6) Specific Objectives of instruction (in student performance context, i.e., "The student will--").

As item number 3, Prerequisite Behavior was identified, Training Instruction Specifications were, as a matter of necessity, established which identified its own prerequisite behavior and in turn Training Instruction Requirement Specifications (TIRS) were established for the new prerequisite. It was recognized that this process could be carried down to "absolute-zero" prerequisite behavior.

It was also observed that Course Planners began, as a matter of expedience, to use the TIRS numbers as an engineer uses part numbers, and as a matter of course, Instructors began to search and manipulate existing TIRS as an engineer searches catalogs and fits parts into his design.

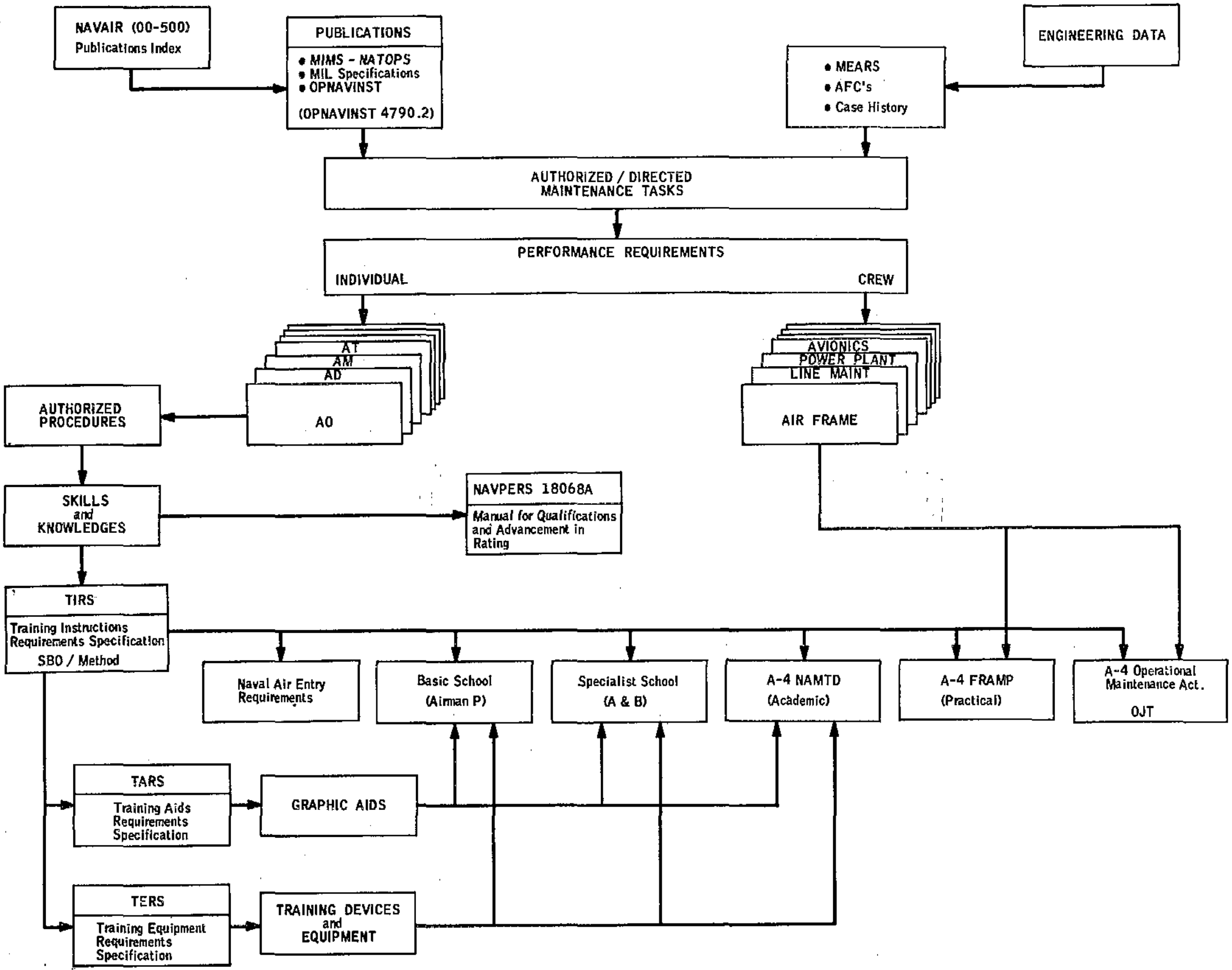
Once the Training Requirements were handled as tangible items, it became a simple matter to create "Top Drawings" such as Naval Entry Requirements, Basic Airman Requirements, Specialist Requirements, etc., and to assign TIRS to the schools responsible to "produce" the behaviors reflected in the design of these Top Drawings. (Figure 2)

The TIRS's are applied to the training program at the appropriate points; i.e., Basic/General-type TIRS's, such as skill and knowledge in the use of standard tools, are applied to the Class "P", "A" or "B" School Curriculums. A-4 peculiar-type TIRS's utilizing academic (clean hands performance) methods are applied to Naval Air Maintenance Training Group Curriculums. A-4 peculiar-type TIRS's utilizing practical performance methods are applied to FRAMP Curriculums, and TIRS's calling for OJT are applied to in-service training curriculums. Each TIRS specifies the Terminal Performance Objective for a particular skill or knowledge and, when combined with all TIRS's applied to a particular course, specifies the terminal performance criteria for the student completing the course.

Figure 3 depicts the development of an engine change crew.

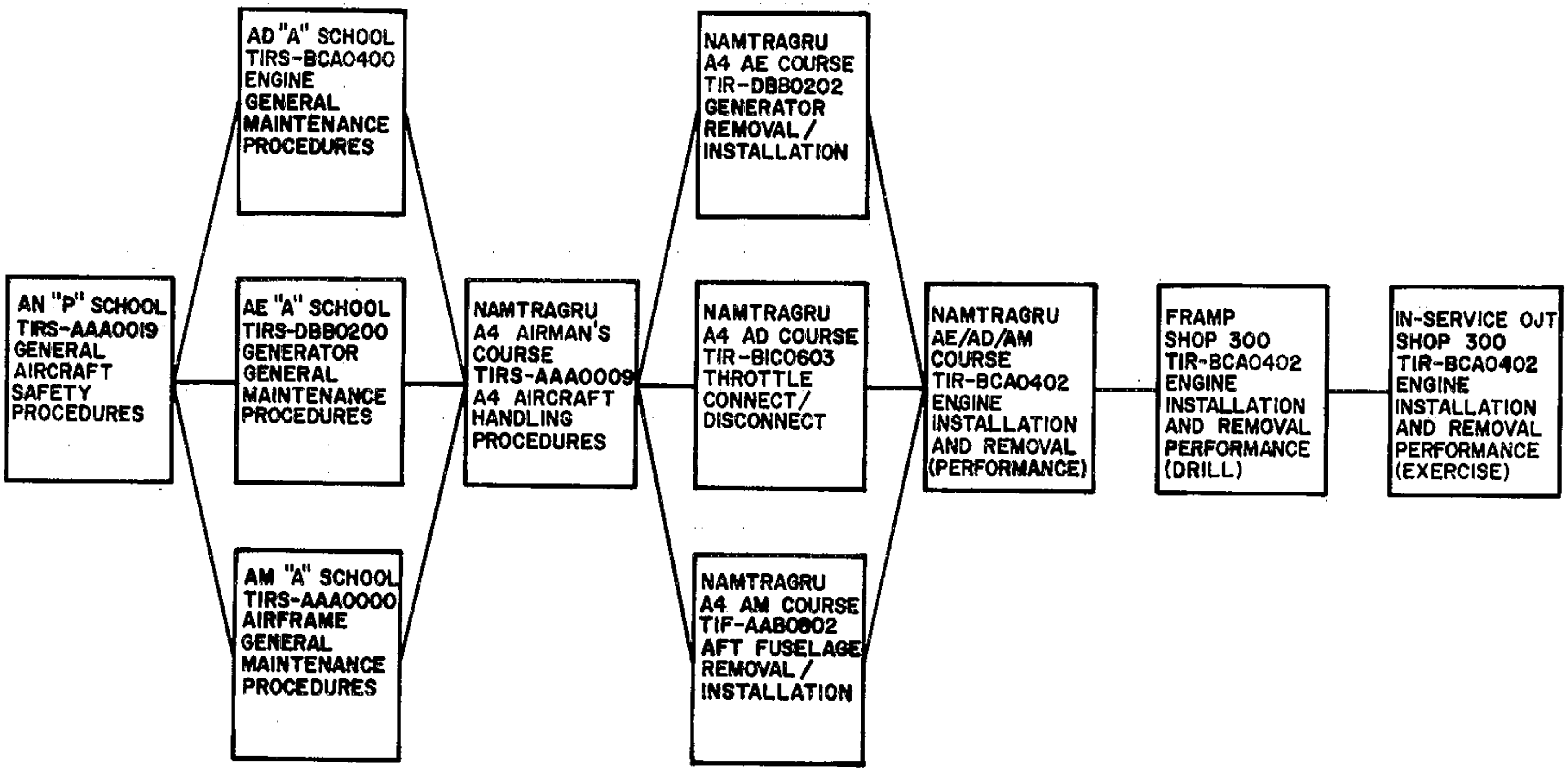
As airmen the personnel attend AN(P) school, where TIRS's of general aviation skill and knowledge comprise the curriculum. From AN(P) school the personnel, as designated strikers, advance to specific class "A" schools to learn the basic skills of their chosen rate.

Training required by all personnel working on A-4 Aircraft is achieved by a Naval Air Maintenance Training Detachment General Maintenance Course or Airman's Course.




**TRAINING REQUIREMENTS**

Figure 2. Training: An Engineering Process




TRAINING INSTRUCTION REQUIREMENT SPECIFICATION DISTRIBUTION
(ENGINE CHANGE CREW)

Figure 3. Training: An Engineering Process

Next, the personnel are again separated by rate and learn specific skills relative to their squadron duties. Here they learn to perform each specific task assigned to their rate, in a classroom environment. As the functions advance in order of system classification to functions requiring coordinated actions between rates, the classes are again combined, still in a classroom environment.

These classes are "rehearsals" for the performance training at FRAMP. At FRAMP the crew works together, under close instructor supervision, to drill in the performance of the task until their level of proficiency has been raised to meet the TIRS terminal performance levels. Finally, in the operating squadron a TIRS governs the OJT performed in the Engine Change Shop under the supervision of the shop supervisor.

Now, setting aside the elements of the Instructional System itself, which as mentioned contains the same strengths and deficiencies as any, the point is that course planners were, for the first time, dealing with tangible items. *Training Specialists were charting the web of the technology, building the* technology, and entering into Technological Contracts with others in the field.

In order to control and direct the expanding process, a control system was established. Called "Training Control", the system served the Training Department in the same manner as Change Control serves the Engineering Department. It tracked and monitored the baseline configuration of the Training Resources, it dispatched commitments against the baseline, and issued Engineering Orders necessary to stabilize the committed baseline documents.

Today Training Control monitors the baseline stability of more than eighty elements which direct the activities related to the production and configuration of training programs, training equipment, graphic aids and other trappings of the Training Trade. These elements include "Proposed Training Plans," "Program Work Statement," "Bids," "Cost Data," "Schedules," "Task Analyses," "Training Requirement Specification," "Security Requirements," etc. These elements are items (parts)of a 7 size drawing, the top drawing of the Military Training Department. Each item is itself an engineering drawing with major assemblies and subassemblies.

As an example, one element of the baseline is drawing 7826999-27, "Customer Directives". It includes NAVAIR 00-500 of the latest revision. When NAVAIR 00-500 is next revised, Training Control will issue a change order. The new or revised customer directives will be examined. If the new directives have created a new task, the engineering top drawing for the "Task Analysis" will be changed. When the "Task Analysis" changes, it will cause new or revised TIRS's, also engineering drawings, to be created. The new TIRS's will be directed into affected courses, or equipment changes, etc.

In this manner the process ensures, in this mini-world at least, that the new customer directive, a new safety procedure for instance, is included in the Training Specification, that TIRS's are created, that equipment or graphic aids are modified, that the customer may have to include new skills in his basic training to meet prerequisite behavior. It even ensures that the customer gets to pay for the added service.

In one instance the system dealt with a target population whose "Input" behavior was included in the baseline. That is, all the tasks of the current functions were already determined and documented. The Training Specialist assigned to the project of a Training Program to induce new equipment into this "target population" used the process, which subsequently proved to be quite accurate, of simply subtracting the "current behavior" TIRS's from the "required behavior" TIRS's, and Training to the remainder.

There are many other facets of handling Training Requirements as tangible items in an Engineering and Production Process, such as resolution of the skill level problem, and definite criteria for method-media selection. But the point is that Training through an Engineering Process is possible and is required if we are to build our Technology.

Recently I found myself in a department store typewriter-display section. I am certain that everyone present knows the phrase that had been typed on every machine "Now is the time--".

Now is the time for us here at this conference to resolve and to act. Why not a Behavior Technology Process? Why not a universal drawing system? Why not a Behavior Catalog? Why not process standards and all the rest.

I call for this conference to be the starting point, that somehow, we conferees start our Technology down the road. If we don't, then who will?

## ABOUT THE AUTHOR

MR. ANDREW KLEMMER is Branch Manager of Military Customer Training and Training Devices at the Douglas Aircraft Company. Mr. Klemmer has been engaged as a Military/Aerospace Training Specialist for 20 years. He has been with Douglas Aircraft Company since 1958 where he has served as Instructor, Training Device Engineer and Program Training Specialist for Military Programs. As Military Training Manager he is responsible for planning and implementing training courses and for the design development and manufacture of training devices.

Long an advocate of Training as an Engineering Process, Mr. Klemmer has implemented a workable system of managing skill requirements as distinct, tangible items. His Terminal Performance Specification and Total Team Performance Warranty has been successfully employed in many U.S. Navy, U.S. Marine, and Foreign Air Force Training Programs.