IN TRAINING, THE SYSTEM'S THE THING

using the systems approach to develop training for Signal Corps personnel

A. K. QUINN
Education Advisor
U. S. Army Signal Center and School
Fort Monmouth, New Jersey

Suppose your wife's leaving for a month with her mother. What's the last thing you, the patient husband, hear from her lips? Very likely it's, "and don't forget to_____." Fill in the blank with any words that come to mind. The point is, she's left you with some tasks to look after while she's away. Another point is, she probably didn't train you in any very systematic fashion. She just told you a lot of things as they occurred to her. Chances are, your list of things are pretty jumbled, and almost certainly, incomplete. And if you didn't even write them down . . . well!

It's surprising how often formal training follows the same pattern. It may be fairly well done, but if it's not systematic, you'll never be sure that it's done as well as it can be, and you'll find it harder to change it once it's set up. This is what the systems approach to training is designed to avoid, and this is why in training and education these days, system is the thing, the big thing.

USCONARC (U.S. Continental Army Command), has directed by regulation CON REG 350-100-1 that all 26 schools under its command will immediately institute systems engineering of training in all courses. This program of course revision is expected to take as many as five years to complete and will extend to all enlisted and officer courses. To understand the USCONARC course engineering system it is necessary to take a close look at training systems in general.

TASK INVENTORY

Take the case of the wandering wife. If we had to prepare a training program for the husband, we'd naturally want first to know what the wife ordinarily does that the husband will have to be trained for. (We'd never ask first what does she *know.)* In other words, we'd make up a list of her tasks: sending out the cleaning; shopping; menu planning; diapering the baby; paying the gas bill; attending the PTA; arranging for Junior's guitar lessons – on and on. Let's call that making a *task inventory.*

TASK SELECTION

We would definitely want a complete list of tasks. Then we would designate those tasks the husband already can do, and those tasks he'll just have to learn on the job (like attending the PTA). What's left are the tasks Dad will have to be trained for. Let's call that process, *task selection.* Next we would examine the tasks, group them into some logical order (e.g., all tasks pertaining to food and feeding together); and finally decide what skills and knowledges we have to train Dad on. Skills like: how to make a souffle; knowledges like: the school bus leaves at 0730. Then we would be ready to set up a fairly decent training program.

We in the U. S. Army Signal Center and School believe that the same commonsense systems approach should apply to training such experts as radar repairmen, computer repairmen and Signal Corps officers. The approach is the same, even if the amount of detail and difficulty of the task are far greater than in the example used above.

One question we are faced with is this: How will we train a high school graduate to repair complicated electronic equipment? In the past the answer was simple: to teach him the fundamentals of electronics and then the sets he will have to work on. The only difficulty with this approach is that it's vague. What are the fundamentals of electronics that repairmen need? Should fundamentals be a two-week course or 20? What training media will we use and how will we evaluate our progress and our product?

INVENTORY OF MAJOR TASK

The answers to these questions begin with what is called an *inventory of major tasks,* which is what we were after for our husband-training course. We must find out what the radar repairman does in the field. We may find that he installs and maintains 10 different radar sets. So we can say he has two major tasks involving 10 equipments. This is where we begin.

It may not look like much of a beginning, because maintaining a radar involves hundreds of different operations our student must learn. But at least we know he will have to *install* the set as well as maintain it. We also know that he does not *operate* the set so we may not have to teach him that particular skill - unless it turns out by systematic analysis that you can't maintain a set unless you know how to operate it.

One of the best ways of finding out what jobs must be learned is to go into the field where the jobs are actually being done and ask around. Ask people doing the job and ask their supervisors. Does or does not the man have to maintain set XYZ? Of course, if you can't get out to the field but you know trained men are coming back to the school to instruct, ask them the same questions. Any source of information is valuable if it tells us what tasks have to be done, how frequently, which require formal training, which are particularly difficult, which can be done merely by following printed directions, and so on.

The next thing we want to know is what is meant by words like "maintain." This is a general term, like "does a housewife's tasks." It doesn't tell you much, even if it is a real task.

SUB-TASK MATRIX

We could subdivide the maintenance operation into sub-tasks like troubleshoot, align, adjust, calibrate, repair, replace, etc. We could make up a handy chart called a matrix and produce something like Figure 1.

Figure 1 should make it apparent that we now know a little more about what will be taught and what will not. The Signal School believes that there's no use teaching a man how to align set 2 if he's not going to do it in the field. It should also be clear that defining tasks involves a great deal of subdividing. Trouble-shooting electronic equipment, for example, is usually sub-divided into the tasks of sectionalizing, localizing and isolating trouble. Such sub-dividing must continue until we arrive at the same point as we did in the case of the desperate husband; that is until we arrive at the specific skills and knowledges that must be learned. Skills like soldering; knowledges like current flows from negative to positive. In other words, we believe, at the U.S. Army Signal School that we have to get down to the "small potatoes."

There are several reasons for such exhaustive analysis. First, it is necessary because a lesson, whether one or two hours long, is made up of a number of small skill and knowledge elements, and these are what we're after. If we don't arrive at just what goes into the lesson plan, there's hardly any reason to begin the whole process.

Also, we know we must be able, at some point, to decide on what training media to use: films, TV, mock-ups, slides, charts, teaching machines, etc. The point is that we can't make such a decision intelligently until we know in detail what has to be learned. We just can't say we'll have four hours on how transistors work and teach all four by TV. There are so many different kinds of learning involved in a four-hour block that TV, or any other single medium, most likely will not effectively handle all of them.

Now, assuming we have identified all the tasks and sub-tasks, down to the skills and knowledges involved, how should we describe them? What information do we need to plan good instruction? What's the best way to state the information?

TRAINING OBJECTIVES

Educators nowadays speak of *training objectives* and this is where they come in. Let's go back to our husband-training problem for a bit. Once we know that Dad will have the task of doing the home laundry, we must ask two questions: under what *conditions* will he do it, and how well or how fast will he do it, in other words, what *standard* will we set?

The logic of this is as follows. We need more than the task, because, what if Dad has no automatic washer? Won't this task condition affect the training? What if he has to wash clothes which are not color-fast? Will he use an automatic dryer? If we answer these, we are setting down task *conditions.*

As for the task *standard,* we are merely asking ourselves *how well* do we want him to perform. Suppose it takes Dad all day to wash two pounds of dish tow-

	troubleshoot	align	adjust	calibrate	repair	replace	etc.
Set 1	x				x	x	
Set 2	x		x		x	x	
Set 3	x	x	x	x	x	x	x
Set 4	x						

Figure 1. Matrix used for subdividing the main task of "maintain."

els, will we give him a passing mark? If we say Dad will have to be able to wash and dry one washload in two hours, we have set a task *standard.*

TESTING

Hold it right there. Standard refers to how well a task must be done, and therefore, standard implies a test. When should we write the test? Obviously we can write it just as soon as we know the task, conditions and standard, all of which go together to make up a training objective. If we're wise, we'll write the test *after* we know the objective but before we write the lesson plan. The test should be based on the *task, not on the teaching.*

Many training people, when they hear about writing tests based on objectives and writing them even before the training is planned, seem to panic. They wonder about over-simplification of tests when we say we want to find out only whether the student has reached the objective. "How about all the other things," they say; "things like how much better student B is than student A? And how about item difficulty and discrimination and deviation?"

To which may be answered, peace, brother. We may still want to know more than whether a man passes or fails. But we say emphatically that the *primary* purpose of a test is to serve as a "go--no go" indication. When you go to the trouble of setting up a good objective, the first thing you want to know is whether it has been reached. Besides there are some practices used in conventional testing that may keep us from really knowing if the objective has been reached. Therefore we stress the primary purpose of tests in our system: can he do the job or can't he? If we need more information than that, we can get it by various means without sacrificing the primary purpose of testing.

Now whether a man has to perform a major duty, a task or sub-task, there always are skills and knowledges involved. These too require objectives. If we're talking at the Signal School about soldering, or splicing wires, or measuring collector voltages on transistors, these are all skills. If you analyze each skill you will *always* find some knowledges, some facts, upon which the skill depends.

ACTS AND FACTS

For example, you can't solder electric connections properly unless you *know* that rosin-core solder is good and acid-core solder is bad. (Acid-core solder will corrode the connection). You can't measure transistor collector voltage unless you *know* that it is a dc, not an ac, voltage. (You have to set the voltmeter to dc or ac; it won't set itself). Obviously, you can't identify the knowledges to be taught without first analyzing the skill. It should also be obvious that both skills and knowledges should be expressed in objective form.

If this is not done, once again, the whole exercise may come to a lot of fuss and feathers – not much else. Instruction at our school is made up of a lot of little things, skills and knowledges included. If you don't specify them in some detail, you run the risk of overteaching. To go back to Dad and his laundry task, somebody's liable to teach him three hours on how detergents are made and on what kind of chemical magic takes place when you add them to water. We don't want to make a chemist out of Dad, we just want him to get some clothes clean.

Just to peek into another field of training, let's look at an objective used in training typists:

> "Typists must be able to transcribe, under office conditions, with an electric typewriter, from a standardized dictated tape of 200 words, four business letters. No more than six letterheads may be used and

no help other than a dictionary. Time limit is 10 minutes. No errors and no more than two erasures per letter are acceptable."*

This objective tells you what to teach and what to test. It naturally doesn't tell you *how* to teach but an objective isn't supposed to – that comes later in the teaching process.

Notice also that the task is clear: to type business letters. There are naturally some sub-tasks, some skills and knowledges to be specified by more analysis: skills like how to insert paper, and knowledges like what the proper margins should be and what the proper salutation is when writing to an archbishop or congressman.

TASK SEQUENCE

Objectives, then, constitute the bone and sinew of the course. When we want to determine the sequence of lessons, we do so by arranging the objective *tasks.* When we write tests, we base them on the objective *standards.* And of course, both lessons and tests are governed by the objective conditions. Given good objectives based on real tasks and given good objective analysis which produces required skills and knowledges, you have the main parts of the training system nailed down.

At this point it makes sense to talk about how to answer the question, How are we going to teach? For this we need to know the sequence of tasks to be taught. Quite simply, this is a matter of sequencing the objectives we have written down. And it will be a lot easier if you've written each one on a separate card or sheet of paper. Once a sequence of tasks is determined, the next stage in the systems approach is to *develop each objective in some detail* – enough to furnish detailed guidance for lesson plans. To return to our original case of the hard-working househusband, his seemingly simple task of doing the laundry would have been broken down into sorting the wash, selecting the detergent, loading the washer and so on. Anyone of these contains learning elements which must be developed, like weighing the clothes and knowing which garment needs gentle agitation. These are elements derived by analyzing the objective into items that may take up to no more than five or 10 minutes of the final lesson.

It would be wrong to oversimplify this part of the systems approach. There are many different ways to sequence tasks, depending on many factors such as whether you will teach small subtasks first and then major tasks or vice-versa. Remember that a baseball team manager with only nine players to consider has 362,880 different batting orders he can use; so what at first seems simple can become quite complicated, if you want to consider all the possibilities. Naturally you would want to group tasks in the same way and so make sequencing that much easier.

This is a very critical stage of the whole process. What we want here is to set down the minimum knowledges and skills necessary. We want the shortest path to the objective. If we do a good job here we will profit greatly, if only by rejecting material formerly thought necessary because the objective was perceived vaguely. The minimum path is the best path; we can always add to the curriculum. It's not so easy to take something out.

MEDIA SELECTION

As one wag put it: a curriculum is like a cemetery. No matter how long what's there has been there, it still has plenty of friends!

As mentioned before, knowing the skills and knowledges in detail make it possible to select *training media* intelligently. It's merely a matter of matching up the learning element with the characteristics of the various media. Some skills will be seen to require the use of a medium that can show both motion and still photographs, so we can select films or TV. Some others will call for a three-dimensional aid or mock up. Some knowledges will call for conference, some for programmed instruction. Since this is the stage where we are putting together lesson ingredients, it is the logical place for media selection.

Knowing these learning elements also gives us ample material for quizzes and other informal and formal tests. We can test, if we want, those relatively minute learning experiences which we have determined are necessary to support the performance of larger tasks. We can do these things only because we've carried our training analysis to detail.

We have actually been talking about preparation for training. We have been identifying teaching and testing points and we have been selecting the most appropriate media. There are many lesson plan formats that can be used to record all this but the best ones will enable the instructor always to know what the current objective is, what the supporting skills and knowledges are, the media and the important points to use for testing and quizzing.

As for the actual conduct of training, let us not say much here. It is of course a key part of the system, but whole libraries exist on how to teach. At this point we want merely to realize that we should teach close to the objective, with a wary eye open for missing knowledges and overlooked skills so that adequate revision can be made to improve the quality of the course.

QUALITY CONTROL

Which brings us to *quality control.* This phrase refers to everything we do to ensure that the product is good and stays good. For us it means making sure that the graduate does a good job in the field. He should, because presumably that's where we started our system – in the field when we asked, what tasks will the graduate be called upon to perform? We based our objectives on these tasks and the tests and lessons on the objectives. So everything should be all right. *Should be!*

But sometimes people do not perform as predicted and we'd all like to know why. One useful step is an analysis of test results. Also, interviewing students

and classroom observation will often pin-point places where the training program is not meeting the objectives.

It is also necessary to keep in touch with the field, to follow the graduate into the field in such a way as to find out how well he fares. A thoroughly-planned questionnaire to be filled out by both graduates and supervisors some three or six months after graduation can tell us much that we need for quality control. The same goes for a continuing surveillance of field organizations, equipment and procedures. Any change here most likely would affect the training course. Setting up a schedule for regular (annual, semi-annual) course review will provide opportunity for continuing readjustment.

Other aspects of quality control have to do with analysis of tests, tasks standards and conditions as well as student and instructor performance. Even the training media used require checking to ensure that they fulfill their purpose. Much time and difficulty can be avoided by proper testing and evaluation of such media as television and programmed instruction before they are approved for use. By "testing and evaluation" is meant ascertaining if students, after viewing a TV lesson, for example, can perform what the TV lesson was designed to teach them to perform or if they know what the lesson was supposed to teach them to remember. If they do not, revision is in order before final approval.

SYSTEMS CONCEPT

Each step involved in systems engineering from task inventory to quality control, depends on the preceding steps being carefully taken. The desired outcome is well trained graduates able to do in the field the jobs they were trained for, in school. Every important phase is covered; course content, training media and course evaluation. Proper attention to each step should bring success.

Success in training depends on so many things that it's foolhardy to single out any one. That would be like saying that the husband whose wife is away for a month will succeed in filling in as long as he keeps a careful record of household expenditures. But to the returning housewife, his success will depend on how well the house has been run in every way – whether order or chaos reigned while she was gone.

And she can tell just as easily and quickly as an Army Inspector General. After all, she has her own system of inspections. Wifely quality control, as many husbands know, can be a terrible thing. There's only one way to beat it. That's by systems engineering.

---

*R. A. Burnstead, "AT&T Systems Approach for Love and Money," in *Training in Business and Industry*, May 1968.

LABOR DEPARTMENT TRAINS 4,480 SERVICEMEN FOR CIVILIAN JOBS

Every day at 1 p.m. a dungaree-clad sailor at the Charleston, S.C. Navy Yard leaves his ship for an afternoon course in hotel-motel management. And that evening, in seersucker suit and black string tie, he puts in four hours of on-job training as a desk clerk at a motel.

He and 4,480 other servicemen in their final months of duty have taken Department of Labor courses during the past two years. Mostly infantrymen, seamen, and artillerymen whose service duties were strictly military, their aim was to acquire the civilian job skills they couldn't learn in service and didn't have before they joined.

The courses are under the Manpower Development and Training Act (MDTA) and cover such skills as TV service, drafting, data processing, welding, auto repair, and hotel-motel management. They are given at 30 military bases in 18 states. Sponsors of the larger projects include Ft. Hood, Tex.; Ft. Leonard Wood, Mo.; Ft. Knox, Ky.; and Ft. Gordon, Ga.

About 2,600 servicemen took MDTA courses in fiscal 1969 at a cost of $1 million; and 1,880 were trained the year before for $995,000.

Under a new $101,000 MDTA contract that runs through 1970, the International Association of Chiefs of Police is training 450 men as rookie police officers. Run under subcontracts with local colleges, the 240-hour course teaches criminal law, patrol procedures, traffic control, and other police skills.

Instruction began in June at Fort Hood, Tex., Fort Dix, N.J., and Pensacola Naval Air Station, Fla. Courses begin in September at Fort Carson, Colo., and Camp Pendleton, California.

The MDTA instruction for servicemen is part of the Defense Department's Transition Program, which provides counselling, training, and job referral to help returning servicemen prepare for civilian employment. Training is given by industry, Government agencies, and the Armed Forces. Most trainees are in their early 20's, with two to four years of service. They are eligible for the Transition Program six months before separation.