DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VIRGINIA 23651

ATTNG

29 April 1977

SUBJECT: Training Developments: CRI and OE

SEE DISTRIBUTION

1. Inclosed are two TRADOC staff papers worth your personal attention.

a. The first deals with training mechanics -- but it could apply to training any technician, and by extension to any learning of man-machine interface. It was written at a DARCOM-TRADOC conference, and is a rendition of the actual dialogue there.

b. The second treats criterion-referenced instruction. Written by a Senior TRADOC staffer after completing the TRADOC Executive Workshop, it reports his reaction to CRI and draws a parallel between CRI and OE -- organizational effectiveness.

2. The recent TRADOC training development conference emphasized the work which lies ahead in refashioning leader courses to take advantage of the success we have enjoyed with CRI and integrating OE into our approach to leadership, per General DePuy's tape.

3. Concerning the latter, we are proceeding with the deliberation due OE as a relatively new "philosophy" of management, as yet untested in many Army organizations. Even its terminology is growing and changing. There is a 3½-year, 5-phase evaluation of OE underway, but in the meantime, we will proceed to provide your training developers with an OE instructional module (at upcoming OE workshop here in early May), from which you can build the leadership training appropriate for your students Army-wide.

FOR THE COMMANDER:

Gorman

PAUL F. GORMAN
Major General, GS
Deputy Chief of Staff
for Training

2 Incl
1. How to Train Mechanics
2. CRI

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HOW TO TRAIN MECHANICS

16 April 1977
HQ TRADOC, ODCST

The US Army industrialized warfare, yet the Army has performed poorly in fashioning that key cog in the modern military machine -- the mechanic. The battle effectiveness of any given weapon system is a function of the inherent capability of the materiel (including its intrinsic reliability, maintainability, and trainability); the proficiency of the men who operate, maintain, and supply it; and the tactics or technique of the commander who employs it.

$$E_B = f\ (W,P,T)$$

Despite advances of W via human engineering intended to minimize requirements for levels of P which are costly to develop or difficult to sustain in the force, the Army's record in fielding systems with which its mechanics could cope is not reassuring. For every 10 soldiers there are 7 major weapon systems, and already the list of maintenance-plagued systems is long and growing. With 44 major new systems coming into the Army inventory over the next several years, there is cause for concern, if only because past systems which were heralded with Edsel fanfare proved turkeys in the hands of troops, e.g., M114, M551, M602, IHAWK. Invariably, field commanders and maintenance managers, when confronted with low operational availability rates, condemn the training of mechanics. Consistent with the American view that schools are societal levers, the answer must lie in better TRADOC courses. This view crystalizes in recommendations as follows:

Field/DARCOM Proposal

- Lengthening institutional training courses, emphasizing basic theory and extensive practice

and/or

- Revising personnel policy to assign higher aptitude trainees to mechanic MOS

and/or

- Increasing field support of unit maintenance by civilian technicians, either civil servants of the Development and Readiness Command or its contractors.

Incl 1

Such proposals usually evoke counterargument from the Training and Doctrine Command, to wit:

Field/DARCOM	TRADOC Counterargument
Longer courses	Expensive. Student man-years are part of the TTPS account, frugally managed by Congress and other budgeteers. In a tight-structured volunteer force, long courses are very costly indeed for the Army.
Smarter mechanics	The Army is in a declining market for people, and fewer high aptitude soldiers are likely to materialize. Reading rates are falling across all aptitude groups.
More civilians	Not a solution to training soldiers. Few technicians are sound trainers, and while technicians are better at fixing the gear, how about preparing soldier-mechanics for war?

But TRADOC is wholly committed to high E_B, and understands in spades that in the short run, for a fielded system, manipulating P and T is the only recourse available to commanders. Its counterarguments are not designed to dismiss the challenge of training better mechanics, but to direct attention to counterproposals:

Field/DARCOM Proposal	Argument	TRADOC Counterproposal
Longer Courses	Too costly	More efficient training. Full use of individualized Criterion Referenced Instruction (CRI) in institutional training and broad recourse to Structured On-the-Job Training (SOJT) in units.
Smarter Mechanics	Not an option	Develop Integrated Technical Documentation and Training (ITDT) to fit empirically technical manuals and other training materials to the mechanics the Army has and is likely to get.
More Civilians	No solution to training	Engage existing technicians in Structured On-the-Job Training (SOJT) in units.

Most logisticians, even within TRADOC, are reluctant to accept these counterproposals, doubting their fundamental practicality. Besides mistrust of CRI and self-pacing, plus disdain for OJT, they hold that maintenance units are wholly committed to mission, especially where troubled materiel figure in same, and have no time to devote to training mechanics. Moreover, mixing untrained mechanics with complex equipment is dangerous and expensive. Finally, SOJT is only feasible under supervision, and mechanic-supervisors are in chronic short supply.

These are objections which deserve serious consideration. Concerning CRI, the fact is that few who have troubled themselves to inquire into what has been happening within TRADOC, as its instructional system redesign has brought properly engineered courses on line, can help but be impressed with the evidence that CRI is a success-oriented, cost-effective training methodology. In CRI training, indiscipline diminishes, learning -- as measured by end-of-course performance tests -- takes place more rapidly, and substantial student man-year savings materialize. Here are examples drawn from recently implemented self-paced courses:

COURSE/MOS	COURSE LENGTH (BEFORE CRI/ AFTER CRI) IN WEEKS	% REDUCTION IN CRS LENGTH	% ATTRITION (OLD/NEW)	ANNUAL TRAINEE MAN-YEAR SAVINGS
17C Field Artillery Target Acquisition Specialist Course	8/4.5	44%	21/6	57
17B Field Artillery Radar Crewman Course	10.4/8.0	22%	15/5	17
26B Field Artillery Radar Maintenance Course	25/22	12%	17/1	12
93F Artillery Ballistic Meteorology Course	9.8/6	39%	12/8	12
35D Meteorological Equipment Mechanic and Repairman Course	9.8/8	18%	18/15	3
27E Wire Guided Missile Repairman Course	14.6/12.6	14%	13/10	16

Concerning the issue that units have no time to devote to SOJT, we should be clear that the Department of the Army Maintenance Management System (TAMMS) provides for on-the-job maintenance training. TM 38-750-1 establishes procedures for accounting for man-hour expenditures by civilian and military personnel, which are incorporated into the standard Army computer systems at each installation. Per TAMMS, these man-hour expenditures are classified into five major categories with detailed labor distribution codes for each category:

Category	Labor Distribution Codes
1. Productive-Direct	(01) Direct Labor
2. Productive-Indirect	(03) Supervision (05) Maintenance Training (12) Stock Chasing (15) Cannibalization
3. Nonproductive	(21) Awaiting Tools (22) Awaiting Transportation (24) Awaiting Parts
4. Duty Absence	(30) Military Training (31) Installation Duties (33) TDY (36) Personnel Processing
5. Nonduty Absence	(41) Pass (42) Annual Leave (43) Sick Leave (45) Personal Affairs (46) AWOL

Time charges for each labor distribution code are posted to data processing cards for semi-monthly analysis. In addition, reports are prepared on manpower utilization for completed maintenance work from DA Form 2407. The minimum Department of the Army objective for manpower utilization, established in DA Circular 700-25, is 30% for productive labor -- including (05) Maintenance Training. But it is a rare installation which achieves that minimum.

In June 1976, the US Army Audit Agency published a report on Maintenance Support of US Active Army Forces in CONUS*, which audited seven installations, including some of the largest concentrations of tracked vehicles. This audit followed up a 1975 GAO report, and like the GAO, the AAA found low productivity. In 16 company-size Direct Support and General Support units involving 1715 direct labor maintenance personnel (E-5 and below, worth $16.8 million per annum), audited Forms 2407 showed the following man-hour utilization:

Installation	No. Units	Maintenance Man-Hours Assigned	Maintenance Man-Hours Used	Utilization Percentage
A	1	54,040	3,674	7
B	3	165,040	44,982	27
C	4	206,574	24,881	12
D	3	150,720	25,228	17
E	1	50,664	3,218	6
F	2	85,680	31,449	37
G	2	108,800	16,489	15
Total	16	821,518	149,921	18

When asked about low percentage utilization, supervisors usually cited "Duty Absence" or "Nonduty Absence" causes. However, detailed observation of 11 units over 1 month established that although TAMMS accountability was not maintained per TM 38-750-1, through analysis of duty rosters, personnel status reports, and other records, it could be shown that scheduled duty plus nonduty absences constituted only about 40% of total available man-hours.

Installation	No. Units	Military Training	Leave	Details	Other	Total
A	1	616	640	6711	344	8311
B	3	5489	5410	2342	2265	15506
C	4	4860	3300	21372	8796	38328
E	1	1954	392	636	640	3622
G	2	1936	1696	7456	3440	14528
Total	11	14855	11438	38517	15845	80295
					Total Available	199264

*Audit Report: SO 76-233, Maintenance Support of Active Army Forces in CONUS published on 23 June 1976. This report also highlights ineffective use of DARCOM technicians.

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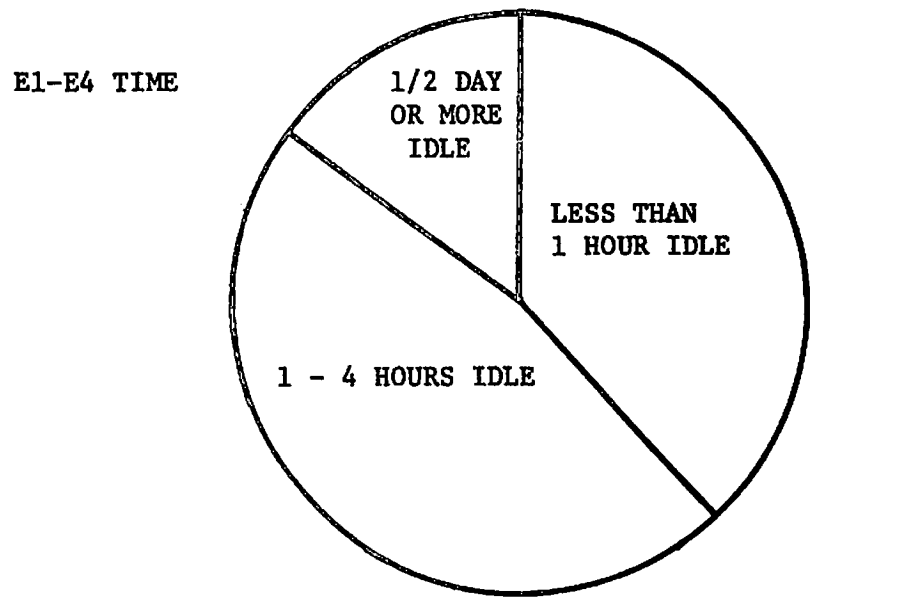
In these units, observed productive maintenance amounted to 31,012 man-hours, or less than 16% of the total 199,264 man-hours assigned. This means that if the surveyed units had devoted only another 31,000 man-hours to SOJT maintenance training under supervisors or DARCOM technicians (all "productive-indirect" labor), they could have met DA minimum productivity objectives and still have some 30% of their available man-hours for scheduling other activities.

The picture which emerges from the above report is entirely consistent with the findings of the TRADOC survey of the Army conducted in autumn 1976, in both USAREUR and CONUS, concerning productive time use of over 750 lower grade enlisted personnel in combat, combat support, and combat service support units.

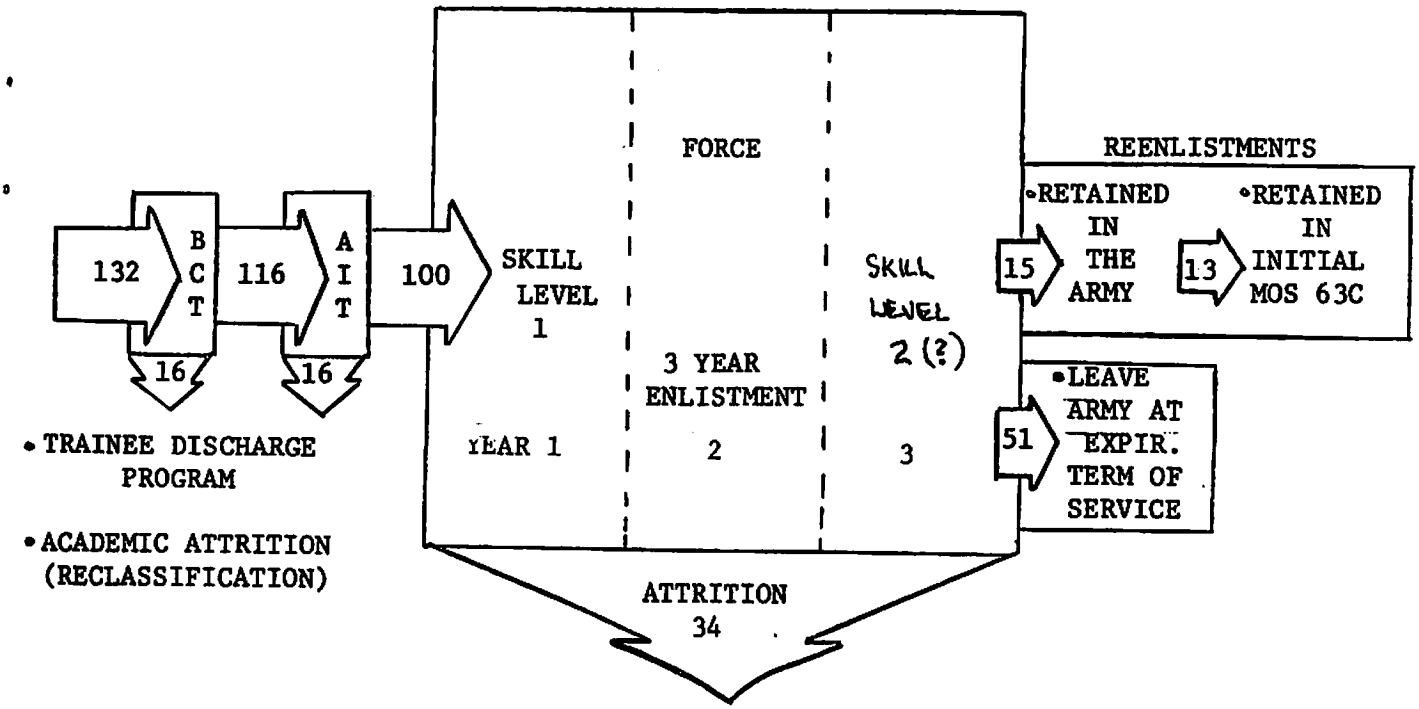


Respondents indicated large amounts of time during each working day in which they had no gainful employ. To TRADOC, these data speak eloquently to the feasibility of, indeed the necessity for, Structured On-the-Job Training (SOJT).

Mechanics, like all soldiers, perceive their relationship with the Army essentially in terms of job and Military Occupational Specialty (MOS). Surveys by N. W. Ayers and others of attitudes toward reenlistment establish beyond reasonable doubt that the key to their reenlisting is job satisfaction. For a volunteer Army, the importance of raising mechanic reenlistment rates can be illustrated by citing the fact that one armored division, one of those surveyed in the AAA report, recently reported that it had less than 55% of its authorized track vehicle

mechanics (MOS 63C). Among the contributing factors to the division's plight is the following depiction of overall 63C drain from the force:

SKILL DRAIN (1st Term Profile) 63C



.EXPEDITIOUS DISCHARGE PROGRAM, UCMJ, OTHER LOSSES

TRADOC believes that it can cut down on the foregoing skill drain by:

- Reducing attrition in AIT
- Increasing motivation of AIT graduates

} via CRI in institutional training

- Providing improved Extension Training Material (ETM) to support SOJT for specific weapon systems

} via better training in units

During FY 76 and FY 77, TRADOC invested $241,000 in developing a criterion referenced 63C Advanced Individual Training program for use at the Armor School, which it will implement in FY 78. This course is individualized and self-paced. Validations -- tests with a sample of

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72 entry-level soldiers -- indicate that the program can produce on the average a soldier trained on more tasks, to higher standards, in 27% less time. Attrition in the test sample was 12.5%, substantially lower than in conventional training. The programed texts developed at Fort Knox for use in the CRI will themselves be useful ETM for field units. But as important will be the Integrated Technical Documentation and Training (ITDT) being jointly developed with DARCOM.

It would not be cost effective to send 63C back to Fort Knox for training each time a new tracked vehicle is introduced to the field. Equipment variety creates a challenge for the trainer. Any 63C might serve in tank, artillery, or infantry units and is expected to be able to maintain the entire range of tracked vehicles therein now, or to come. There is no way he can receive detailed training at Fort Knox on each of these vehicles, so he is trained functionally on such things as the power train, fuel or electrical system, using the more common current vehicles as examples. Then when the mechanic gets to the field, he can be trained in depth on specific models through SOJT using ETM, which is a feature of each new system under the Integrated Technical Documentation and Training (ITDT) program. Via ETM, he can develop from an apprentice to journeyman mechanic.

Although ITDT is relatively new, its foundations go back a number of years. Numerous studies, conducted by all the services, have shown potential savings in systems which utilize ITDT characteristics.

FOUNDATIONS OF ITDT

- 20 Years of DOD JPA Research/Experimentation
  - Fully Proceduralized JPA'a (UH-1H)
  - SIMMS (Radar)
  - PIMO (C-141A)
- 10 Years of Army Experience with Systems Approach to Training
  - TEC
  - Self-Paced Courses
  - CRI

Fully proceduralized JPA's were developed for the UH-1H helicopter in the Vietnamization program for the Air Force by XYZYX Corporation and were evaluated in 1971. Fifty-four US and 36 Vietnamese technicians were involved. Some were experienced journeymen, some were apprentices, and some were novices. No matter what the level of experience, all

technicians performed maintenance and troubleshooting tasks equally as well or better using JPA's in contrast to TM's. JPA's were especially beneficial to apprentices and novices.

In 1964, an evaluation of the Symbolic Integrated Maintenance Manuals (SIMMS) program was carried out for the Coast Guard using 42 subjects on a radar. The SIMMS group identified the three malfunctions used in the test 96% of the time, while the conventional group identified them 70% of the time. The SIMMS group took half as much time to troubleshoot.

Project PIMO (Presentation of Information for Maintenance and Operations) was the most extensive test of improved job aids. Conducted for the Air Force from 1964 to 1969, PIMO consisted of an evaluation of fully proceduralized aids for non-troubleshooting maintenance tasks (job guides) and simplified maintenance dependency charts for troubleshooting, A large scale field evaluation was conducted at Charleston AFB in 1968 using job aids produced for organizational maintenance on the C-141A. In over 1000 observations of performance with PIMO, no error was observed. In non-troubleshooting tasks, experienced personnel using standard procedures had shorter maintenance times than they did when using PIMO; however, time to repair using PIMO was reduced with repetition. Apprentice technicians performed non-troubleshooting tasks without error using PIMO in slightly more time than experienced technicians did when they used PIMO. In troubleshooting tasks, only experienced personnel were used. There was an 11% reduction in time using PIMO troubleshooting aids versus standard procedures.

Overall, there have been more than 90 recorded evaluations of ITDT-like materials, and taken together, these indicate that ITDT has the potential to provide:

Reduced Error Rate 75%

Reduced Spare Parts Demand 30%

Reduced Time in Training 25%

Reduced Manpower Requirement 35%

Overall MTTR

Reduction of 40%

The Army's ITDT concept melds together lessons learned from three previous studies on job performance aids with TRADOC's CRI. The concept is that the documentation and training materials must provide the soldier the information he needs to know to do his job. It presents the soldier with technical data in a fully illustrated, easy-to-read, step-by-step format supported by a training package to teach him critical tasks; frequently recurring tasks; and procedures relative to troubleshooting, safety, and emergencies. Key features include:

- Development based on a validated list of critical tasks.
- Workshop aids developed with the target audience and work conditions in mind.
- Technical data fully proceduralized -- presented in job sequence -- and organized for accessibility.
- Training materials and technical documentation which are fully integrated.
- Technical manuals and ETM verified by users under realistic conditions prior to acceptance -- they must do the job with typical soldiers or they must be redone.

Hence, ITDT underwrites both CRI and ETM for SOJT. It meets the needs of either institutional or unit trainers. More importantly, ITDT equips the force to develop more competent, confident soldier-mechanics, which in turn will lead, so the surveys establish, to fewer soldiers bored or disaffected by their job -- therefore vulnerable to EDP and other pre-ETS losses. And it should lead to more reenlistments by mechanics for their own jobs. Of course, once a mechanic is reenlisted, the Army wants to upgrade his skill level, promote him, and otherwise forward his usefulness. ITDT will play an integral role in the Non Commissioned Officer's education program as well.

In summary, since the Army wants more and better mechanics, it has no satisfactory alternative except to adopt with all possible speed:

- CRI in its service schools and training centers.
- ITDT for use Armywide.
- SOJT in units.

CRITERION-REFERENCED INSTRUCTION

16 April 1977
HQ TRADOC, ODCST

As I talk with young soldiers and young officers and students of the War College, or as I think about the surveys that have given me an indication of how they feel about different subjects, one aspect of the Total Army that comes across positively is the subject of training. I think this is attributable to two causes: One, the realism in training, and two, criterion-referenced instruction. I hear particularly a lot of positive comments (from the younger officers) about the ARTEP and the SQT. Criterion-referenced instruction, to me, seems to have a profound significance--not just because of what it does to training, but because of what it does, and can do, and has done to the Army as a whole.

Look at criterion-referenced instruction from a systems point of view. Imagine for a moment the Army as composed of three great, big subsystems. One subsystem we'll call the Technological subsystem. That contains the knowledge, the skills, the intelligence necessary to perform the mission. Another large subsystem we'll call the Administrative subsystem. This subsystem consists of the rules, the regulations, the paperwork, the processes and the procedures whereby the knowledge of the other subsystem is linked into the Army. In other words, the Administrative subsystem describes procedures for manipulating or handling the content of Technological subsystem.

Now, let's lay out a third subsystem. That's the Human subsystem. It consists of the people (with OVM attitudes, values, goals, and motivation) who, following the rules and procedures of the Administrative subsystem, utilize the knowledge of the Technological subsystem in the accomplishment of operational tasks which lead to accomplishment of the total organization's mission. This, then, is the three component model I'll be referring to as I talk about criterion-referenced instruction. (There is a similar, but more definitive five-component model that works the same way, but this one is easier to understand.)

Back in the old days, we had a system--a training subsystem if you want to call it that--for getting the technological information and the people in the organization together. The procedure normally started out with some general idea of what we wanted the student to know at the end, this objective being decided largely on the basis of the experience of the senior man present. The instructor then made an estimate of how long it would take to do this, had this estimate arbitrarily cut by about a third by the bosses, then proceeded to set up a series of lesson plans to accomplish the training mission. Responsibility for the instruction lay with the instructor. Many of us can recall the old homily knocking around the service schools, "If the student failed to learn, the instructor failed to teach!"

Incl 2

Now, along comes criterion-referenced instruction. It does not rely principally upon the judgment of the senior man present, nor upon the instructor who may or may not have seen the task or skill being performed. Instead, it starts with a study of the soldier, on the job, performing the skill for which other soldiers are to be trained. CRI analyzes the component tasks of that skill, determines the proper sequencing for learning to do those tasks, and then, with a lot of hard work, the instruction is developed from that point.

The actual learning is no longer the responsibility of the teacher, but rather the responsibility of the individual who takes the training. And, most importantly, the end result belongs to the student. He made it, whatever it is. This is the main motivational key. The student gets concerned about the training because it belongs to him. It's his investment. So his goal becomes identical to that of the organization.

What this arrangement does is effectively shift the monkey to the student's back. And the 'ole monkey provides him with an optimum, no-waste path or track to a behavior, a skill, a knowledge, an ability which he knows is actually required on the job. Furthermore, the individual does this pretty much at his own speed, fast or slow, depending upon his ability and how he wants to allocate his time and effort. He gets responsibility...and he gets to be, in a sense, his own boss.

There are other significant differences between criterion-referenced instruction and the way we used to do things. Grading disappears, and instead, the student can find himself in either of two conditions, passed the criterion test, or not yet passed the criterion test. Grades, then, don't become the focal point of interest that they were many times in the past. What becomes the focal point is the completion of the tasks that are going to be required on the job, and to the standards that are going to be required on the job. So, the emphasis shifts from an individual competing with other individuals to an individual competing against specific standards. (In your mind, run this one up into the officer ranks and out across the whole Army.)

To me, as I look at criterion-referenced instruction, there are two main strong points. One is the reality of the whole thing, in that the end product is focused in on what the individual will actually be doing on the job. This causes some problems when I think in terms of the traditional continuum of differences between training and education, and I'm still not able to handle, with criterion-referenced instruction as a model, those forms of learning which require the student to develop some sort of a base of knowledge from which he can generalize to a non-specific situation sometime out in the future. Nevertheless, towards the training end of the continuum, the CRI mode has the obvious advantage of having the student train for a specific skill which is clear, precise, and real--not someone's opinion, arbitrarily applied.

The other big difference in criterion-referenced instruction lies in the motivation of the student. What I see here is the individual given the responsibility to learn himself; provided the materials to do that (materials which have been put together by a technology of learning); and given a specific, believable, realistic, easily understood goal. Damned near any man wants to do well, to be a winner. CRI gives him a good chance. He picks up the ball and runs with it.

There are all sorts of data to show the greater efficiency of criterion-referenced instruction over the way we used to do it--data which applies to increased ability on the job; data which applies to massive savings of time and money and effort; data which applies to certain indirect benefits, like AWOLs and incidents. Measures of effectiveness. To me, then, US Army criterion-referenced instruction represents perhaps one of the most massive organizational effectiveness interventions that any organization in the country has undergone. I say that because, in a sense, criterion-referenced instruction took a view of the Army as a system, focused in specifically on the task of training, saw an interface between the human and the technological subsystems that could be improved, and then set about to improve that particular interface. It's not that the older way was "wrong." It's just that there was a better way waiting to be found. The mechanism used was a combination of better organizing in the Administrative subsystem and the application of several motivational principles that fired up the Human subsystem and brought to bear some of its powerful capabilities.

I think the parallel between CRI and OE can be carried even further. The extensive interview and survey effort of the 1971 Board for Dynamic Training was, in a way, a large-scale "sensing session." From that, the CATB got the "client" (Chief of Staff) committed to a long-term, large-scale change. If we look at the organizational effectiveness idea of a "consultant", Dr. Mager, Dr. Kauffman and other civilian educational technologists constituted the consultant. The markedly different perspective of training and the training technology that they brought in from the "outside" were looked at objectively by an Army trying desparately to get its whole training activity up to par. The educational technologists were the "change agents." We, inside the Army, had, all along, everything we needed for criterion-referenced instruction. But, we were kind of set in our ways. All of our decision makers in the past had been trained in the old way of training. Because of that, we had a predisposition. We studied and supervised our training in terms of deviations from what it was "supposed to be." But along came CRI, and a new way, and the TRADOC. The "supposed" got changed. The end result is a pretty well turned-on Army as far as training is concerned. More importantly, the end result is the development of specific skills that will be required on all those jobs which, when put together, become the component tasks of the desired end product--the mission.