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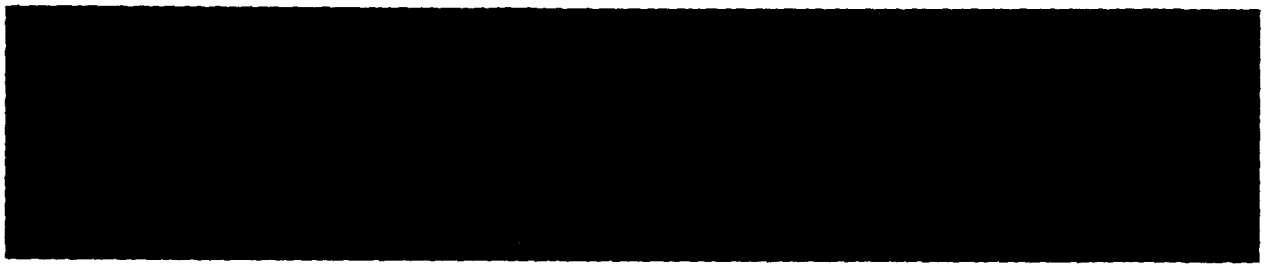

PROCEEDINGS

ISSUES OF MILITARY COST/TRAINING EFFECTIVENESS

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Symposium at the 14th Interservice/Industry Training Systems and Education Conference

San Antonio, Texas
November, 1992

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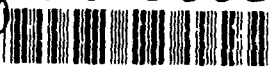

Institute for Simulation and Training
3280 Progress Drive
Orlando FL 32826

University of Central Florida
Orlando, FL 32826

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PROCEEDINGS

ISSUES OF MILITARY COST/TRAINING EFFECTIVENESS

Symposium at the 14th Interservice/Industry Training Systems and Education Conference

San Antonio, Texas

November, 1992

Chair: Michael Parmentier, Office of the Assistant Secretary of Defense, Force Management and Personnel

Panel: J. Peter Kincaid, Institute for Simulation and Training, University of Central Florida

Michael McCluskey, Army Research Institute, Monterey Field Unit

Eduardo Salas, Naval Training Systems Center

Dee Andrews, Air Force Armstrong Laboratory

Discussant: Jesse Orlansky, Institute for Defense Analyses

Editor: J. Peter Kincaid

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This proceedings reports a panel discussion at the 14th Interservice/Industry Training Systems and Education Conference which was held in San Antonio, November 1992. The panel was titled, "A Study of Cost and Training Effectiveness." The panel discussion consisted of presentations from representatives of the Army (Army Research Institute), Navy (Naval Training Systems Center), Air Force (Air Force Armstrong Labs), and Department of Defense (Office of the Assistant Secretary of Defense for Force Management and Personnel) as well as the Institute for Simulation and Training (of the University of Central Florida) and the Institute for Defense Analyses. Participants reported on projects, procedures and policy related to Cost and Training Effectiveness Analysis (CTEA) from the perspective of their particular agencies. Also included in this proceedings are audience and panel comments.

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FOREWARD

This report partially fulfills the requirements of contract N61339-85-D-0024, D.O. 17 "Cost and Training Effectiveness Analysis Techniques," with the U.S. Army Simulation, Training and Instrumentation Command (STRICOM). The project was initiated by the Training and Performance Data Center and is sponsored by the Office of the Assistant Secretary of Defense (Force Management and Personnel) (OASD/FM&P). Mr. Don Johnson directs the project for OASD/FM&P.

This report is a proceedings of a symposium held at the 14th Annual Meeting of the Interservice/Industry Training Systems and Education Conference, in San Antonio, Texas, November 1992. The symposium reported herein is part of a project being conducted by the Institute for Simulation and Training of the University of Central Florida to: (1) assess current practices by the military services in conducting cost and training effectiveness analysis (CTEA), and (2) develop a military standard for conducting CTEA.

William J. Bramble, Jr., John Muller, and Valerie Truhan provided considerable help in preparation of this report.

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INTRODUCTION

Michael Parmentier
Office of the Assistant Secretary of Defense,
Force Management & Personnel

I'd like to talk about some major points that lead the military to where we are today in assessing and controlling cost-effectiveness of training systems and to to give you some background as to our objectives in formulating policy. The first point is that training is big business. It is surprising the amount of dollars the Department of Defense (DoD) spends on training. In individual training alone, we're talking in the neighborhood of fifteen to twenty billion dollars a year. Collective, or unit, training brings the total to the fifty billion dollar a year range. Training is big business in defense and domestic areas.

The second point is that military training is the very foundation of our nation's continued strength in the world. The utility of training has been proven numerous times, the most recent demonstration being in the Desert Storm/Desert Shield campaign.

We all know where the budget is headed. We all know where the forces are headed. At the same time as these things are headed downward, technology is advancing very rapidly, heading upward. One of our concerns is that we don't let technology out-pace our ability to use it to our advantage.

Training, in many cases, is high-risk and uncertain. Policy-makers in Washington and from services throughout the country see impressive demonstrations, and their response is, "Gosh, I really want to implement that stuff. How do I do it?" What they really should be asking is: "How do we make training work for us? What is the best way to provide training to an individual or a group? Should we use a simulator, a computerized model or an actual operational vehicle?"

The Role of the Office of the Assistant Secretary of Defense, Force Management and Personnel

The Office of the Assistant Secretary of Defense, Force Management and Personnel (OASD/FM&P) has a responsibility to monitor the effectiveness of military training systems within the DoD and to ensure that adequate resources are allocated to military training to maintain combat readiness.

My office -- OASD/FM&P (Readiness and Training) -- is challenged with formulating policy for cost and training effectiveness of military training systems. We are continually responding to fundamental and far reaching questions relating to training budgets, OPTEMPO (such as fuel, ammunition and equipment use), large training system procurements, and the relative impacts on readiness of competing training alternatives. As the DoD budget declines, increasing pressure will be placed on justifying continued training expenditures. The rationale for developing complex training systems will, of necessity, include documentation of their cost and training effectiveness.

Increased guidance and oversight by the Office of the Secretary of Defense (OSD) is needed to ensure that cost and training effectiveness studies are systematically conducted and documented. Methodologies and measures of effectiveness must be consistent to support comparisons between simulator-based training and real world training exercises. Results of analysis must be documented and utilized by decision makers at OSD and service levels to support future training decisions.

OASD/FM&P responsibilities for overseeing Cost and Training Effectiveness Analysis (CTEA) require that CTEAs are:

- Based on mission requirements
- Consistent with readiness goals
- Consistent with service mission
- Consistent with service training systems.

Now is the time for rethinking the issues of how we are going to use simulators and models as we are rethinking issues related to cost and training effectiveness. Today, we have some experts who are going to discuss relevant work that is mostly completed and address where we need to go in the future. They are going to need your help and I call upon you to provide that help.

Introduction of Speakers

I will now briefly introduce each of the panelists and their topic areas.

Peter Kincaid is from the Institute for Simulation and Training at the University of Central Florida. He is the Principal Investigator for the development of a military standard for cost and training effectiveness being sponsored by my office. Thus far, the study team has evaluated and documented methodologies, variables, and measures of effectiveness related to CTEA. The emphasis for the study team for the second year of the project (they are in the first year, now) will be to develop a military standard for conducting CTEAs.

Michael McCluskey is from the Army Research Institute (ARI) Monterey Field Unit. He is going to address work related to unit performance evaluation at the Army National Training Center (NTC). The ARI Field Unit at Monterey, California, has the mission of storing and analyzing data collected from the NTC and other U.S. Army instrumented ranges. This source of data represents an invaluable asset in evaluating the effectiveness of highly realistic field training. Research at ARI has validated principles of training which have been demonstrated to have a have a significant effect on NTC performance. For example, findings have related the NTC outcomes to various aspects of training at home station, including OPTEMPO. Evidence gathered by ARI is convincing and provides substantial insight into principles of training for optimal transfer to operational performance.

Eduardo Salas is from the Naval Training Systems Center (NTSC) in Orlando, Florida. His work focuses on team training issues. The Naval training community, as well as the training communities of the other services, place a high priority on the systematic analysis, design and development of team training technology. During the past few years, NTSC has been conducting theoretically based and practically relevant R&D to enhance our understanding of what team performance is, how we measure it, and what instructional strategies can best be used to optimize team training. Lessons learned from this R&D effort have substantial implications for the design of team training systems, for the Navy and other services. The R&D is continuing and is addressing methodological and practical problems.

Dee Andrews is from the Air Force Armstrong Laboratory. He is going to recap work some of you may have seen earlier in the week on the CTEA for the C-130 aircraft.. Then he is going to look at the difference between cost and training effectiveness and cost-benefit analysis. He is also going to discuss a model for multi-ship training.

The US Air Force has adapted the policy of converting Aircrew Training Systems (ATSs) from primarily Air Force operated systems to contractor operated systems, specifically the ATS for the C-130. Therefore, it is vital that cost-

effectiveness data be collected that help the government better understand the benefits and limitations of contracted ATSs. The C-130 is perhaps the largest CTEA ever conducted by any U.S. military Service.

The cost-effectiveness analysis used in this study provides a satisfactory framework for evaluating changes to large, complex training systems; it may even serve as a useful model for the other Services.

Our discussant for today will be Jesse Orlansky from the Institute for Defense Analyses. Dr. Orlansky is well known for his studies related to cost and effectiveness of military training systems. He is also a frequent participant in panels such as this one.

Developing a Military Standard for Cost and Training Effectiveness Analysis

J. Peter Kincaid
Institute for Simulation and Training
University of Central Florida

The principal objective of our project which I will describe to you today is to support the Office of the Assistant Secretary of Defense for Force Management and Personnel (OSAD/FM&P) in developing a military standard for conducting CTEA. OSAD/FM&P has a requirement to monitor the effectiveness of military training within the DoD. Some specific tasks that must be included in a military standard are to:

- Establish procedures and policy (performance-based)
- Monitor effectiveness of military training systems within DoD
- Ensure allocation of adequate resources for military training to maintain combat readiness

The major purpose of military training is to prepare for combat and other operations; yet training is not often specifically evaluated with this goal in mind. More typically, the value of training is measured within the context of a training event (such as a Tank table for tank crews). It is difficult to measure the effectiveness as well as the cost of a fielded training system. Nevertheless, knowledge of how a fielded training system provides for operational readiness is essential for designing new training systems, which almost always have a large degree of similarity to existing systems.

Decision makers in the military services, as well as in the Department of Defense (DoD), are regularly faced with choosing the most cost-effective training alternative. In this era of declining military budgets, those responsible for procuring expensive training systems need to justify their choices with validated data for both cost and effectiveness in preparing for operational readiness. Without validated cost and training effectiveness data, coupled with sound analytical practices for choosing among training alternatives, the resources available for training will be in jeopardy. Currently, it is difficult to make valid comparisons among competing training requirements as practices for Cost and Training Effectiveness Analysis (CTEA) are not standard across services and military agencies.

The intended users of the guidance to be contained in the military standard are government decision makers responsible for developing and acquiring training systems. These decision makers are always faced with budget constraints and must find efficient alternatives to achieving readiness requirements.

Issues Related to CTEA

Here are a number of quotes from papers at meetings such as this one and contained in such "blue ribbon" reports as issued by the Defense Science Board.

I start with one of the most compelling quotes, which is from an Army Captain in Desert Storm after having won a battle fought in a sandstorm in which his forces were heavily outnumbered. When asked, "Why did you do so well?" he replied, "Sir, this isn't our first battle. This is our tenth battle. We fought three wars at the National Training Center and a lot of other simulations, like SIMNET." Those of us in the military training community love to hear a quote like that. There was general consensus that part of the success of Desert Storm was a result of the most effective training in the history of the military.

"Consideration must be given to training effectiveness during the design and development of military training systems."

Weinclaw & Orlansky
I/ITEC, 1983

This is a quote from our discussant and another author at this meeting nine years ago bringing up the same issue that we're dealing with today: In fact, Dr. Orlansky has told us, that this issue is one that he's been working on for some thirty years and that we're still addressing. We have to address it now, seriously.

"Meaningful and timely measures of the effectiveness of the training of any Army unit are tools which can be used to improve the training of that unit...Currently in the Army, quantitative measures relating to unit training are inadequate."

1985 Army Science Board
Training and Training Technology

In 1985 when this statement was made, quantitative measures relating to unit training were in considerable need of improvement. That situation has improved considerably, as Mike McCluskey, from the Army Research Institute, will discuss later. His Field Unit has done some really excellent work at the National Training Center (NTC).

Here is a quote from PM TRADE (now STRICOM) that is absolutely true:

"We have generally been unable to conduct hard analyses of training alternatives because we have not properly measured the results of training; yet despite the costs of training systems, no comprehensive assessment technology program is in place."

1989 PM TRADE Technology Integration Plan

And, the most recent quote comes from the current Defense Science Board:

"One of the things we do not do well is assess the technical feasibility, cost, schedule, and military worth of systems in concept formulation. Military worth relates to the preparation of troops for combat readiness and is the most important consideration."

1992 Defense Science Board

Points of Impact - Training System Life Cycle

If you're trying to make an impact in maximizing the cost and training effectiveness, there are several points where you can do it. We use a model of systems development which is shown in Figure 1. The Defense Science Board (1992) pointed out that we're deficient at intervening at the concept formulation stage. We are really much better at intervening in the design and development stage. Most of the tools that are used by the military services and contractors in designing training systems, and in designing weapons systems in general have been well developed, and used. Once the basic configuration of the system has been set, there is much less opportunity to make large trade-offs that can result in either major savings or increased efficiency of the system. Formal evaluations are done at deployment, usually the first field-testing. Some systems are studied very effectively, and some systems are hardly evaluated at all. Once the system is fielded, there are operational lessons learned which can give feedback into operational requirements. So, looking at this simplified life-cycle of the training system (depicted in Figure 1) we can see that the major impact will be analyses conducted during the concept formulation stage. The cost issues relating to the trade-off for training effectiveness and similar analysis have to be done during the entire life-cycle. We also need to address these issues more systematically than how it's done today.

We're developing policy in accordance with existing standards, such as MIL-STD-1379D (*Military Training Systems*). In addition, a survey of current service policy for cost and training effectiveness, conducted at IST has found substantial inconsistencies in cost and training effectiveness data.

The expert panel with whom we've been working includes members from the Department of Defense Training and Performance Data Center, now DITRA (Defense Institute for Training and Research Analysis), the Army Research Institute, Army TRADOC which includes TRADOC Analysis Command (TRAC), the Naval Training Systems Center, Air Force Armstrong Laboratory, the Institute for Defense Analyses, and the Institute for Simulation and Training at the University of Central Florida. Resource Consultants, Inc. is also participating in that panel.

To determine service CTEA practices and techniques, we've gone through many abstracts, most of those have come from the Defense Technical Information Center, over 2,000 of them. We've identified about 300 of those that we consider particularly pertinent to our effort. These have been archived in a database called the Training Evaluation Cataloging System (TECATS) which we use as an analysis tool (DITRA, 1992). We're not particularly interested in establishing a database, *per se*, but rather getting a snapshot of what's being done today and some insight on what needs to be done to understand current cost and training-effectiveness practice. We've had two expert panel meetings. One was held in Orlando, and one was hosted by the Army Research Institute in Monterey.

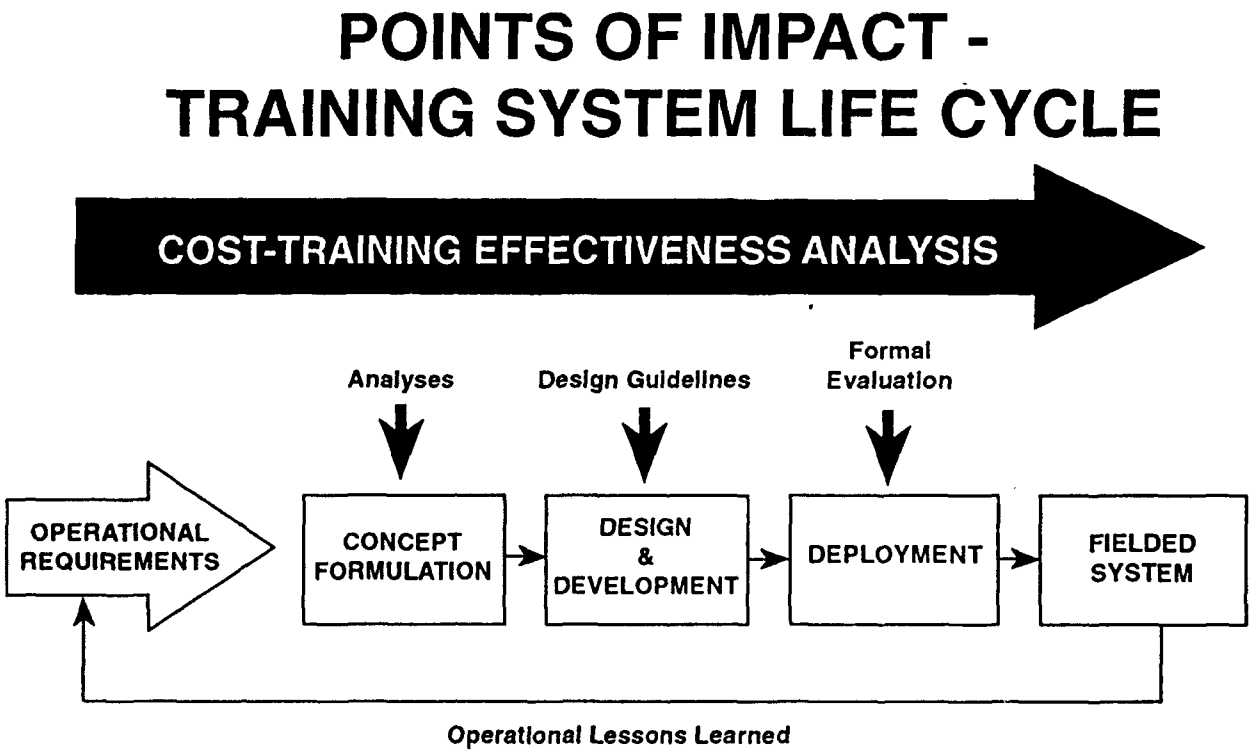

Figure 1. Points of Impact for Training System Life Cycle

Measures of Effectiveness

Cost and training effectiveness policy must be based on a foundation of operational requirements: combat readiness, or the closest thing to combat readiness that we can measure, such as performance at the National Training Center, Red Flag and major fleet deployments. Effectiveness can be measured on a number of different levels: training requirements, objective data validity, training strategy (that is the usage and the context of the intervention, for example the mix of the use of operational equipment - full mission simulators, inexpensive computer-based training, and so forth).

Some of the next steps will be developing the Department of Defense policy guide, based on the initial findings. We will be establishing a joint working group of practitioners. These will be people who must implement the military standard once it is promulgated. We will be determining some of the commonalities across the services, as well as things that are not common across the services. We will be establishing measures of effectiveness for establishing the military standard.

The two phase study is outlined below.

Phase 1

- Conduct literature review of key studies
- Document significant findings in PC-based cataloging system
- Conduct analyses based on document findings
  - Identify existing CTE methodologies, variables and measures of effectiveness
  - Document trends in conduct of CTE studies
- Develop matrix of requirements vs. training interventions
  - Initial matrix is for Army

Phase 2

- Establish Joint Service program elements
- Determine common Service program elements
- Establish Military Standard for DoD CTE Program

This concludes my presentation.

Discussion

AUDIENCE: Do you intend that the standard should cover cost issues?

KINCAID: Yes, that's our intention right now. We haven't examined the current costing figures as much as we've examined other things. Part of cost and training effectiveness is cost; we have to address that.

AUDIENCE: Each of the services has a cost analysis function which operates according to Service guidelines. What are you doing to make your guidance consistent with service standards? We have to respond to that. We intend not to override or interfere with existing procedures, but to establish some minimum commonalities and requirements at the Department of Defense level, and then to examine very carefully what's already in place.

If you in fact sponsor a training-effectiveness study for a selective training system acquisition, will you intend to do this in parallel with the existing service requirements or do you intend that as a substitution?

KINCAID: We're trying to piggy-back on existing Service regulations and practices as much as we can. We'd like to do this without putting new requirements on the services. And indeed, the requirements that do come out in the military standard will be coordinated with representatives from each of the Services.

PANEL: Let me summarize what we just heard. For those of you in the audience who are working for the government or who do analytical studies, one issue is to develop methodology providing information relating to training effectiveness. For those of you who are delivering training programs or training equipment, your attention ought to be placed on the means to support those acquisitions with that kind of methodology. We need to remember that cost is for the life-cycle, and training effectiveness should relate to readiness. The reason to make that point is that the technology to evaluate new equipment in a combat environment is becoming available through Distributed InteractiveSimulation, such as SIMNET.

Cost /Training Effectiveness Analysis and Training Benefit Cost Analysis in the U.S. Air Force: Two Examples

Michael McCluskey
Army Research Institute
Monterey Field Unit

The mission of the Monterey Field Unit is to conduct research to develop and test methods which permit:

- Unit performance assessment.
- Field validation of unit training practices
- Development of methodology to support analysis and trends of Army requirements, unit performance, and training practices

and to increase Army unit combat performance capabilities through improved:

- Collective training
- Management of collective training
- Conceptualization of Army requirements.

The Field Unit Chief is Dr. Howard McFann, and the Field Unit is part of the Training Systems Research Division which has its headquarters in Alexandria, Virginia. We have two major activities: (1) research related to collective training and (2) developing techniques for unit performance measurement. An additional major activity, part of our unit performance measurement task, is to maintain the Combat Training Centers (CTC) Archive. I first want to comment on the Army requirement for the research and clarify the context in which the work is occurring. The requirement placed on ARI by the Army is to: (1) measure unit performance effectiveness at the CTCs and preparatory conditions and techniques employed at home station, and (2) quantify the relationship associated with effective performance. Our objective is to describe relationship between training resource expenditures at home station and unit performance at the CTC, with primary emphasis at the National Training Center (NTC). The approach we are following is to perform a longitudinal study to describe the relationship between training resource expenditures at home station and unit performance at the CTC. We are conducting a two phase analysis as follows:

- Phase 1: Macro analysis of extant data
- Phase 2: Detailed micro analysis involving longitudinal study of FORSCOM divisions.

The units of interest are tactical units, both heavy armor and light mechanized brigades, which travel to NTC to experience the Army's most realistic combat training. More than 1,100 vehicles and 3,500 soldiers are transported from their home station in the continental U.S. for a rotation in which they are challenged at battalion task force level to fight for fourteen days and nights in some of the harshest terrain in the U.S. Simulated combat situations arise both in force-on-force and live fire contests. A highly trained and dedicated opposing force (OPFOR) is employed in the force-on-force defense and offense exercises. The NTC's 1,000 square miles permits battalion commanders to deploy their troops in task force formations and undergo some six force-on-force and three live fire day and night exercises. Instrumentation provides data on such factors as position location of vehicles, firing, and communications to include provision through MILES (Multiple Laser Engagement System) to record hits by whom, when and at what range.

Information Sources

We receive information from three sources: (1) the NTC, (2) the Joint Readiness Training Center (JRTC), which is geared for Light Infantry and low to moderate combat, in Arkansas, and (3) the Combat Maneuver Training Center (CMTC) which is located in Germany.

When we receive information, we structure this data so it can be placed in the archives at various places, and arrange it so it can be listed in a catalog format. The catalog is automated so analysts can find the information they need. Then, after workshops, etc., we get feedback on the collection process.

Purposes of the CTC Archive are to:

- Maintain the Army Archives for CTC data and records and mange access
- Establish and maintain a research database for measurement research, lessons learned, and trendline analysis
- Maintain a research data base

We receive a wide range of information for our CTC Archive. The take-home package and after-action reviews are the primary sources of information used by most analysts. They contain a great deal of training assessment information organized by mission, boss, and battle phase. We also get the operation orders and plans and map overlays that are prepared by the units. In addition, we get observer/controller logs, from individuals who are controlling the events that occurred and the particular conditions that existed during that rotation exercises. We also receive communications tapes. There are forty channel communications tapes that record everything that is heard during the exercise program by the rotating unit as well as the operating reserve control. We have firing events and casualty information that we receive from the observer/controllers, either from the MILES equipment or from their own assessments.

Purpose for Unit Performance Measurement

There are three main purposes for unit performance measurement:

1. To develop methods to provide lessons learned feedback for improving Army training doctrine, material, and leadership.

2. To develop methods to provide CTC with unit performance information for feedback as part of their after action review to units.

3. Develop methods for measuring unit combat performance and assessment of unit combat readiness.

Our overall research strategy is to "look at" units from various perspectives which include:

INPUT - Input is the type of effort involved, such as delegating equipment, material, fuel, ammunition, training facilities, and number and quality of personnel.

OUTPUT - Output is the achievement of objectives such as number of exercises completed or unit proficiency.

PROCESS - Process includes the management and training techniques used to obtain quality of performance for given interrelated inputs such as collective tasks in the Mission Training Plans (MTP) and NTC performance.

EFFECTIVENESS - Effectiveness relates the outputs to the inputs and the processes. In this area researchers will examine what is the most efficient way to use input and processes to achieve desired output.

Home Station Training and NTC

In tests that we've run relating home station training to success at the NTC, a number of correlates have become obvious (Hiller, McFann, and Lenowicz, 1990; McFann and McCluskey,

1992). In terms of execution in training, the brigades that did the best followed the principles of training: train as a team, train as you fight, and use performance oriented training. Successful brigades organized early for combined arms training The brigade that did the best did that well in advance of the NTC rotation -- about four months. The brigade that was less successful didn't do that until about one month before the NTC training. As to "train as you fight," the successful brigade emphasized the use of MILES, field training, and combined arms.

Let's look at battle-staff integration in terms of NTC performance. We have the percentage of force-on-force success and a judgement of the degree of staff integration which was done by the commanding staff of the rotating units. Here we can see the importance of battle-staff integration in terms of the success of the success of the NTC.

The key to battle-staff training was the extent to which the battle-staff Standard Operaitng Procedure (SOP) had been developed, and was a part of the combined arms training. Again, these are readings by the commander of the staff concerning the extent to which they had done that.

The realism of the training at the home station was another factor. For the most successful brigades, the training at home station was supposed to be just about as hard as the ones at NTC. For the less successful brigades, their training was considered to be much easier than at NTC.

Vehicle operational readiness by mission sequence and type of draw was another big factor. What this refers to is the percentage of vehicles that were operational for each mission. Now, the type of draw, in the physical case, refers to the case where the unit comes to the NTC, and accepts the equipment given to them. The extended draw refers to a particular unit which came much earlier to the NTC and spent a lot of time checking out the equipment and making sure it was operational. If not, then they would make sure that there was an exchange or that it was made operational. Those two things together led to big differences at the end of the rotation in terms of operational equipment. We can see that the platoon which was composed of a higher percentage of less experienced soldiers did not perform as well.

I think the most important recommendation refers to the Mission Essential Task List (METL) process. As I said in our earlier discussion about the training management cycle, the METL process needs to be broken in terms of the items that are put on the METL and the way that information was managed from that point.

Now I'd like to review a list of the characteristics of the most successful brigade. The most successful brigade: had a higher casualty-exchange ratio, higher training miles for their tanks and Bradleys, they had extensive use of MILES, they had a larger number of field days on discrete tasks, they had the highest level of battle-staff integration - in fact they trained for more than a year together on battle-staff integration. The home station training was considered to be equivalent to the NTC. They developed battle-focus, in other words, specific training. There was program time for the commander to assess and repeat training as they went through the training management cycle and deficiencies were found, and training time was programmed to make corrections for them. The most successful brigade was least affected by training distractors.

Discussion

AUDIENCE: Have you done any work relative to the number of hours that people put into simulation in trainers and how that affects their performance at the NTC.

McCLUSKEY: We did have a fair amount of data that was collected at home station on the use of training aids and devices. We did not get any relationship partly because we didn't have good data. What we did get was information about how many times these devices were checked out, we really didn't home in on effective hours of training. We're going to have to do a more controlled study in order to answer that question. I think it would be safe to say that we need to take a look at the relationship between hours in simulators and performance at the NTC.

PANEL: The services have a priority to protect their OPTEMPO. In some cases in which OPTEMPO has been reduced, they have made certain trade-offs between that and other things they've wanted to do. There is no strong indication of lower levels of OPTEMPO in the services. The Congress, on the other hand, is trying to cut OPTEMPO, but right now we seem to be holding our own pretty well. Historically, there had been more slack in budgets so that if you took cuts, you could make it out in other areas. As the budget draws down and as we get tighter on resources, I think that the services are going to find it much more difficult to reallocate funds from other areas to protect the OPTEMPO that they need. So, indeed, it is going to be a lot tighter than it was in the past.

AUDIENCE: It is my understanding that the Army agreed to give up OPTEMPO miles for active funds in exchange for funding of the Close Combat Tactical Trainer (CCTT).

McCLUSKEY: I'm not aware of the TRADOC issues, as you mentioned them. Certainly the relationship between OPTEMPO at home station and performance at NTC is strong. They've been replicated in our research. Now, how we trade off OPTEMPO with training devices has yet to be determined.

PANELIST: Let me make a general comment about that, too. I can't speak for the Army, since I'm not in the Army. What you're going to see is a lot of focus on the training of the reserve components. There has been a call for training of the reserve components at the centers like the NTC; the problem is availability of ranges, etc. As our active forces reduce size, there may be more space for the reserve forces to go to the NTC. But there is a concerted effort on the part of the DoD to get more time of this sort for the reserve component. It's just going to be a matter of time before this works out. First of all, you've got to figure out what the force structure is and what the relationships between the reserve component and the active component units are. Then, it may be a lot easier to determine how you actually invest in training.

ORLANSKY: Let me summarize some of the issues that I see in Mike's presentation. I think we have a remarkable relationship (a correlation of .6) between tank miles, and casualty exchange ratio. Its fascinating that data, as limited and as unclear as that, would show such a strong relationship. It does not follow, however, that all the groups that had large amounts of tank miles performed well. The issue then, ought to be to look for the ways in which the effective groups use their tank miles as distinct from those that did not. Just giving everybody tank miles would probably be a silly thing to do without assuring yourself that they are used in an appropriate way.

Secondly, a good deal of the data that was described here was gained the hard way - after the fact. And, again, it is fascinating that they can still find meaningful relationships with that poor of a research design, after the fact, when data were originally collected, and put in a pile some place without any idea of who would want to use it or whether it was even the right data. Now the reason that I make this point is that in systems like SIMNET, you would have a fantastic capability to get data which is there routinely all of the time. That only tells you what happened during those combat exercises, but that is

done remarkably well. You have to add to that all of the training plans, and the command staff relationships which the SIMNET data don't use. The data issue is more or less solved in systems like SIMNET, and it can have a reasonably long-term view in the ways in which additional data of that sort can be melded with it from improvements being made on the instrumented at ranges. You will, in effect, be able to get much better range data in the future that will actually link very closely with what you're now able to get in SIMNET and in simulators now under development, particularly CCTT.

Implications of Team Training R&D for CTEA

Dr. Eduardo Salas
Naval Training Systems Center

Those who study organizational effectiveness have noted that teams are often called on to perform crucial and sometimes hazardous tasks. In fact, industrial, governmental, and military organizations are especially dependent on successful team performance in order to ensure outcomes such as competitiveness, high quality of products and services, readiness, and safety. Today then, it is imperative that the science of team training and performance helps practitioners understand the dynamics of teamwork, while at the same time, providing guidance for optimizing team ability to solve organizational problems. My purpose here is to briefly illustrate what our point of departure was in approaching the issues associated with team training and performance and then to describe how this relates to the issues before our panel today.

Point of Departure

Research into team training and performance has spanned several decades. Many diverse disciplines have devoted time and resources to team performance research, and numerous studies of team-group performance have been reported over the past several years. Fields such as psychology (military, organizational, social, and engineering), sociology, instructional systems development, and engineering have sought to understand the nature of teams and team performance and how to best design team training programs and systems. Unfortunately, this body of literature has yielded few theoretically driven, empirically based guidelines or prescriptions for designing, managing, and developing teams. In short, despite over 50 years of investigation in this area, we are only beginning to understand the complex behavioral phenomena associated with teams.

Part of the cause of this state of affairs was identified in the mid-1980's. Scientists concluded then that: (a) researchers had not specified or agreed on the definition of a team; (b) very little systematic, empirical research had been conducted that addressed the process (i.e., moment-to-moment interactions) of team performance to show what fosters or hinders the development of an effective team; (c) there was a lack of sound performance measurement tools and methodologies for capturing the dynamic and often time-dependent nature of team performance; (d) the knowledge, skills, and abilities necessary for effective team performance needed to be identified; and (e) there was a lack of guidance on what to train, when to train, and what instructional environmental demands to reach these goals.

From a behavioral standpoint, teamwork appears to comprise a complex of behaviors including performance monitoring, performing self-correction of errors, providing task and motivational reinforcement, adapting to unpredictable situations, using closed-loop communication, and predicting each others behavior. This last set of behaviors is intriguing in that we can now use concepts (and findings) from cognitive psychology to understand team functioning. For example, my colleagues Jan Cannon-Bowers and Shari Converse have hypothesized that team decision-making performance may be enhanced via training to foster "shared mental models" of the task and team. That is, by providing team members with knowledge (and guided practice) about their teammates, task requirements, and interdependencies, they can develop accurate models and representations of the team task. Therefore, team members would learn when, how, and why to pass information at the

appropriate times, without the need to communicate explicitly. In trying to uncover why some teams work well and others do not, our measurement methodologies have improved. My colleagues Dan Dwyer and Cathy Volpe have developed and tested tools and approaches for capturing individual and team performance in complex environments. The methodology is primarily based on observation of key constructs and behaviors for each team member. It is also tied to the scenario (i.e., simulation exercise), creating opportunities to observe and track individual performance as well as team processes outcomes. Although it is not perfect, we can begin to diagnose, remedy, and enhance team performance in training using these methods.

We know from our experience that team training and performance research is time consuming, expensive, labor intensive, and slow (i.e., results don't happen overnight). Indeed, our ability to conduct meaningful research that solves behavioral phenomena has proved to be a major challenge. We have concluded that in order to design and develop instructional strategies for teams in naturalistic settings, a research program that is focused, multifaceted, long-term, and resources rich (i.e., in terms of people, test-beds, and funding) is required. The Tactical Decision Making Under Stress (TADMUS) program has been our attempt to develop such a program.

TADMUS was initiated under the sponsorship of the Office of Naval Technology in 1990 in response to incidents that occurred in the Persian Gulf in the late 1980's. The goal of the program is to gain an understanding of the kinds of decision-making processes that occur in tactical command and control teams while under stress (e.g., heavy workload, time pressure, or ambiguity). Based on this understanding, it is our intention to develop training and simulation principles (a similar component that focuses on decision support systems and displays is being conducted at Naval Command and Control Ocean Surveillance Center in San Diego) that will help to mitigate the impact of stress on individual and team decision-making performance.

Where Are We Going

The notion of shared mental models (mentioned earlier) is one of the theoretical bases on which our research is being conducted, see 'Individual Characteristics' in Figure 2. Specifically, the manner in which we hypothesize that shared mental models relate to team effectiveness has several implications for the understanding of team performance and training. As an explanatory mechanism, the team mental model construct is useful in understanding how teams are able to coordinate behavior and select task strategies in the absence of explicit coordination activities. Under conditions of high workload, time pressure and other kinds of stress, such implicit coordination appears to be critical.

With respect to training, strategies designed to foster development of shared mental models have the potential to improve team performance. For example, we are investigating the following training strategies.

1. Position clarification. Intervention designed to provide information regarding the structure of the team and task, the interrelationships among team member positions, and the roles and responsibilities of each team member could be hypothesized to improve team performance by enhancing common task and team expectations. Such training, which represents requisite team and task knowledge could be presented via information presentation, demonstration computer-assisted instruction, or via written material. Such training would represent initial preparatory training, but would probably not be sufficient to develop shared mental models. Another potential training technique that may be useful for this purpose is role playing, which also has the benefit of making the trainees more active participants in the training.

2. Guided practice and feedback. Past research has indicated that unguided practice can lead to development of inaccurate mental models. These findings suggest that teams should practice tasks under the guidance of instructors. Feedback and debriefing mechanisms must be designed to result in accurate, common expectations for the task and team. In addition, feedback regarding specific behaviors that must be changed should be more effective in establishing accurate expectations than general, less specified feedback. Simulation and exercises would be a most appropriate means to provide such practice opportunities.

3. Cross-training. A potentially useful strategy to training common mental models may be to cross-train team members on tasks that are related to their own task. Such training would be beneficial to the extent that it helps team members to learn what their teammates will need (in terms of resources, information, and assistance), given various task demands.

4. Team-leader training. Training team leaders to foster development of shared mental models also has potential value. It can be hypothesized that team leaders who are trained to articulate their own view of the task and team, who

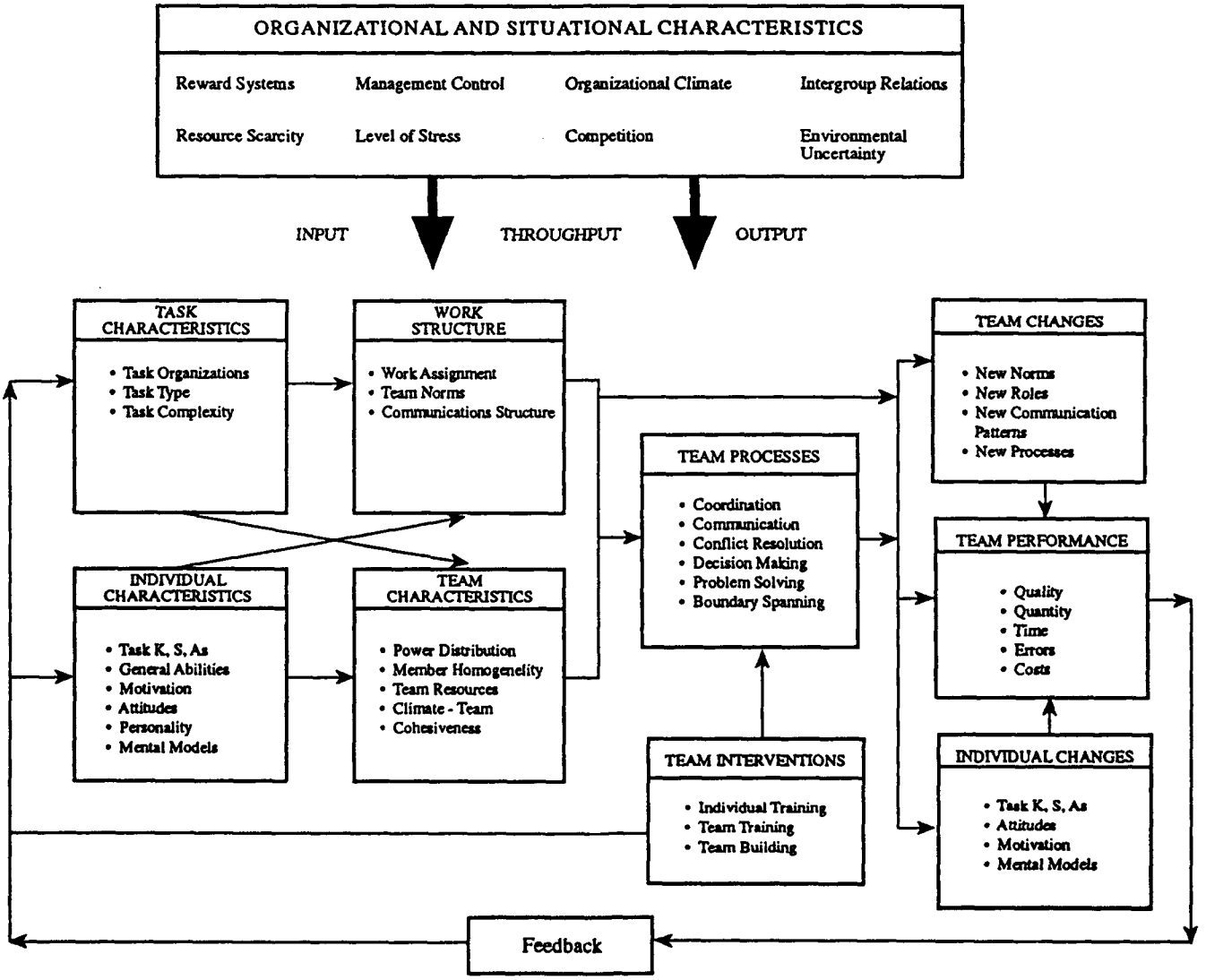

Figure 2. Team effectiveness model (Adapted from Salas, Dickinson, Converse and Tannenbaum)

encourage discussion and strategy formation among team members, and who make clear their expectations of team members' behavior should be successful in helping their teams to develop shared mental models.

In sum, the science and practice of team training and performance is maturing, evolving, and exciting. The 1990's look promising! We will continue to further our understanding of this complex behavioral phenomenon in the hope that, through theory, methods, and data, we help organizations solve problems in the future.

Discussion

PARMENTIER: I think this cost-benefit analysis issue relates to the Cost and Operational Effectiveness Analysis (COEA). Apparently, with the development of the new acquisition regulations (DoD's "5000 series"), the Army was faithfully trying to conduct COEA's. The other services were less faithful with regard to responding to the requirement for a COEA. I think you'll find that the lack of documentation, and the lack of formal procedures caused some of the reluctance. For a major weapons system, the cost of doing a COEA can run into the tens of millions of dollars, easily. There was some resistance to accept that process.

The new 5000 series regulations, which may be old before too long, are seriously requiring COEAs. In the new acquisition strategies and processes that we're using, the other services had to come on line. There was some discussion, informally at least, by the Army, as to, "Hey look, we keep clocking up all this data to meet the requirements for doing the COEA, and it's being used against us. Those other guys don't do it, and they're getting away with it. Let's rethink this process! If they're not going to be required to do it too, then we're not doing it." We need to explain to everybody how they should handle this in a uniform fashion. Hopefully, that's what we'll be able to achieve when we do provide the guidelines that are in demand here.

ORLANSKY: I'd like to comment on some very important changes that are taking place that are going to impact on military training.

There is a requirement that new developments in technology in these areas be demonstrated with what's called Advance Technology Demonstrations using simulation.

The performance of new technology will be demonstrated and evaluated in a simulated environment, of precisely the sort that you see during this convention. One of the major areas focuses particularly on man-in-the-loop simulation specifically synthetic environments. Distributed Interactive Simulation is being used widely as a method of evaluating the effectiveness of new technology in these key high-priority areas, all of which involve manned operations. That is the basic theme of this meeting.

AUDIENCE: Do you have any indication of what the military leaders think about distributed simulation and the utility of synthetic environments?

ORLANSKY: I have a half-good answer. I know as a fact that work on the significance of synthetic environments and distributed simulation has been briefed through the Joint Chiefs of Staff (JCS) and the Secretary of Defense. I don't mean that they were overwhelmed when this was described, but rather that changes are taking place on the Joint Staff as well as in the services, particularly the Army, to attempt to implement this. That's the thing which is significant. A particular office has been assigned responsibility for running this program in the JCS. That office did not exist before. Beyond that, it's not appropriate to say what the JCS will do.

But significant institutional changes are being made in these organizations (as reported to me by a senior member of the JCS). That looks to me like a very positive sign.

I'd like to focus our discussion on "What do we do next?" Given the well-developed and meaningful background that has been discussed, what should we do to cope with the problems in training that we know are coming.

One key issue in training concerns performance measures. We've done quite well, I think, with measures of individual performance at technical training schools. We've done modestly well, but not impressively, with team training. But I think we're going to leap-frog that issue of team training. I doubt that we will ever get a comfortable and clear answer to measuring the effectiveness of team training. Dr. Salas is perfectly free to differ with me on that, but even assuming we know how to do that, it's going to take time to develop. But that does not really bring us to what we really want to know, and that is the measurement of combat effectiveness.

Let me make a straightforward, if not outrageous statement: I think that the purpose of the military is to win wars. If you believe in that, then you want to have your measures of performance related as well as you can to how well it helps those folks win wars on our behalf. If not for us as people, for your sons or daughters. Take this seriously; it's an interesting and important perspective. The question about military training has to do with military performance and with researchable process measures, such as, for example, whether people talk well to each other, and with the number of communications. While these are probably useful process measures and you couldn't perform well without that, the question has to be how does that kind of performance relate to performance in combat on the battlefield. Those are measures related, essentially, to casualty exchange ratios and related items. There are many, many measures of that sort. People like us in training have to learn how to relate the effectiveness of performance with what it would mean on the battlefield against a determined enemy.

I don't know why this point has to be made. It is one thing to train people at a school how to put together and take apart a radar at school. You wouldn't have an effective force unless the radar worked, so that's important. But that's an intermediate measure. What you want to get out of all that is that after you know how to start the engine on an airplane, turn on the radar, read the scope, and talk properly on the radio, you want to know what difference it makes in an encounter against a determined enemy.

Our concept of training and measurement that is relevant, has to sooner or later be put into those terms. That's not as hard as it seems. The only thing interesting about that is the extent to which we have neglected doing the obvious. There are other kinds of folks, such as the military and operations research folks, who do this all the time. We ought to learn how to listen to them. That's their business! When you use a combat model, you're doing, more or less, what we're talking about in training, except you're ducking the effort it takes to qualify the personnel. You're measuring how well two different forces might operate against each other as estimated by a model. That's a substitute for what would happen in a training exercise. The issue still is at the end: how does one force operate against another? Combat models are based upon rules, algorithms, combat experience, modest guesses that attempt to work a problem: given a force of a particular size and composition with certain weapons, will it prevail against an enemy under certain conditions? If you think that's idle talk, that's the way in which many, many new acquisitions are evaluated.

We have an enormous opportunity. Suddenly, we have the capability to do many of those types of analyses on a simulated and controllable battlefield. That was the whole point of showing you where the technology is going, and where our leadership is trying to move us. This is toward evaluating equipment, tactics and training exercise environment with performance measures which are military exchange performance measures.

That's exactly where we have to go. We have to learn what others have done with this. Then we can relate it to our own analyses. Regarding effectiveness measures, they should relate to an exercise in simulated battle, rather than proficiency in terms of curriculum requirements or other training measures. In simulated battle, it becomes possible to collect empirical data.

In a synthetic environment you get lots of performance data, whether you like it or not. These data are almost more than we know how to handle. Though there is an issue about how to use it well, the data are there. It is difficult to reconstruct from NTC data what happened in those battles, but it can be done in an interesting way. As soon as any SIMNET-type exercise is over, the data are there. If you are interested, you can even review the data while the exercise is going on.

That exists now in SIMNET. The Joint Tactical Exercise Simulation System (JTESS) will give us the same kind of data on an enlarged basis. JTESS will include not only simulators, but actual weapons on instrumented ranges, and computer models. As a side note, this is the same kind of equipment that we would use in actual combat. The equipment is now not very different from what you could get during an actual exercise or during a war.

So the question of "you train as you fight, and you fight as you train" is going to happen. What does that mean for us? It means that in developing our ways of evaluating the effectiveness of training equipment, we can do it in a combat-like environment, and that will carry over to an actual combat environment. In different ways, I stressed that the performance measures we need for training ought to be combat related. We have to figure out how to do that well.

Finally, there is one more point that I would like to make and it comes out of the Desert Storm experience. That particular war was a fascinating case for America, first in the way we got into it, which is none of our business, and then the way we handled it, which is everybody's business. I heard some afternoon reports where our military leaders made a very good point. It was that the equipment which worked very well in Desert Storm was the result of decisions made fifteen years ago. That's the length of time of the development and acquisition process. If we would have a war five years from now we would use equipment that exists today.

The thing that was special about Desert Storm was that we knew the enemy, had lots of training time and, on the political side, we had national concurrence. Our military forces were able to do their job. They knew the enemy. I think the change that we see coming in may not give us those opportunities. No potential enemy will ever be that stupid to allow us to do again what we were able to do in Iraq. In the future, we must be able to engage the enemy with enormous force, high synchronization, and an opportunity to win quickly with minimum casualties. If we're on the plus side of this scenario, we might engage. If we're on the minus side, the chances are that we would avoid getting engaged.

If you accept this, the training implications are that you have to be able to win in the American way. In other words, we need synchronization, enormous force focused for short periods of time, and performance that will minimize casualties.

Air Force CTEA Programs

Dee H. Andrews
Aircrew Training Research Division
Air Force Armstrong Laboratory

I'll begin by discussing two projects performed at the Armstrong Laboratory, Air Training Research Division. Our research concerns pilots and their training. In conjunction with other groups at Armstrong Laboratory, a contractor (SRA) and the Military AirLift Command, we have recently completed a very extensive cost and training effectiveness study with C-130 aircraft (Derrick, Tomczak, Nullmeyer, and Burright, 1990). We have also been involved with another effort to develop a cost/benefit model for multi-ship training. Both of these projects provide tools as we get more serious about cost and training effectiveness analysis.

In my opinion, there are major differences between training effectiveness, cost analysis and cost/benefit analysis. With training cost-effectiveness analysis, the basic assumption is the cost, or the quality and quantity of the output (in our case, graduates from the training program), remains constant. The benefit-cost approach makes some assumptions about variability, both quantity and quality of the output, and cost as well. (Note: see the discussion at the end of this paper relating to these points).

These benefit-cost studies are generally much more difficult to perform because we have to do such things as convert the benefit into a metric which can be compared with cost (usually money). Usually, some very subjective judgements must be made about benefits, which is not easy to do.

C-130 Training Systems

In 1982, the Air Force Scientific Advisory Board issued some recommendations about building a model aircrew training system. The model was developed by 1985. The first attempt to implement the model was a contract with CAE-Link to convert a completely blue-suit training operation in the C-130 Aircrew Training System (ATS) to a blue-suit/contractor operation. They tried to apply guidelines recommended by the Air Force Scientific Advisory Board to the C-130 training program. This was generally well done. The contractor took ground-based training (academics and simulators). The blue-suit folks still do the flight training.

A major emphasis of the new aircrew training system was a shift toward lower cost devices. Computer-based training (CBT) was used for the first time. As a result of the effort, flight hours were reduced.

The development of the new aircrew training system was a massive effort. The contractor examined a total of 43 different courses involved with the C-130. The sheer size and complexity of the program and interrelationship between courses made it difficult to do a benefit-cost study.

Training Cost-Effectiveness Analysis Framework

A parametric modeling approach was set up to establish cost-effectiveness relationships between several important variables. We spent considerable effort deciding how to measure effectiveness. We finally decided that check-rides with multiple instructors was the most important and best measure of effectiveness.

We examined four solution alternatives which are summarized in Table 1. The first was the Combat Engagement Trainer (CET). The CET

Table 1
Training System Alternatives

I. Pair of CETS in each squadron - linked to each other and able to link to all other sims in Wing

II. Pair of CETs in each squadron - linked able to link to all other sims in DART domes in Wing

III. CETs in each squadron - linked able to link to all other sims in wing DART domes in Wing and other Wings

IV. CETs in each squadron - linked ABle to link to all other sims in system DART domes in Regional Centers

Table 2
Four Training Alternatives with Costs and Benefits

	Annual Costs	Annual Benefits
Alternative I 18 squadron centers, linked	$12.9m	$32.6m
Alternative II 18 squadron centers, linked to other squadrons	$13.3m	$46.9m
Alternative III 18 squadrons centers, linked plus Wing centers	$21.7m	$75.2m
Alternative IV 18 squadron centers, linked plus Regional centers	$29.6m	$87.9m

uses a glass cockpit and costs about $300,000 to build. It is fairly high-fidelity in areas such as radar representation. The CET represents the low-end of the multiship training options. We examined pairs of CETs in each squadron, throughout all the F-15 squadrons in the Air Force. We assumed the CETs will be linked to each other and possibly to other CETs in other squadrons. Another alternative involved looking at a pair of CETs in each squadron, linking them to each other and to the others in the wing, using a higher fidelity visual device, a Display for Advanced Research and Training (DART). The DART is essentially a low-cost dome. For the third alternative, we used CETs in each squadron, which are then able to link to all other sims in Wing and in other Wings.

Finally, the most costly approach is similar to the three others except that we use regional centers for the training instead of doing the training at the units. We might have three regional centers, perhaps two in the United States, and one in Europe. These were the alternative approaches we considered most interesting.

Table 2 shows annual costs for the cost-benefit approach described. Annual costs include developmental, research and other costs presented in considerable detail. In the second alternative, the cost varies considerably and there is less benefit than for some of the other options. However, using the model, if you look at the cost-ratio, alternative II has advantages, primarily because of its costs.

When cost-benefit ratios are considered, the specific requirements of the decision-maker, engineer, squadron or wing commander, must be understood. This is a very subjective process. By looking at spreadsheets, we cannot eliminate subjective judgement, it is still very much required. A benefit-cost ratio that looks very high may be unacceptable to an organization for various reasons. But we do have sets of spreadsheets and can vary any of the costs and related benefits.

Conclusions

In conclusion, these tools are very useful in assessing cost and training effectiveness. The approach that the contractor, SRA, developed are quite useful when it comes to the Air Mobility Command and the Armstrong Laboratory. We have further developed this benefit-cost model. Other benefit-cost models are available, but for our particular requirements, we considered it important to develop our own model. The hardest part involves translating benefits into a dollar figure.

The personnel who perform cost-training effectiveness analyses are not researchers. They are from field agencies such as the Army's Training Analysis Center and the Air Force Operational Test and Evaluation Center (AFOTEC).

As I understand it, AFOTEC has been given an expanded mission. They are responsible for hundreds of new projects. Historically, they have looked primarily at simulator issues. Now, they are getting more involved with training systems evaluation. They are trying to become more adapted to the notion of training systems in general and to develop expertise in that area. They should be provided with tools that will help them efficiently conduct training effectiveness and cost-benefit studies. As mentioned earlier, it is crucial that we talk to decision-makers.

The approach I like to use is to sit down with a decision-maker before deciding on an evaluation approach. Present the decision-maker with two or three different scenarios. I ask the decision-maker, "What decisions would you make if we did this evaluation and found X? If we found Y? If we found Z? Frequently, that cuts directly to the concerns of the decision-maker, who may be unable to immediately articulate concerns. In the educational literature, there are numerous examples of decision-makers who do not know

what to do with the data collected after costly evaluations. It is crucial for those who collect the data to meet with decision-makers first to determine what issues are of greatest concern.

This leads to the next point. Start with the leaders at the top. "Top Brass" in the Pentagon and the Congress need to understand the meaning of asking for a particular kind of data. They need to understand the requirements generated.

The final point is that efficiency, in my opinion, is the heart of the issue. Efficiency assumes effectiveness. If you don't have effectiveness, you are not efficient. You are just cheap. Cheap sometimes is not sufficient. You have to add the extra part, the effectiveness issue.

Discussion

(Note: Dr. Burke Burright, an economist at the Air Force Armstrong Labs was asked by the panel to define "cost-benefit analysis.")

BURRIGHT: Cost-benefit analysis really answers two related, but not identical questions. You use cost-effectiveness analysis to identify the most efficient way of reaching your stated goal. You know your objective, such as training some individuals to increase their efficiency level. Cost-effectiveness analysis is used to determine the most efficient way of reaching your established objective. In that sense, in my way of thinking, efficiency and cost-effectiveness are synonymous.

Cost-benefit analysis is useful when you are trying to evaluate alternative systems which have different outputs and costs. It systematically evaluates, in dollar terms, the present values, and the alternative system's benefits and costs. The difference between the present value of an alternative's benefits and its costs is its net benefits. To decide which system to buy, one should look at the alternatives' net benefits. The one with the largest net benefits would increase most our nation's wealth.

ANDREWS: That's where I think our model comes in so handy. Because it has been developed by people who are qualified to do cost-effectiveness analysis. You get the raw input data from pilots who don't know cost-effectiveness analysis form anything else. Once you've got their estimate of benefits, then you can bring in these other people of expertise and their approaches.

ORLANSKY: Are there models so elegant that they can disguise the ignorance with which you start? I think the issue is interesting enough to be worth a debate, and you ought to realize that there are different points of view on how you do an analysis. We're trying to figure out a way to do it right, rather than debate it.

In a cost-effectiveness evaluation, you have two things you can manipulate. You could, in principle, vary effectiveness. You could, in principle, vary cost. But that's very hard to do. So all of the analyses are truncated to specific cases. Namely, you either know, or you assume that the output or performance that you are going to get with a new system is about the same as you get with your baseline system. For practical purposes, that is often the case. It is not a bad assumption. Then, you clearly opt for the possibility that gives you the same result at less cost. You need an estimate about the value of the benefits in dollar terms. It's a healthy discussion to acknowledge that you're taking those estimates benefits available from people who are in no position whatsoever to know what kind of judgement they're making for you.

ANDREWS: I'm not sure that's exactly true. I mean, these are people who fly the training sorties in the aircraft, they do know something about the simulators. When you ask them to compare capability or potential benefit of one to another you may have some problems, but I don't think their opinion is inconsequential. I value their opinion.

BURRIGHT: I could think from one perspective, you could say, "Why ask pilots?" They are amateurs. What do they know about this stuff? On the other hand, my question is - who knows better? Who do you view as experts if the pilots are not allowed to speak for themselves?

ORLANSKY: The point I've made is not that you wouldn't want to do that kind of analysis. I'm saying we don't have an opportunity and the right information that will support that kind of analysis. Therefore, you don't do it. Maybe we can come back to this. At this point, let's open up for general discussion.

AUDIENCE: There was reference made to decision-makers. The target for a study of this sort would be some decision-maker at the congressional or Department of Defense level. Would decision-makers lower than the Department of Defense or Congress use this type of economic analysis? Who do you want to read this and consider these alternatives?

ANDREWS: Those who worked on the C-130 study can tell you that they have been briefing various generals in the Air Mobility Command. The Air Mobility Command decided some time ago that they were basically going to contract out virtually all their ground-based training for aircraft. They've done more than just the C-130. So this is the first time, I think, that anyone has tried to capture any kind of cost-training effectiveness analysis for aircraft switch-overs. It looks as if they made a fairly good decision. The output remained the same and the cost is probably less. Then, of course, they want to extrapolate, I'm sure, to the other aircraft and assume that they can pat themselves on the back and say, "We made a good decision about those, too." However, that may be stretching it. It may be something they need to be cautious about.

The benefit-cost model I mentioned is developing. Dr. Orlansky has brought up some very good points that we worried about from the start. I would be particularly interested in people such as vendors who sell whole total training systems, the F-22 for example, to the Air Force. This kind of a model might be of some use to them, as they are trying to decide what to propose, and how to go about it. It might be potentially useful to personnel such as those in the training system procurement office up at Wright-Patterson Air Force Base. They have to make decisions about different types of approaches. It could even be of some interest to the folks who run the training centers - the military folks, the commanders, or the civilians - if they've got to make some changes to their training systems.

So there is potential there but, as we pointed out, there are problems as well. I'm not sure all decision-makers would know how to use these types of analyses or would want to use them. There are other ways which you can go about making these decisions which they do all the time.

KINCAID: A general way of asking that question is: what good is a detailed analysis to a decision-maker who doesn't have the time to really study it. Typically, the decision-maker is going to get a brief. The backup data is available. It's done by the military agency doing the analysis, or a contractor who's interested in how a particular piece of training equipment fits into an entire training strategy. I think it's very valuable that a briefing has some validity in terms of a well done analysis behind it that may not be presented in detail to a decision-maker.

ORLANSKY: The C-130 study is absolutely first-rate. The issue is fairly straight forward. When air training is done by a contractor, the issue for the government is whether the output is the same as when performed by the government itself. The government took the position that it must monitor the quality of the output. For the cost-effectiveness study, conditions were put in the contract to measure the nature of the output

and to permit and analysis of the results. A reasonable assumption was made that the output would be about the same. Thus, control was placed over effectiveness in this particular case.

Although the analytical opportunity is about as good as one can hope for, you might still want to be a little bit skeptical about the clarity of the results. The skepticism stems from the variation in "effectiveness of the output". This is a difficult measuring issue. In the military, people go out of their way to help those who don't proceed as fast as others. Thus, it isn't as if everybody gets equal amounts of resources for training. There are clearly efforts made to bring along the slow ones. There is disproportionate support given to the slow ones to make sure they can qualify. But that's not bad. I think that working assumption that you have equal effectiveness with contractor and government provided training is probably a good enough assumption.

SALAS: I'm not an expert on cost analysis by any means, but it seems to me that most of this cost-benefit analysis is done for political reasons. I make this observation because it seems that we spend a lot of time looking at cost-benefit ratios, and other detailed information, and by the time you raise the question a lot of the decisions have been made.

AUDIENCE: The cost-benefit model might work best in concept exploration, whereas some of these other techniques, like cost-effectiveness come in later, where you have a prototype.

AUDIENCE: After doing some checking around, I found out that the Air Force, for example, does not have a regulation concerning cost-training effectiveness studies for training systems. When I discovered this, I was surprised because of the literally hundreds of millions of dollars that have been spent on training systems. I know of Air Force projects which have used an Army regulation for these kinds of studies.

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