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IDA PAPER P-2042

MACRO-LEVEL TRAINING DATA:  
A CONCEPTUAL MODEL RELATING TRAINING COST  
AND EFFECTIVENESS DATA TO  
TRAINING POLICY INTERESTS AND ISSUES

Richard S. Gibson  
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August 1988

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Prepared for  
Office of the Assistant Secretary of Defense  
(Force Management and Personnel)



INSTITUTE FOR DEFENSE ANALYSES  
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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) IDA Paper P-2042		5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION Institute for Defense Analyses	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION DoD-IDA Management Office		
6c. ADDRESS (City, State, and Zip Code) 1801 N. Beauregard Street Alexandria, VA 22311		7b. ADDRESS (CITY, STATE, AND ZIP CODE) 1801 N. Beauregard Street Alexandria, VA 22311		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION OASD/FM&P	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA 903 84 C 0031		
8c. ADDRESS (City, State, and Zip Code) The Pentagon Room 3B930 Washington, DC 20301-4000		10. SOURCE OF FUNDING NUMBERS		
		PROGRAM ELEMENT	PROJECT NO.	TASK NO. T-L2-407
11. TITLE (Include Security Classification) Macro-Level Training Data: A Conceptual Model Relating Training Cost and Effectiveness to Training Policy Interests and Issues				
12. PERSONAL AUTHOR(S) Richard S. Gibson, Jesse Orlansky				
13. TYPE OF REPORT Final	13b. TIME COVERED FROM 8/86 TO 4/88	14. DATE OF REPORT (Year, Month, Day) August 1988	15. PAGE COUNT 79	
16. SUPPLEMENTARY NOTATION				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Training management models, training policy, training data bases, training cost, training-effectiveness, training readiness, macro-level training management, training management, training research, training analyses	
FIELD	GROUP	SUB-GROUP		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) <p>This paper is the first phase of an analytical effort to determine the types of data required to support the needs of OSD and the Services for formulating and supporting training policy decisions and to assess the adequacy of current training data bases. The conceptual model of the training system presented here is intended to provide a systematic description of some of the functional elements of the training system and to help define the types of data that are most useful for the operation and management of the training system. The Training Management Model (TMM) describes the operation of the military training system and specifies the major training effectiveness data that are needed from a macro-level management perspective. The TMM and its three functioning modules were used to define the categories or types of data that are required by macro-level training managers at the DoD and Service levels. The data requirements were integrated into a proposed set of strategies and options for the development of the needed macro-level training data bases.</p>				
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL Richard S. Gibson		22b. TELEPHONE (Include Area Code) (703) 578-2839	22c. OFFICE SYMBOL	

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Accession For	
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DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



INSTITUTE FOR DEFENSE ANALYSES

Contract MDA 903 84 C 0031  
Task Order T L2-407

## FOREWORD

This report was prepared by the Institute for Defense Analyses (IDA) under Contract MDA 903 84 C 0031, Task Order T-L2-407. The cognizant technical officer for this task is Mr. Gary Boycan, Assistant Director, Training Systems and Technology, Office of the Assistant Secretary of Defense (Force Management and Personnel)/Training Policy Directorate.

This paper presents a conceptual model of the training system which is intended to serve as a systematic aid to help understand the managerial relevance of some of the functional elements of the training system and to help define the types of data that are most useful to guide the operation and management of the training system. The training system model, in conjunction with a survey of the available training performance effectiveness data, was used to define the categories or types of data that are most needed for policy planning by senior training managers at the DoD and Service levels. The data requirements were integrated into a proposed master plan for macro-level training data base development.

## ACKNOWLEDGMENTS

The many contributions to this paper by colleagues and friends who provided technical advice and detailed comments are gratefully acknowledged. We are especially grateful for the assistance provided by Bruce Angier and Stanley Horowitz of the Institute for Defense Analyses for their patience and endurance in reviewing multiple drafts of the paper. Special thanks are also given to Franklin L. Moses of the U.S. Army Research Institute for the Behavioral and Social Sciences and Henry L. Taylor of the Institute of Aviation, University of Illinois, whose insights and comments played a major role in the revision of this paper. We are also indebted to those named below whose comments and suggestions helped improve this paper, and hope they will overlook any failures to follow their advice. The authors alone are responsible for what appears in this paper.

Paul Chatelier	Perceptronics, Inc.
Bertram W. Cream	Air Force Human Resources Laboratory
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J. Dexter Fletcher	Institute for Defense Analyses
Curt Gilroy	U.S. Army Research Institute
Gary Green	Defense Training and Performance Data Center
David K. Horne	U.S. Army Research Institute
Rodney D. McConnell	Management Consulting and Research, Inc.
John Metzko	Institute for Defense Analyses
Hendrick W. Ruck	Air Force Human Resources Laboratory
Thomas Sicilia	Defense Training and Performance Data Center
Henry Solomon	George Washington University
Wayne Waag	Air Force Human Resources Laboratory
Joseph Zeidner	George Washington University.

We appreciate the assistance provided by Carol Graham and Anthea DeV Vaughan in the preparation of this paper.

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## ABBREVIATIONS

AAW	Anti-Aircraft Warfare
AMOPS	Army Mobilization and Operations Planning System
ARTEP	Army Training Evaluation Program
BFTD	Battalion Field Training Day
BTD	Battalion Training Day
CASREPs	Casualty Reports
CBI	Computer-Based Instruction
CINCLANTFLT	Commander-in-Chief U.S. Atlantic Fleet
CNTECHTRA	Chief of Navy Technical Training
CPF	Cost-Production Function
CRTRNG	Combat Readiness Training Index
DoD	Department of Defense
DON	Department of the Navy
DSB	Defense Science Board
EW	Electronic Warfare
FHP	Flight Hour Program
FMC	Full Mission Capable
FTD	Field Training Detachment
FY	Fiscal Year
HQDA	Headquarters, Department of the Army
INSURV	Board of Inspection and Survey
JCS	Joint Chiefs of Staff

MC	Mission Capable
MPT	Manpower, Personnel and Training
NTC	National Training Center
OJT	On-The-Job Training
OPPEs	Operational Propulsion Plant Examinations
OPTEMPO	Operational Tempo
ORE	Operational Readiness Evaluation
OSD	Office of the Secretary of Defense
PEF	Performance Effectiveness Function
PMR	Primary Mission Requirement
REF	Readiness Evaluation Function
SHAREMs	Ship ASW Readiness Effectiveness Exercises
STRAC	Standards in Training Commission
TACAIR/ASW	Tactical Air/Anti Submarine Warfare
TACTS	Tactical Aircrew Combat System
3-M	Aircraft Maintenance and Material Management System
TMs	Technical Manuals
Top Gun	Navy Fighter Weapons School
TRADOC	U.S. Army Training and Doctrine Command
TMM	Training Management Model
TRASANA	TRADOC Systems Analysis Activity
TRC	Training Readiness Condition
UNITREP	Unit Status and Identity Reporting System
USN	United States Navy
WWMCCS	Worldwide Military Command and Control System

## EXECUTIVE SUMMARY

A Macro-Level Cost Data Base has been established at the Defense Training and Performance Data Center in Orlando, Florida to assist in the development and support of training policy. The Institute for Defense Analyses was tasked to "provide an overview of the kinds of data available and their relevance to training management issues and to the development of macro-level training data bases." This paper provides a rationale for determining the types of data most relevant to establishing training policy. It also provides a series of recommendations for data base development in the form of a Macro-Level Training Data Base Master Plan (Table 6, p. 66).

The Training Management Model (TMM) is central to the development of a rationale for structuring a data bank needed to support training policy. The TMM provides a logically consistent, parsimonious approach to the development of a responsive macro-level training data base. Based on a small set of assumptions about the nature of both the macro-level training manager and the training system, it provides systematic guidance in understanding the operation of the training system from the perspective of the macro-level training manager. The TMM's primary purpose is to serve as an aid in the design and development of training data bases.

The TMM consists of three parts: Cost-Production, Performance Effectiveness, and Readiness Evaluation. The Cost-Production Function is primarily quantitative in nature. It is concerned with the cost and the effectiveness of the training system needed to produce the numbers of trained personnel needed to meet approved organizational requirements. This is the standard operating condition of the training system. Problems may cause a departure to one of the other two functions, but the standard baseline is the Cost-Production Function.

The Performance Effectiveness Function is concerned primarily with the ability of the trainees to perform well on the job. It focuses on the questions of how effective the training is in terms of how well personnel are able to perform on the job after they complete training.

The Readiness Evaluation Function looks at the quantitative and qualitative effects of training on combat readiness. Readiness evaluations can take either of two forms: prescriptive or empirical. The prescriptive form evaluates whether all the individuals and functional units have completed the required training courses and events. The empirical form provides a linkage between training and combat or combat-related performance achievement measures.

The TMM and a survey of the training performance evaluation literature provide the basis for estimating the types of data that a macro-level training manager will need to formulate and support a wide range of training policies. Data base options and strategies are presented in association with each of the three operating functions. The separate sets of data base options and strategies are summarized and integrated into a Macro-Level Training Data Base Master Plan (Table 6, p. 66). The Master Plan presents a road map for data base development. It also provides a vehicle for judging the adequacy of current data bases.

## I. BACKGROUND

Training is important to the proper functioning of the military, but training managers frequently have difficulty in competing for scarce resources in a highly competitive financial arena. There is a need to be able to estimate accurately the impact of policy decisions on training readiness and force effectiveness. If the relationship between the amount and type of training and effectiveness in combat could be demonstrated in quantitative terms, the formulation of training policy would be relatively simple and the competition for resources would be minimal. Training programs are based on traditional practice supported by the trial-and-error of experience. The value of the right kinds of training was presented dramatically by Rowland (1985):

Many accounts of operations refer to the problems of using inexperienced troops; there is a clear impression, albeit not quantified, that inexperienced troops do not perform in battle as well as those who have prior combat experience. Apart from basic training they have been expected to learn 'on-the-job'--that is the lucky ones learn--for others it is too late, so it is hardly an efficient process.

A significant portion of the reason that training has a problem in competing for funds stems from the complexity of the training system and the difficulty in relating changes in training resources to specific changes in training outcomes. Training managers have, in essence, been required to argue that more training is better and that less training is worse without being able to state either how much better, better is; or how much worse, worse would be. Consequently, although training receives respect for being an essential component of military operations, it often loses the competition for funds to other interests that can show a more exact relationship between budgeted resources and results.

### A. MAGNITUDE OF TRAINING MANAGEMENT RESPONSIBILITIES

Training is an essential element in the operation and performance of the Services. It provides the knowledge and skills necessary to convert naive, inexperienced entry-level personnel into the qualified operators and technicians needed to support a large, technically sophisticated military force. The training process requires billions of dollars for individual

training and additional billions for collective training. The size and complexity of the military training system creates a major management challenge which creates a demand for improved management tools for developing, evaluating, and justifying training policy decisions.

The Services conduct both individual training and collective training. Individual training prepares individuals to perform specific duties and tasks, while collective training prepares groups (teams, crews, etc.) to accomplish tasks required of the group as an entity. Most individual training is conducted at formal schools, while most collective training is accomplished in operational field units, i.e., at military bases and in field exercises. Both types of training affect training readiness (DoD, 1983)

### **1. Individual Training**

The magnitude of training and the effects of personnel turbulence on individual training can be summarized as follows: According to the Military Manpower Training Report FY 1988 (DoD, 1987), individual training for recruits, officers, specialized technicians and pilots is expected to cost 18.5 billion dollars in Fiscal Year 1988. Specialized skill training accounts for the largest number of students and the largest total cost; the highest cost per student is for flight training. About 75 percent of this student load was due to the entry of new personnel into the military service; this is a consequence of a significant number of relatively short military careers where as much as one-quarter of the entire military force may leave each year. When we combine the number of man-years of students and instructors, we see that 12 percent of all military man-years are always assigned to schools.

### **2. Collective Training**

Both the collective training process and its effects are difficult to analyze because they encompass the full spectrum of tasks performed by teams and larger functional units. However, like individual training, collective training activities require a significant investment of resources. Pellicci (1985) indicates that collective training is the most expensive type of training in terms of total recurring operating and support costs. However, the costs of collective training are not known precisely at present.

The Services do not budget for unit training as a separate activity. The Services' operations and maintenance budgets include a line item that provides funds for unit training; this line item also includes funds for operations and some support. (GAO, 1986).

### **3. Readiness Training**

The relationship between readiness and resources is an important question, but one without readily available answers. This problem is one which applies to defining the relationship between resources and combat readiness, in general, and training readiness, in particular. The DoD Force Readiness Report for FY 1986 (DoD, 1985) states:

It is reasonable to inquire about the relationships of resource expenditures to the subordinate readiness indicators and to wonder about the cost of increasing readiness. Efforts to respond to this inquiry are grouped under the rubric--relating resources to readiness. As with many reasonable questions the answer is quite difficult. (p. 4).

Later the same report concludes:

Thus, while we know many resources that go into readiness, it is not feasible at this point to accurately estimate just how much the readiness indicators will change as the result of specific resource expenditures. (p. 5).

### **B. CONSTRAINTS ON TRAINING MANAGEMENT**

The macro-level training manager is positioned at the highest level of the DoD or Service training management organization. From this position, the training system is shaped through the use of budgetary powers either to approve, support, and defend or disapprove, resist, and oppose the proposed budgets for some part of the training system. The macro-level training manager's powers to influence the budget are constrained by the need to respond to the training requirements imposed by external forces such as weapon system development and personnel policies.

Personnel policies and weapon programs are major forces in shaping the training establishment. An example of the interrelationship between personnel and training policies was presented in the Department of Defense Readiness Report for FY 1984 (DoD, 1983). The Marine Corps structure, which calls for a high proportion of junior personnel, requires the training of numerous replacements each year in order to maintain the force at trained strength. The continuing influx of new personnel and the continuing loss of trained personnel serve to define the quantity and types of training needed. The training managers must decide how to meet the required training goals.

Other personnel policies and the effects of those policies contribute to a continuing state of instability as personnel are promoted, rotated, released, and retired. Unit stability or the lack of it places a significant burden on collective training. (The effects of these

personnel policies are probably intensified by the fact that personnel tend to forget previously learned procedures.) An army battalion that completes a field exercise this year will in many respects be a different organization when it is scheduled for the same exercise next year.

### **C. NEED FOR MACRO-LEVEL TRAINING DATA BASES**

In recognition of the need to improve the supportability of training resource needs,

a

1982 Defense Science Board study group recommended that DoD set up a centralized data and analysis center for the defense training community. The DSB concluded that, while good training data appeared to exist, the information was not readily available and was not always in a form best suited to the needs of training managers. (Sicilia, 1985)

### **D. ANALYTICAL OBJECTIVES**

The tasking for this project included the following goals:

1. Provide an overview of the kinds of data available and their relevance to training management issues and to the development of macro-level training data bases.
2. Identify the data required to evaluate several illustrative and representative policymaking situations.
3. Collect and evaluate the data required for at least three prototype policy decisionmaking situations to demonstrate the range of policy decisions that can be supported by the Macro-Level Cost Data Bases.

#### **1. Objective of This Paper**

This paper is the first phase of an analytical effort to determine the types of data required to support the needs of OSD and the Services for formulating and supporting training policy decisions and to assess the adequacy of current training data bases. It focuses primarily on the first of the three goals noted above. The first goal can be stated in the form of two questions:

1. What types of data should the Macro-Level Cost Data Bases contain?
2. Do the current data bases contain the data needed to support training policy decisions?

In order to respond to these questions it will be necessary first to specify the management needs to be satisfied by the macro-level training data bases. After determining the kinds of information most likely to be needed by training managers, it will be necessary to assess whether the needed information is available. These prerequisites lead to the following formulation of the current work: (1) develop a conceptual model of the training system to serve as a guide for identifying the types of data most needed by macro-level training managers; and (2) determine the availability of the required data and test the validity of the conceptual model of the training system through a series of case studies of representative training policy questions. This paper will present a conceptual model of the training system from the training manager's perspective. Based upon the model and a summary of some of the relevant data, some strategies and options for developing the required data bases will be presented. The results of the case studies will be presented in subsequent papers.

## **2. Objectives of Further Work**

Further work will address the second and third objectives of this project. The utility of current data bases for the macro-level training manager will be evaluated through the use of a set of representative policy case studies that demonstrate and assess the ability of the data bases to support cost-effectiveness analyses of training.

## II. SCOPE

The basic thesis guiding the preparation of this paper was that a description and understanding of our military training system, the types of training effectiveness data, and the utility of these data for the macro-level training manager is a necessary first step in the process of identifying the specific cost, effectiveness, and cost-effectiveness data and data base architectures needed to support training policy decisions.

The conceptual model of the training system presented here is intended to provide a systematic description of some of the functional elements of the training system and to help define the types of data that are most useful for the operation and management of the training system. The Training Management Model (TMM) describes the operation of the military training system and specifies the major training effectiveness data that are needed from a macro-level management perspective. The TMM and its three functioning modules were used to define the categories or types of data that are required by macro-level training managers at the DoD and Service levels. The data requirements were integrated into a proposed set of strategies and options for the development of the required macro-level training data bases.

### III. TRAINING MANAGEMENT MODEL

There are a number of possible approaches to building macro-level training data bases. One approach would be to try to gather all of the available training data and then figure out how to apply them to solving a variety of policy level training problems. However, given the massive amount of data that could be collected, this approach would be very expensive and cumbersome without being able to guarantee responsiveness to training manager needs. A second, somewhat better approach would be simply to ask macro-level training managers to indicate what kinds of information are needed and to build the data base on the basis of specific requests. This approach is more highly focused, more economical, and is clearly responsive to the managers' needs. For some highly repetitive problems, this approach is highly satisfactory. However, in many instances, this approach will produce data bases which can respond to last year's problems this year and this year's problems next year or at some undetermined future time. A third approach would develop the training data bases on the basis of a conceptual model of the functioning of the training system from the macro-level training manager's perspective. Like the second approach the manager's needs are the primary driving force of the data base development. However, since the model provides a more global perspective, the data bases will be responsive to a wider ranges of problems and a much greater ability to respond to the training manager's future needs can be built into the architecture and content of the data bases.

Thus, the framework for a Training Management Model has evolved with the benefits of insights provided by reviewing the significant data base development efforts at the Defense Training and Performance Data Center, discussions with a macro-level training manager, and a survey of the training performance evaluation literature. The TMM represents an initial effort to represent the training system from the macro-level training manager's perspective. As such, the model is intended to serve as a systematic aid to help understand the managerial relevance of some of the functional elements of the training system and to help define the types of data that are most useful for its operation and management. Hopefully, this model will serve its primary purpose of aiding in the design and development of training data bases and will also serve to stimulate the development of

more sophisticated models of the training system that could be used to further advance training management capabilities.

## **A. ASSUMPTIONS, CONCEPTS, AND DEFINITIONS**

### **1. Macro-Level Training Manager**

The model building effort begins with the basic assumption that the macro-level training manager seeks to respond to approved national defense needs by providing adequately trained personnel, on time, and for an acceptable cost. It is further assumed that the size of the training budget and its allocation directly determine training capabilities and capacities which in turn directly impact the unit costs and quality of the training output. The macro-level training manager uses budgetary powers to manage training capabilities and capacities as means of achieving the goal of providing adequately trained personnel, on time, and for an acceptable cost.

### **2. Conversion of Resources to Training Products**

A clearly visible linkage between the requirements generated by technical and *organizational systems* and training products should make it possible to use the training data bases for formulating and supporting policy decisions in a precise and quantitative manner. From the macro-level training management point of view, money is the common denominator of the various components of a training system. It can be converted into various training resources in the form of student and instructor time, training facilities, and equipment. The process of converting resources into training activities and products is schematically represented in Figure 1. Resources used for training are not available for other Service needs, such as aircraft, ships, tanks, or weapons.

The training process converts an objective, tangible object (money) into a subjective, intangible quality (combat readiness). However, as part of the process, the training system produces many types of numbers related to the consumption of resources and the production of trained personnel.

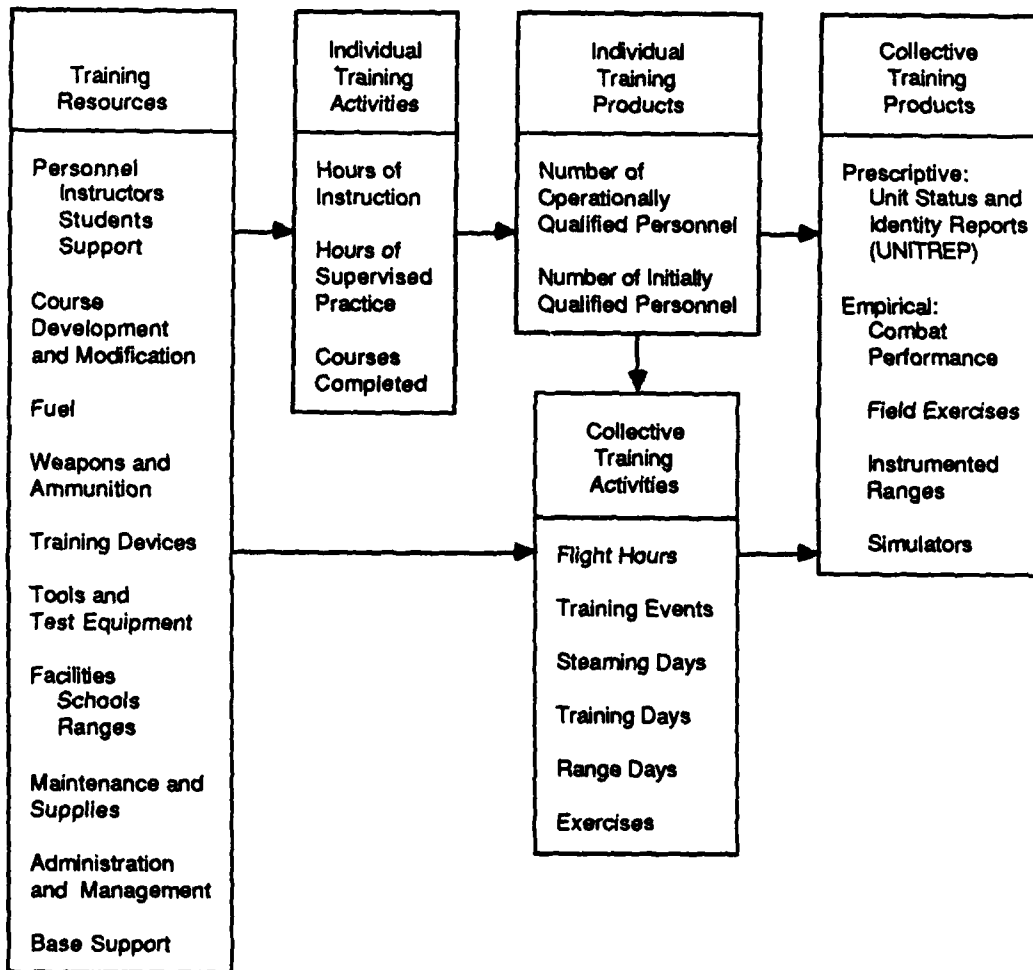


Figure 1. The Conversion of Resources into Training Activities and Products

### **3. Definitions**

#### **a. Cost-Effectiveness of Training**

Before the cost-effectiveness of training programs, methods, or devices can be determined, training products need to be defined and some measure(s) of training effectiveness must be identified and assessed. The evaluation of training effectiveness, costs, and cost-effectiveness represents a significant problem. A recent review of the economic issues in cost-effectiveness analyses of military skill training by Henry Solomon (1986) made the following observation:

A survey of the literature revealed several major difficulties in evaluating the cost-effectiveness of alternative training procedures and technologies. One major difficulty is the assessment and measurement of training effectiveness. A second is the lack of information on job performance resulting from training.

#### **b. Training**

Training means many things to many people. In order to avoid misunderstanding, it seems appropriate to specify the conceptual approach to training used in this paper. Training will be considered as something done to personnel (i.e., a "treatment") to improve their ability to perform some set of required military tasks (i.e., the "requirement"). Training is primarily reactive. The characteristics of personnel and systems design combine to determine the quantity and quality of training needed to assure the minimum acceptable performance levels of specified weapon and support systems. This paper seeks to define training data characteristics and to provide a rationale that will assist macro-level managers in the process of organizing and using training data bases to support training policy decisions.

#### **c. Performance Measurement**

Performance measures to assess the effectiveness of training will be considered within several broad categories. First, is the effectiveness of the training system to produce adequately trained individuals and units in a reasonable time for an acceptable cost. Second, is the assessment of individual performance within the training and as it influences the operational units. Finally, is the assessment of the effects of training on collective performance measures assessing either achievement in combat or probable contributions to combat readiness.

## **B. OPERATION OF THE TRAINING MANAGEMENT MODEL**

### **1. Basic Dynamics**

The Training Management Model (TMM), shown in Figure 2, shows the relations between the following components that affect the training manager:

1. requirements
2. resources
3. type of training
  - a. individual
  - b. collective
4. performance evaluation/quality control
5. readiness status.

The training system is driven by military requirements. The requirements are based on national strategy, perceived threat, the character and needs of present and projected platforms and weapons systems, and personnel quantity, quality, and turbulence. The results of the training provide feedback which also serves to modify the requirements. This complex of external and internal factors serves to establish the magnitude of required training and the composition of the training system.

Training resources are allocated and the needed individual and collective training programs are conducted to meet the goals established by the requirements. The requirements specify the number of personnel to be trained, the types of technical specialties needed, the individual and collective training to be accomplished. "Training requirements are determined by estimating the probable future attrition of required levels and skill mix of personnel due to completion of enlistments, retirements, and the need for increases in personnel levels due to increases and/or changes in weapon systems and force structures." (Solomon, 1986)

### **2. Structural Components of the Model**

The macro-level training manager must be concerned with three major functions addressed by the training system:

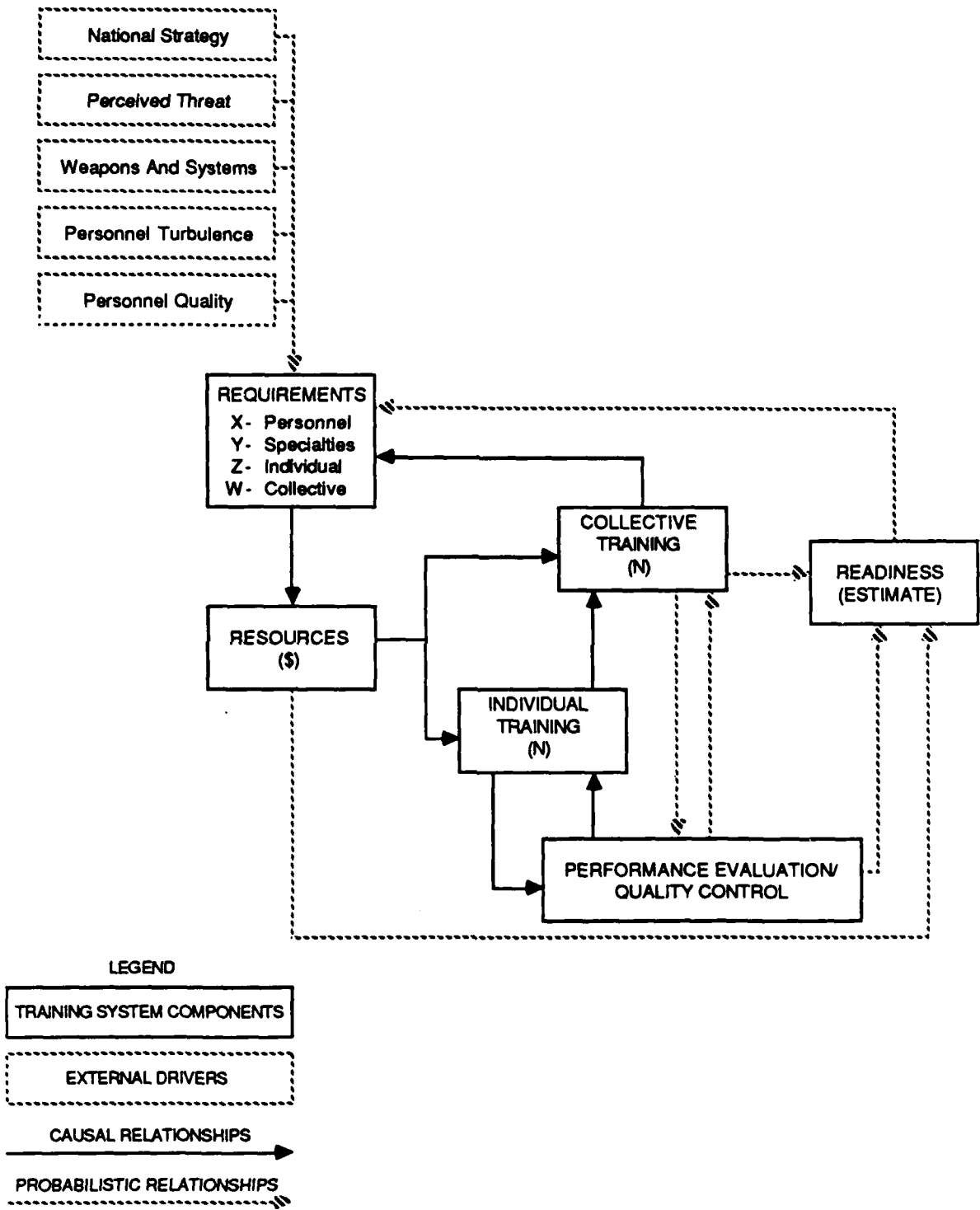


Figure 2. Training Management Model

1. the cost and production aspects of training,
2. the effectiveness of training,
3. level of readiness resulting from training.

The following discussion shows how these functions are handled by the TMM. In the following chapters, each of the major functions of the TMM will be discussed more fully in conjunction with examples of the available training effectiveness data and the presentation of a set of proposals for the development of macro-level training data bases. The three major training management functions represented in the Training Management Model are shown in Figure 3. These functions represent basic ways that the macro-level training manager interacts with the training system. The basic functioning of the overall training system does not change, as the manager's orientation and data needs change to respond to various specific problems.

#### **a. Cost-Production Function**

The Cost-Production function of the TMM describes the normal operation of the training system. This is represented by a continuous feedback loop consisting of the following four elements: Requirements, Resources, Individual Training, and Collective Training. Based upon approved sets of requirements, resources in the form of budgets, facilities, and personnel are channeled into individual and group training programs which ultimately serve to fulfill or modify the existing requirements. The Cost-Production function depends upon two assumptions: (1) the training courses and events are effective in conveying the necessary information and skills to the personnel involved, and (2) trained personnel, teams, and units advance the state of readiness and potential combat effectiveness of the armed forces. When these assumptions have questionable validity, the training manager needs to obtain appropriate performance or readiness data.

The Cost-Production function is primarily quantitative in nature. It is concerned with costs and the ability of the training system to produce the numbers of trained personnel needed to meet approved organizational requirements. The manager's concern is to provide the required number of trained personnel on schedule and within budget. Except when the training system fails to provide an acceptable product in terms of the quantity and quality of trained personnel, this is the standard operating condition of the training system. The bulk of the macro-level training managers information requests will be generated from within this functional module of training system operation.

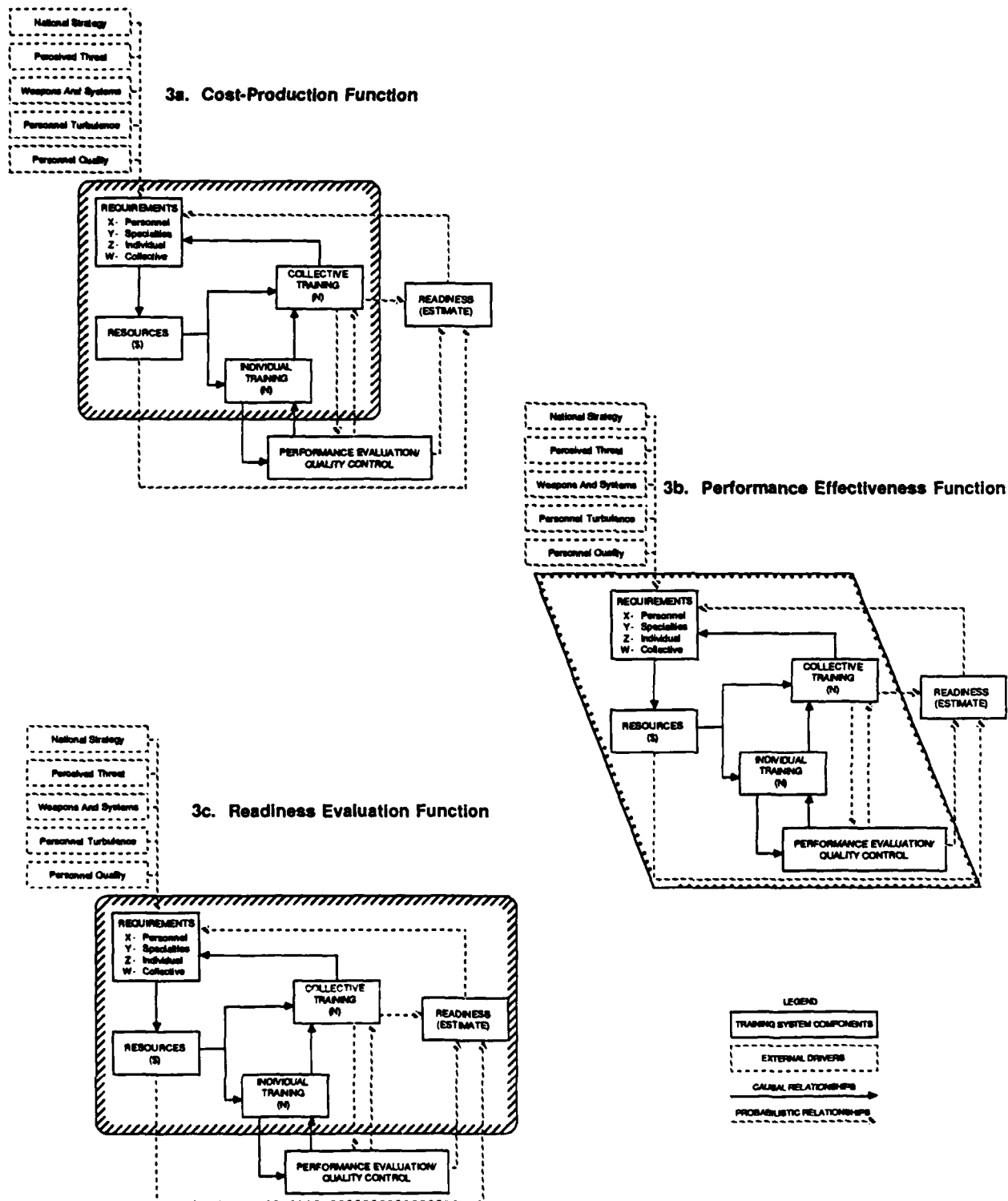


Figure 3. Training Management Model Functions

## **b. Performance Effectiveness Function**

The Performance Effectiveness function of the TMM supplements the Cost-Production function in several ways: (1) within training courses, individual performance data (e.g., test scores) support the training quality control process and provide the basis for deciding whether an individual should continue the next phase of training, graduate, recycle, or attrite, and (2) data on group performance in weapon systems (training or operational) provide a basis for evaluating the effectiveness of training courses or techniques. A positive relationship between training and readiness and potential combat effectiveness is implicitly assumed. The Performance Effectiveness function in Figure 3 consists of five elements: Requirements, Resources, Individual Training, Collective Training, and Performance Evaluation/Quality Control. There is a continuous feedback function between the Individual Training element and the Performance Evaluation/Quality Control element. However, only a possible feedback function is represented between Collective Training and the Performance Evaluation/Quality Control element.

This function is concerned primarily with the ability of the trainees to perform well on the job. It is concerned with the quality of training and more importantly with the quality of the performance skills of trained personnel. It focuses on the questions of how good the training is or how well personnel are able to perform on the job after the completion of training. This is one of the most commonly conceived notions of training effectiveness. Although data on effectiveness (test scores or job performance evaluations) can have a dramatic impact upon training policy, most of these data needs are formulated, collected, and used at the individual training (micro) level and have only negligible impact on policy-level decisionmaking.

It is interesting to note that while the large amounts of performance data collected within training courses are essential for the operation of the training system, they may be of little or no value to the macro-level training manager. However, group data of performance within systems can be very useful in assessing the impact of training courses or of alternative training techniques upon performance. This type of data may be used to either support or resist changes in training programs or techniques. Training changes based either on performance quality or cost-effectiveness impact budgets and are of value to the macro-level training manager.

### **c. Readiness Evaluation Function**

The Readiness Evaluation function like the Performance Evaluation function acts primarily as a supplementary element to the Cost-Production function. The Readiness Evaluation function can perform in two distinct ways. The first way of functioning is represented in Figure 3 by three elements: Requirements, Resources, and Readiness. These three elements provide for a continuous evaluation of how well the prescriptive readiness requirements have been met--have all the individuals and functional units completed the required training courses and events. The second way of functioning uses all the elements in Figure 3 and provides a possible linkage between training and empirical readiness evaluations.

This third function of training system operation looks at the quantitative and qualitative effects of training on combat readiness. The criterion of effectiveness can range from a certification that the approved training requirements have been met to an actual measure of combat relevant performance. The outcomes from these operations are capable of having very significant impact upon the operation of the training system. However, once a problem has been satisfactorily resolved, the training system goes back to the baseline operating condition represented by the Cost-Production function.

## **C. DISCUSSION AND CONCLUSIONS**

The TMM provides a conceptual model of the major interactions between the macro-level training manager and the training system. Based upon a small set of assumptions about the function and goals of the macro-level training manager and the nature of training, the TMM provides a broad perspective of the types of data that are most likely to be required for the solution of training policy questions.

The TMM provides data on three aspects of training: Cost-Production, Performance Effectiveness, and Readiness Evaluation. The Cost-Production function is the normal operating condition. Here, the macro-level training manager is primarily concerned with costs, the effectiveness of the training system, and ways to improve the cost-effectiveness of the system. If the effectiveness or cost-effectiveness of a training effort becomes questionable, then the Performance Effectiveness of the training system becomes the dominant concern. Here, performance data, primarily of individuals or groups in training or recently graduated from training, become the macro-level training manager's primary area of concern. If the contribution of training to combat readiness is questionable, then the Readiness Evaluation aspect of training becomes dominant. In this case, the focus of the

manager's interest may be either the adequacy of the training system in providing all the courses and unit training events required for combat readiness or else how well the courses and unit training events contributed to some measure of combat effectiveness. When questions concerning Performance Effectiveness or Readiness Evaluation have been answered, the control function reverts back to the Cost-Production aspect of training. All three functions can coexist depending on what aspects of training are dominant at any time.

#### IV. COST-PRODUCTION FUNCTIONS IN TRAINING

In its simplest form, the Cost-Production function in the TMM counts the number of personnel trained and compares these figures with the resources consumed and with the number of trained personnel required. More sophisticated versions of this aspect of the training system might consider the training systems as being directly analogous to hardware production lines. A training program can be viewed as having start-up costs, and fixed and variable costs based on production rates. If training production systems are linked directly to the technical and organizational systems that they support, then the training data bases can be used to evaluate the probable consequences of policy decisions.

From the training manager's point of view, the Cost-Production function can provide the most policy relevant information about the training system of any of the major functions if the following two assumptions are acceptable:

1. That training courses are effective in conveying the necessary knowledge and skills to the personnel involved.
2. That trained personnel advance the state of readiness and potential combat effectiveness of the armed forces.

These assumptions are generally acceptable and training managers normally operate within a Cost-Production frame of reference. Consequently, their greatest need will be for training data base information that assists them in providing the required number of trained personnel, when needed, and for a minimum cost. The Cost-Production function in training is presented in Figure 4.

Data for the Cost-Production function cluster into three categories which are reviewed next: level of effort, training capabilities and capacities, and training proficiency. The level of effort category contains examples of the kinds of information used to assess levels of effort in training such as student training loads and inventory projections for individual training and flight hours, steaming hours and battalion training days for estimating the magnitude of collective training. The training capabilities and capacities

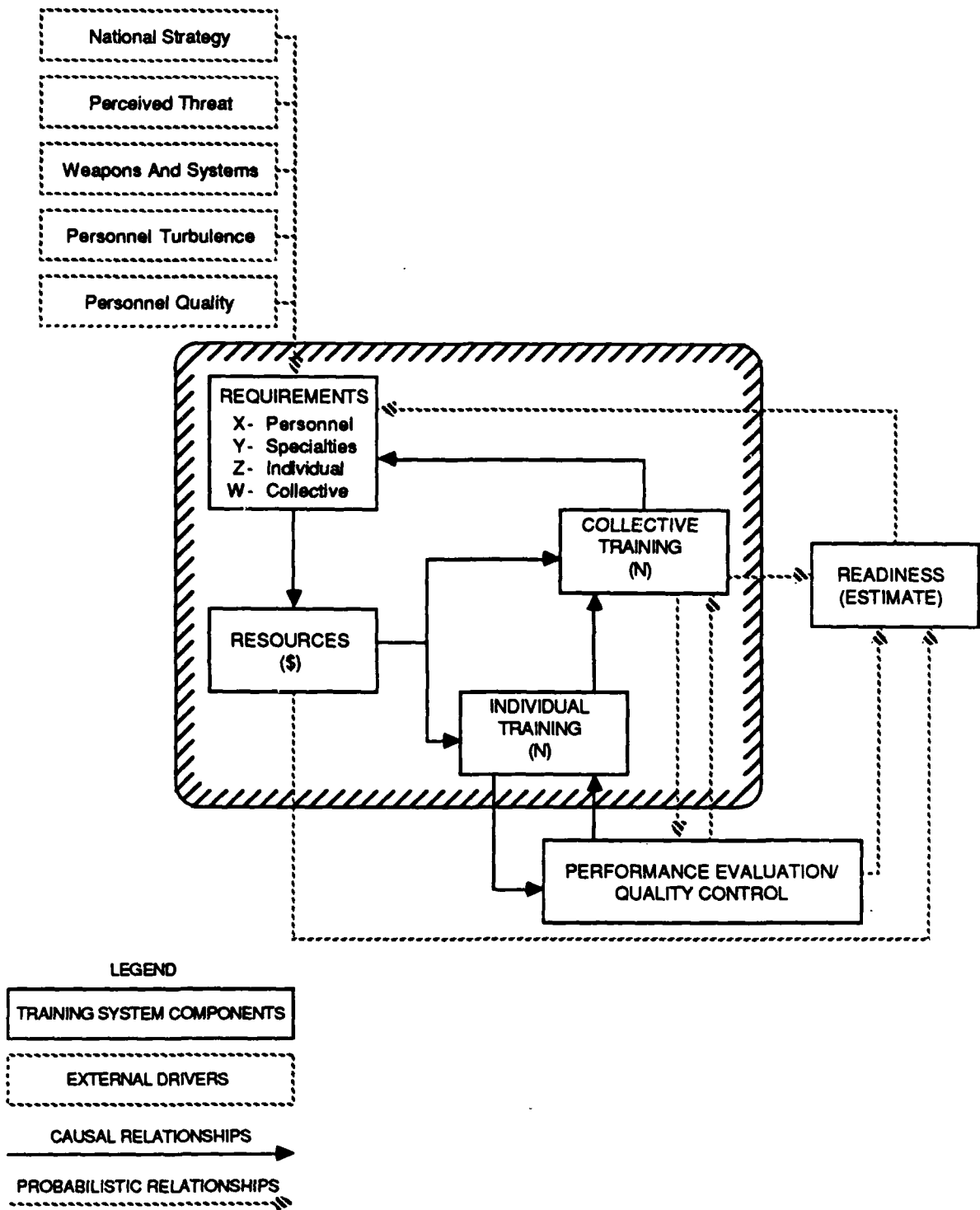


Figure 4. Cost-Production Functions of Training

category contains the descriptive, trend, and functional data needed by the training manager to properly manage and develop the training systems' physical and personnel resources. The training proficiency category contains measure of how well the training system has responded to approved training requirements.

## **A. TRAINING SYSTEM LEVEL OF EFFORT**

### **1. Individual Training**

According to the Department of Defense Force Readiness Report for FY 1984 (DoD, 1983), the level of effort of individual training can be monitored through the use of two indices:

1. Student Training Loads - indicate the total person-years of individual training contained in Service budgets.
2. Inventory Projections - indicate the effect of projected training loads in reducing occupational imbalances.

In combination, these indices provide information on the magnitude of the Services' individual training plans and on whether these plans provide enough people trained in needed skills.

### **2. Collective Training**

The level of effort of collective training can be monitored through a number of different indices. Flying hours, steaming days, and battalion training days are the measures used most frequently to gauge the approximate level of effort involved in team training.

#### **a. Air Warfare Training**

Flying hours represent the principal index of aviation training activities. The Department of Defense Force Readiness Report for FY 1986 (DoD, 1985) noted that the flying hour program is the largest and most significant of all Air Force training programs. Approximately 35 percent of the Air Force Operations and Maintenance (O&M) budget supports flying operations. It should also be noted that the training value of flight hours varies according to the purpose of the flight. With respect to the Air Force, the DoD Force Readiness Report (1983) stated that the data on flying hours per pilot per aircraft does not differentiate between readiness and non-readiness related flying: that is, those flying hours

directly associated with increasing the pilot/crew's proficiency to perform combat missions versus the hours spent in collateral or support flying.

In discussing the Navy's flight hour program, the Department of Defense Force Readiness Report for FY 1986 (DoD, 1985) presented the following information:

Primary Mission Requirements (PMR) constitute those hours required in TACAIR/ASW flying that aircrews must accomplish to achieve a certain level of training. It also encompasses executing fleet operations and the performance of support tasking. The Department of the Navy (DON) goal is 88 percent funding of PMR, which includes two percent simulator flying. Although PMR funding percentage has declined since FY 1977, the DON budgeted for an increased percentage funding for PMR in FY 1985 of 86 percent and continued this upward trend with a FY 1986 funding level of 87 percent.

The difference between training goals and budget support for training was also noted by Cavalluzzo (1985).

Within the USN air community, optempo signifies flying hours per quarter. The flying hour goal was stable between 1977 and 1984. Budgeted flying hours have fallen continuously, however, over the same period. For nondeployed squadrons alone, the numbers are even lower because deployed squadrons have averaged approximately 115 percent of goal, and the difference must be made up by the nondeployed community.

The flying hour is also used as the basic unit for planning training in Army aviation. According to the Force Readiness Report for FY 1984 (DoD, 1983), the Active Army Flying Hour Program (FHP) provides the minimum number of flying hours needed to support individual training and to maintain unit level proficiency for aviation units at their programmed manning levels. The increase in flying hours from year to year is related not to aircraft inventory but to aviator inventory, since the Army FHP is based on the number of hours required to attain and maintain both individual and unit proficiency.

A major problem for the training manager is the task of estimating the impact of partial (i.e., "insufficient") funding on training readiness. One of the questions that needs to be addressed is whether the data bases will enable the training manager to predict the relationship between various amounts of partial funding and quality of unit performance or readiness level. This is a complex question that would require the use of two or more of the TMM's major functions. In the Cost-Production function, the training manager should be able to use the data base to document the relationship between decreased funding and decreases in the amount of training time. As a next step, either the Performance Effectiveness or the Readiness Evaluation functions would be invoked to document the

relationship between decreased training time and measurable decreases in indices of performance effectiveness. However, from the Cost-Production perspective, the training manager is primarily interested in how well the prescriptive requirements are being met, the cost savings from any new instructional techniques or technology insertions, and whether conditions are improving or deteriorating.

#### **b. Sea Warfare Training**

Steaming hours provide a measure of some aspects of the amount of crew and unit training for sea warfare. Like flight hours, steaming hours represent a measure of training opportunity. However, there are no production equations that convert steaming hours to either training readiness or unit proficiency. Cavalluzzo (1985) provided some insight concerning the ambiguousness of the relationship between the use of resources and its results in training.

The primary mission of the nondeployed fleets of the U.S. Navy (USN) is to prepare personnel for deployment. On-the-job training while underway allows a crew to work as an integrated unit in a hands-on setting. But it is very expensive, and until now, no one from the analytical community has tried to measure the readiness payoff of the expenditure. Thus, it is not possible to say with any degree of precision what would be gained by stepping up nondeployed activities, or conversely, what would be lost by cutting back. Although more work is needed, preliminary estimates of the association between nondeployed activity and training readiness, based on a variety of measures, are positive.

#### **c. Ground Warfare Training**

The indices of levels of effort of ground warfare training seem to be more variable and more subject to interpretation than the training resource measures used in the other warfare categories. The battalion training day (BTD) and the battalion field training day (BFTD) are the most frequently used indices of level of effort for ground warfare training. The DoD Force Readiness Report for FY 1986 (DoD, 1985) indicated that the level of effort for Army collective training had remained relatively stable during the 1983 to 1986 time frame. "The average BTDs per battalion remains virtually steady at about 162-164 per year."

The BTD is used as a reporting unit but not as a planning unit. According to the Department of Defense Force Readiness Report for FY 1984 (DoD, 1983), Army training is not managed by BTD but by training events, which are planned by units and with funds that are budgeted well in advance of the specific fiscal year. BTD's provide a general index

of the amount of time devoted to unit training, but do not measure the contribution of training to readiness. Other factors such as availability of ranges, training facilities, spare parts, personnel and leader fill/quality, or availability of fuel are significant factors that impact the amount of training that can occur.

The Marine Corps uses the battalion field training day (BFTD) as a reporting unit. According to the DoD Force Readiness Report for FY 1984 (DoD, 1983),

BFTD's are developed by unit commanders to quantify collective training conducted in the unit environment. Planned BFTD's are resource-constrained, and include unit deployments as well as local training programs. For Marine Corps ground force units BFTD's include that training which:

- Is designed to improve the unit's mission capability
- Is at least eight hours in duration
- Is conducted in the field and/or from amphibious shipping
- Involves the majority of the unit's effective strength.

The use of situationally unique measures of training levels of effort significantly complicate the training manager's task. Attempts to use measures that cannot be combined and which are loosely related to training goals are bound to produce results that are limited in their contributions to policymaking functions.

## **B. TRAINING CAPABILITIES AND CAPACITIES**

The management, development and structuring of the capabilities and capacities of the training system represent the macro-level training manager's unique sphere of influence. As such it may be the single most important area for the formulation of training policy. Many of the major parameters influencing the operation of the training system (e.g., numbers of personnel to be trained, the quality of the personnel, and even the skills to be mastered) are externally imposed upon the training system and its managers. As with the manager of a manufacturing, production, and distribution system, a training manager needs to know a great deal about production capabilities and capacities in order to make informed cost-effective decisions.

Descriptive, trend, and functional information are needed in order to manage the present and to plan for the future. The required descriptive information includes: budgets and how the budgets are allocated to different types of training; training capabilities; descriptions of the kinds, amounts, and the unit costs of the training accomplished; and summaries of the training capabilities including their capacities, levels of utilization,

locations and physical condition. The trend information should be able to provide census types of information so that the training manager can know what the systems capabilities used to be, what they are currently, and what they are likely to be in the future (with and without anticipated management interventions). The functional information would include formulas and descriptions of how different factors influence the cost-effectiveness of training (e.g., decreases in the quality of personnel should increase training times and costs, increases in the use of computer-based instruction should decrease training times and possibly costs by some anticipated amount, and a knowledge of the levels of personnel turbulence and rates of forgetting could (if known) be used to establish the collective training refresh rates required to maintain the desired levels of unit proficiency). Information that contributes to the construction and evaluation of alternative training scenarios can provide the training manager with powerful policymaking tools.

The macro-level training manager also needs to be able to aggregate and simplify the capabilities and capacities information. A training system with a worldwide distribution of assets which trains people in hundreds of occupations through the use of thousands of courses is too complex for any individual to fully comprehend; hence, the need for aggregation and simplification. As a purely imaginary hypothetical example, giving the training manager a computer listing of all the weapons firing ranges in DoD with their locations and capabilities would be of minimal, if any, value. However, if all of the appropriate range data were summarized, it might reveal that some 2,000 ranges are currently available and that current training needs require the use of 1,500 ranges; but that due to environmental problems, 1,600 ranges would go out of operation in the next five years and that most of the remaining ranges would be in Alaska and several foreign countries. This sort of summarization of capabilities, needs and trends would clearly provide the basis for formulating training policy.

### **C. TRAINING SYSTEM PROFICIENCY**

This section will present some examples of data relating to the quantitative aspects of training system proficiency. These data include include examples from both individual and collective training. The measures of system proficiency are indices of how the training system has responded to the prescriptive quantities, types, and levels of individual and collective training deemed necessary for the desired state of national readiness.

## **1. Individual Training**

The sequential training milestones that need to be satisfied to become a Fully Combat Qualified Marine aircrewman provide a good example of a quantitative relationship between the specified training program and the desired training proficiency goal. The DoD Force Readiness Report for FY 1984 (DoD, 1983) provides an example of prescriptive levels of training:

The following training sequence generally applies to produce a combat qualified Marine aircrewman: Marine flight students are trained in Navy training squadrons to the point where they are formally designated as Naval Aviators or Naval Flight Officers (25% ready). They then proceed to Marine training squadrons where they receive training in a specific type aircraft to become Combat Capable (60% ready). The new aviator is then assigned to an operational squadron, which trains him to become Combat Ready (70% ready), Combat Qualified (85% ready), and Fully Combat Qualified (100% ready).

The training manager needs to know how many should have been trained to each level, how many were trained to each level, and at what cost. In order to determine how well the system is performing, it is also necessary to have data from past years to determine how well system production and costs compare with previous efforts and to determine whether there are any observable trends.

## **2. Collective Training**

Prescriptive training readiness is a joint product of the number of personnel assigned to a unit, the number and types of individual training courses that they have completed, and the collective training exercises that the unit has completed. The DoD Force Readiness Report for FY 1984 (DoD, 1983) indicated that with respect to individual training,

The formal school network must qualify individuals in occupations necessary to staff programmed manning vacancies. This training will affect personnel readiness, which is reported by matching on-board trained personnel to the unit's programmed structure.

The interrelationship between training readiness and other readiness variables was emphasized in the same publication (DoD, 1983) by the statement

To a large degree training readiness is a dependent variable, very much influenced by a unit's personnel and equipment status.

Several studies have reported that the amount of training influences training readiness. Horowitz and Angier (1985) reported that the "quantity of formal Navy training was a consistent predictor of ship readiness." Cavalluzzo (1985) reported that a "1-day-per-quarter rise in training is associated with a 2.26 percent rise in the number of ships that are combat ready upon deployment."

#### D. DISCUSSION AND CONCLUSIONS

In order for a data base to support the Cost-Production aspect of making training policy, it should be able to provide information regarding the allocation of funds for training, cost of training, levels of effort, and measures of system proficiency. The present analysis assumes that data describing the funds allocated to training and training costs are available; however, whether they are the right kind or are in appropriate formats are questions that need to be addressed in a future analysis. Generally accepted measures of levels of effort are available in the form of measures such as student training loads and inventory projections for individual training and flying hours, steaming hours, and battalion training days for collective training. Some training system proficiency measures such as training program completions, productivity estimates, and training readiness reports are either available or at least obtainable.

Second only to the adequacy of training production is the status and capability of the training system. A significant proportion of training dollars is invested in the facilities, equipment, and organizations needed to conduct training. The macro-level training manager needs to know what the training capabilities are, where they are located, what their capacities are, their degree of utilization, their condition and whether they are improving or deteriorating. Since many policy decisions are made with respect to these training capabilities, it is essential that the data banks be capable of providing both current descriptive summaries and historical trends regarding these training capabilities. Catalogs of training capabilities and annual summaries of training production accomplishments are important aids to the policymaking process.

In a generic sense, we have identified the types of data needed to support cost-effectiveness analyses of the Cost-Production aspect of training operations. Examples of the required data types have been presented. These data either are or could be routinely acquired for use within training data bases. Based upon the TMM, the development of data bases to support management requirements within the Cost-Production function should receive the highest priority because: (1) this is the normal frame of reference for a macro

level training manager, and (2) the data appear to be of the sort that could be collected routinely for use in training data bases. Further work is needed to determine the extent to which the required data exist in current training data bases and whether they are the proper form to be used to answer specific training policy questions.

#### **E. DATA BASE OPTIONS AND STRATEGIES**

The development of a data base to support the Cost-Production aspect of training system operation should be the macro-level training manager's first priority. The short-term best option would appear to be one in which fairly simple descriptive data bases were established. These data bases should be capable of accurately tracking and summarizing budget allocations for training, training costs, student loads and inventory projections. Additional data bases should be capable of providing descriptive summaries of training facilities and equipment--including their capabilities, capacities, location and level of utilization. Efforts should be made to be able to list, summarize, and simplify the data in periodic and on-demand reports to aid in the development of training policy.

On an intermediate term basis it should be possible to develop data on trends by incrementing the data files on an annual basis. This trend data would assist the training manager in specifying what the training accomplishments and capabilities were, what they are now, and what they are likely to become. This is the kind of training management information that would assist DoD and Service level training managers in responding to Congressional requests for information and program justification by relating past levels of funding support to current accomplishments and relating current and anticipated problems to projected needs for support.

Probably the most important long-term strategy would be one which planned the development of the data bases as a means of developing and verifying key functional relationships. In both the development and justification of training policy, the training manager needs to know or to be able to project the effects of the training policy on the cost-effectiveness of training. The ideal goal would be to be able to simulate the operation of the total training system because of its obvious utility for analytical purposes. However, there are many levels of sophistication between where we are now and this kind of an ideal goal. Considerable benefits could be accrued by systematically collecting from the training data base, special data bases, and the research literature information on the functional relationships between key factors influencing the operation of the training system and their effects on costs, system productivity, and the cost-effectiveness of training. This

information could be summarized in a dictionary of training management information. The known information could assist in answering "What if" questions and in identifying gaps in needed management information. These identified information gaps could be used to guide the course of research and future data base development.

## **V. PERFORMANCE EFFECTIVENESS FUNCTIONS IN TRAINING**

Performance quality/achievement data, particularly when the performance is significantly below established standards or has been reported as unsatisfactory by a blue ribbon panel, can lead the manager to a consideration of the Performance Effectiveness function of training operations. The results of performance effectiveness evaluations can produce significant and lasting changes in the training system. However, once the changes have been programmed, budgeted and implemented, interest reverts to the Cost-Production aspect of training operation. Since the training is now assumed to remain satisfactory, the performance effectiveness data cease to be of major concern at the policy level.

The information in this chapter will be presented in two sections. The first section will discuss the characteristics of the Performance Effectiveness function of the Training Management Model (TMM). The second section will present and discuss examples of the kinds of data needed to assess the effectiveness of training. These data were derived from individual and collective training. The focus of the data is either on the quality of performance during training or on some measure of operationally relevant performance. When these measures are aggregated and when they can be related to training techniques, the amount of resources used, or the intensity of the training activity required to achieve different levels of training results, they become significant to the macro operation of the training system.

### **A. DESCRIPTION OF THE PERFORMANCE EFFECTIVENESS FUNCTION IN TRAINING**

Training is an acknowledged obligation of all military organizations and is usually assumed to be at least minimally effective unless proven otherwise. (Since training is under the direction of personnel experienced in the specialties being taught, this is usually a reasonable assumption.) Perceptions of training inadequacies may serve to generate sufficient interest in a problem area so that a special study is conducted and changes to the training system are proposed and approved. In some situations the reported observations

of the quality of trained performance may involve the locus of responsibility for training as well as the quality of training. For example, perceptions of a problem in Navy maintenance training were presented by the Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT) in a message (1981) to the Chief of Navy Technical Training (CNTECHTRA):

Today's apprentice-technicians are generally incapable of carrying out the basic tasks related to equipment maintenance. As a result, the senior petty officer is required to fulfill these basic tasks and outside assistance must be called in to accomplish journeyman petty officer tasks. (cited in Keeler & Guynn, 1986).

The message clearly indicates that a higher level of training is needed before the technicians are sent to the fleet. Later, the Navy decided to transfer a greater portion of the training responsibility to the fleet. In 1986, Burlage reported the Navy's decision that

Schoolhouse training for sailors entering 18 support ratings will be reduced an average of 25 percent by October as part of the Navy's newly announced plans to cut formal instruction and shift more of its responsibility to the fleet.

It is significant that neither of these judgements regarding either the adequacy or the agent responsible for training directly address the skill levels to be attained through formal initial skill training. Better representation and quantification of apprentice and journeyman skill levels would add significantly to the precision and justifiability of training management decisions.

Figure 5 represents the Performance Effectiveness function of training system operation; the performance evaluation element is labeled Performance Evaluation/Quality Control. The block diagram illustrates several characteristics of the Performance Effectiveness aspect of training. First, it is a supplement to the Cost-Production aspect of training. Second, while it can influence either individual and collective training and/or the requirements for each, performance data are used principally to evaluate the adequacy of student progress in individual training. If student evaluation scores are above the minimum acceptable level, the students are retained for the next phase of training or are graduated from the course. If the student scores are below the minimum acceptable level, the students are either recycled through the failed training segment or they are dropped from the course. This process is analogous to the use of multiple product inspections on an assembly line. The primary function of student evaluations is one of quality control to assure that no technically unsatisfactory students are graduated from the training program. (At this point

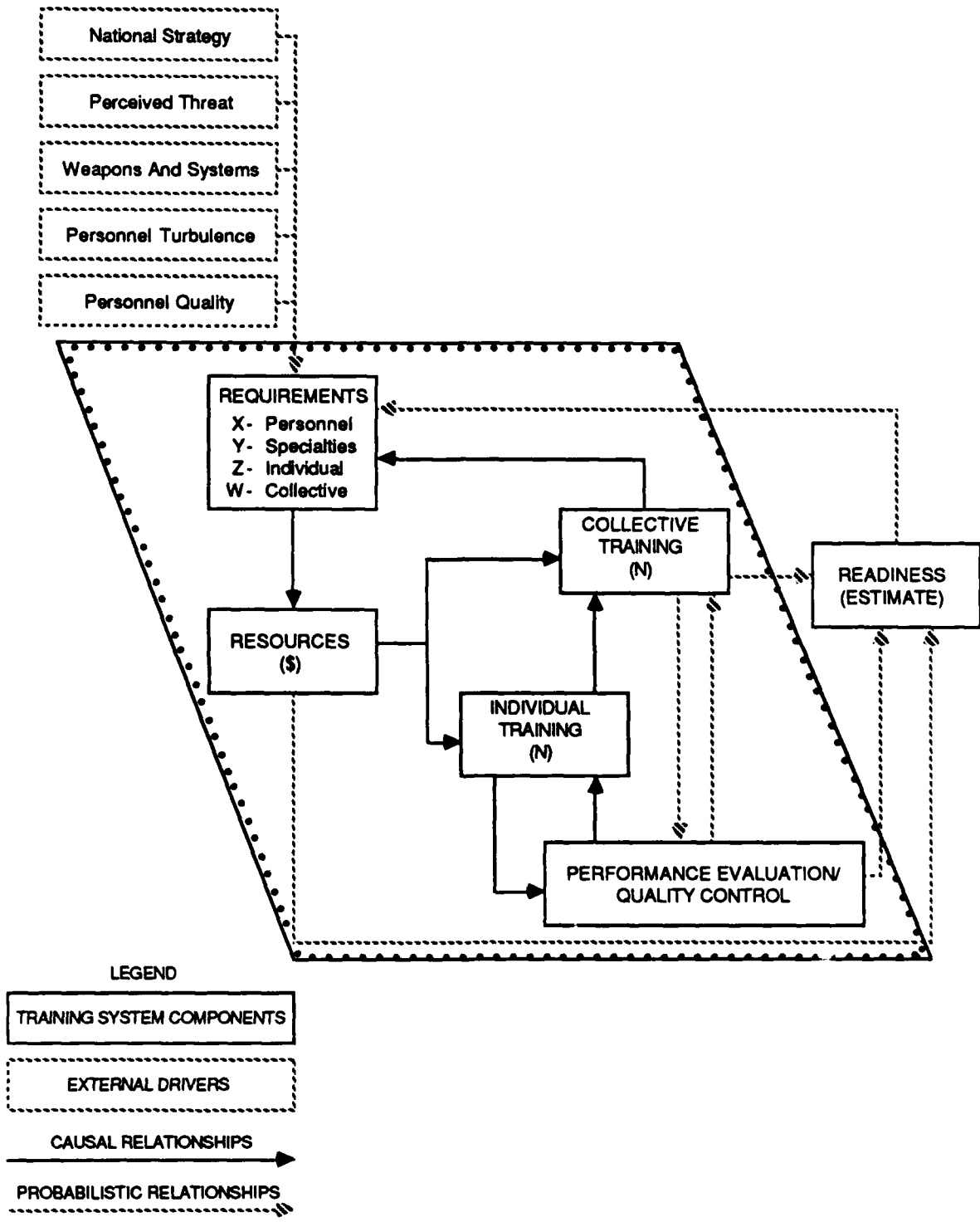


Figure 5. Performance Effectiveness Functions of Training

it may be worth noting that although a great deal of learning occurs during training, the function of training is more directly analogous to the function of the shaping phase of a classical instrumental learning paradigm. Like shaping, training consists of a number of preliminary familiarization and learning experiences that ensure that the desired behaviors are likely to occur. The types of performance data, decreasing error rates or increasing speed over time that are the essence of traditional learning curves do not occur until the student completes training and begins to apply his or her skills on a regular basis [examples of this type of on-the-job learning curve can be found in Quester and Marcus (1985)]. However, the extensiveness or the quality of the training determines the magnitude of the first point on the curve and probably the slope of the curve as well; i.e., more fully trained personnel probably demonstrate higher levels of initial performance on the job and improve at a faster rate than less effectively trained personnel (Gibson and Orlansky, 1986.)

Another major limitation on the macro-level use of performance data stems from the fact that they are usually very specialized and cannot be meaningfully aggregated. Consequently, performance data are most likely to serve as a quality control element for a particular training course. In this capacity its existence and operation are generally irrelevant to the needs and interests of the macro-level training manager. On those occasions when performance data reach the level of visibility needed to influence requirements, it is likely to be in a major way which will require a long-term change in resource allocation caused by the addition or deletion of training programs. Any time that the quality of training is seriously questioned or any time that the macro-level manager feels that proposed training changes may affect training quality, it will be necessary to have access to the appropriate performance effectiveness data.

## **B. PERFORMANCE EFFECTIVENESS DATA**

### **1. Individual Training**

#### **a. Aviation Training**

Flying hours have been found to be related to operational performance in the forms of boarding rates (i.e., percentage of successful carrier landing attempts), Operational Readiness Evaluation (ORE) grades and bombing accuracy. Cavalluzzo (1985) reported that as flying hours declined, there is a substantial increase in the dispersion of boarding rates. At higher flying-hour rates, average boarding rates were higher and clustered more closely to the average (see Table 1). Cavalluzzo's analysis of the ORE grades closely

paralleled the results of the boarding rate analysis. Higher squadron ORE grades were associated with higher average monthly flying hours (see Table 2). Cavalluzzo noted that the relationship between flying hours and ORE scores also held true for interfleet comparisons.

Interfleet comparisons yielded an equally dramatic difference. Squadrons in the Pacific Fleet average less than 80 percent as many monthly pre-ORE flying hours as those in the Atlantic Fleet. Only 39 percent of Pacific Fleet squadrons received scores in the top two ORE categories, compared to 63 percent for the Atlantic Fleet.

**Table 1. Average Boarding Rates During Operational Readiness Evaluation (ORE)<sup>a</sup>**

Flying Hours Per Squadron Per Month	Average Boarding Rate	Minimum Boarding Rate	Lower 25th Percentile Boarding Rate
Under 360	88.5	70.0	85.0
360 - 439	90.1	70.5	87.5
440 - 519	93.2	84.0	91.2
Over 519	94.1	89.3	n/a

<sup>a</sup> Cavalluzzo, 1985, p. 372.

**Table 2. ORE Grades and Monthly Flying Hours<sup>a</sup>**

ORE Grade	Average Monthly Flying Hours
Excellent	356
High Excellent	384
Low Outstanding	421
Outstanding	487

<sup>a</sup> Cavalluzzo, 1985, p. 372.

In the same report, she also noted that a 1-percent increase in flying hours devoted to bombing practice was associated with a 1/2-percent reduction in average miss distance. In the case of bombing accuracy, the relationship between practice and accuracy is not a simple linear relationship. Cavalluzzo (1985) reported

...The United States Air Force has some preliminary work that indicates that bombing accuracy is not something which improves gradually with practice, but is instead susceptible to sudden improvement at a later stage, that is, at "journeyman" rather than "apprentice" level, when trainees suddenly pick up the knack. If this is the case, it leads one to believe that as much as two years lead time may be required in order to ensure a high degree of accuracy.

These findings suggest that the amount of training and the operational results for a cohort of trainees may need to be tracked for at least two years before the effects of program increments or decrements can be detected. The notion of step increases in the relationship between resource usage and the effectiveness of the targeted performance would be important in justifying the level and duration of support for some training activities. While the specific relationships would have to be documented at a less than macro level, the verified relationships could be of value in the formulation of macro-level training policies.

Some useful conceptual work and research has been done to relate performance quality/achievement to the cost-effectiveness of aviation trainers. Orlansky (1985) reviewed a series of studies which developed a methodology for assessing the cost-effectiveness of aircraft simulators. The technique compares the relative costs of training in simulators and in aircraft with a measure of the relative effectiveness of progressively increasing amounts of simulator training. This approach combines both cost and performance quality/achievement data to specify the cost-effective range for simulator training. In effect, the use of simulator training is cost-effective until the incremental gain in training benefits from simulators relative to flying is less than the ratio of simulator to aircraft training costs.

The collection and application of this type of specific simulator evaluation data has strong implications for the development of macro-level training management policy. Where simulators are an optional method of training, this technique can serve as a model of the kinds of data that need to be collected and the way that they can be used to formulate training policy. It would be interesting to see how useful this approach would be in evaluating the cost-effectiveness of other simulator applications and computer-based

instruction (CBI). In principle, it would apply to many different types of simulation used as an optional training method in lieu of operational equipment and/or the duration of field training exercises.

#### **b. Ground Force Training**

Measurement of the effects of individual training on the performance effectiveness/achievement appears to be more difficult for Army and Marine Corps ground forces than it is for aviation. This is in part due to the fact that the individual performances occur within a complex of other concurrent activities. Pellicci (1985) has noted that "Individual training is a continuous process but--because it is conducted concurrently with other activities--it requires few dedicated resources, and is not a significant cost driver in non-aviation units." This concurrence with other activities complicates the measurement problem for two reasons: (1) any set of measures will be confounded by the concurrent activities, and (2) no single measure adequately describes the total set of group activities.

Some attempts to assess training effectiveness have produced mixed results. A report on the use of battalion ORE scores to evaluate the effectiveness of training for the Hawk missile by Tubbs, Hansen, Roberts, Abel, and Wilson (1985) was equivocal in trying to determine the cause of the consistently low ORE scores (see Table 3).

The results of the OREs underscore the fact that, in addition to the standards (which are extracted from current Technical Manuals (TMs)) perhaps being too strict, training and maintenance are not adequate to support the required unit readiness. While crew performance is low, reflecting the state of training, the equipment performance reflected by the combined score, is even worse.

Clearly, performance measured against the ORE standards was not very good; however, since these standards were judged as being too strict, it is hard to evaluate training effectiveness since small changes in the standards might result in large changes in the ORE performance scores.

Many of the problems associated with evaluating training effectiveness may be solved through computer modeling and combat simulations. Neal and Paris (1985) reported

There is a new effort at the U.S. Army TRADOC Systems Analysis Activity (TRASANA) to use computer combat simulation models to evaluate the operational significance of training performance criteria and soldier performance resulting from training programs.

**Table 3. Battalion ORE Results<sup>a</sup>**

		Crew Performance (percent)		Combined Crew and Equipment (percent)	Number of OREs
		Fire Control	Launcher		
Battalion	Goal	100	100	75	
1		20	50	30	10
2		10	71	0	7
3		23	66	0	3
4		52	47	43	23
5		55	42	67	24
6		42	57	29	7
Average		35	55	28	12

<sup>a</sup> Tubbs, Hansen, Roberts, Abel & Wilson, 1985, p. 182.

The availability of empirically-based performance standards would be a tremendous asset for training managers. The ability to specify the impact of different levels of training on combat effectiveness would give the macro-level training manager greatly increased leverage in justifying and defending training budgets. If nothing else, the computer models should be useful in identifying the measures and performance relationships that should be validated through the collection of field data.

### **c. Maintenance Training**

A large proportion of the Services' individual training programs are devoted to training the technicians who maintain the vast array of equipment used by the military. Consequently, the assessment of the cost-effectiveness of these programs is important to training management.

Gibson and Orlansky (1986) reviewed a number of job performance measures that have been used to evaluate maintenance training effectiveness. Several measures were identified as meriting consideration for future training effectiveness evaluations: speed of work and net productivity ratings. Data on the speed of work completion reported in maintenance data banks was sensitive to differences in training techniques. For example, studies on the effects of additional formal-type training (Field Detachment Training-FTD) for F-16 technicians indicated that those who had such training performed better and seemed to benefit more from their work experience than those who did not have the additional formal training [Johnson, McConnell & Murdock (1983) and McConnell & Johnson (1984)]. A report by Quester and Marcus (1985) using net productivity ratings, indicated that technicians who had received formal A-school training were more productive on the job than those who had received OJT. (The use of a net productivity rating also provided a common metric for doing a cost-effectiveness analysis of the comparative advantage of A-school versus OJT for a number of technician ratings.)

Most of the maintenance job performance data could be expected to serve a quality control function at the micro levels of training management. However, the development of tools to objectively select training methods and to determine the cost-effectiveness of training also have obvious implications for the formulation of training policy at the macro level of training management.

## 2. Collective Training

Most forms of collective training are so complex that they have previously defied the use of the available measurement and assessment techniques. Consequently, few performance effectiveness data have been gathered and the available data have not had a significant effect upon training requirements. Fortunately, the future for collective training evaluations may be substantially brighter. Advances in the form of instrumented ranges, simulated weapons fire, networked simulators, and advanced multi-element combat simulations promise to revolutionize our ability to measure and evaluate collective training. Training managers need to develop plans for the effective use of these improved forms of collective training evaluation.

Rowland (1985) provides an innovative example of how collective performance effectiveness data can be collected and used. The results of an interactive combat training exercise called REALTRAIN were used to show that some collective training activities can be extremely effective.

From Lanchester's square law--confirmed by analysis of simulated interactive armoured battles--the exchange ratio will be inversely proportional to the number of weapons on each side in battles. Thus for defensive battles a change from standard troops at 50% proficiency at the beginning of REALTRAIN to 95% after two weeks can be equated to the effect of a 95/50 or 1.9X increase in force size without such extra training....Evidently major changes in capability are possible if practice in interactive combat is provided at platoon level or above.

Rowland's evaluation of the effects of collective training as a force multiplier would seem to have real value in estimating the cost-effectiveness of training. If this type of data could be collected on a larger scale and for a significant array of applications, it would allow training managers to develop trade-offs between the costs of training and the costs of increased force size or between more training and less combat fire power. This would be a very powerful tool for the training manager.

Currently, however, except for some global forms of expert judgment (e.g., Operational Readiness Evaluation (ORE)), neither the training program nor the trainees are subjected to routine evaluations. Generally, participation in what is called "collective training" is taken to be equivalent to being trained; i.e., the collective training fulfills a prescriptive requirement and it is assumed to be effective. For these reasons the collection and feedback of quality control information assumes the probabilistic character of an event which may or may not happen.

The scarcity of data on collective training effectiveness can be attributed to two major reasons: (1) Most collective training events are complex and subject to uncontrolled environmental, organizational and social variables. Consequently, performance measures are difficult to obtain and even more difficult to interpret. (2) Many training organizations are resistant to the idea of performance measurement on the basis that the measurement process changes the significance of the event and inhibits learning. The flavor of an anti-measurement training ethic was presented by Skinner (1984) in his description of the Air Force's "Red Flag" air combat training program.

"We do not evaluate people at Red Flag. We don't give them check rides, and we don't let the wings have Operational Readiness Inspections at Red Flag. No evaluations," says the Red Flag CO. "It's a learning program, and we don't want them put under the pressure of a test or evaluation because, invariably, people who are being tested do not learn.

As the real-time data links from the range become more widespread and sophisticated, there will be an even greater tendency for outsiders, particularly contractors and military reformers, to 'keep score' at Red Flag."

Even with the assumption that collective training always accomplishes its training objectives, a major outstanding question remains: How long do the effects of the collective training last? Answers to this question would have significant influence on macro level training policy decisions in terms of the training refresh rates, and the number and size of the training facilities and materials needed to maintain minimum acceptable training levels.

## C. DISCUSSION AND CONCLUSIONS

In order for a data base to support policymaking efforts on the basis of Performance Effectiveness data and analyses, the data should be able to provide information on the skill levels achieved through initial skill training, on-the-job training, and post-initial-skills individual, team and unit training. The training manager should be able to relate these achieved skill levels to the skill level mixes needed for effective military operations. If the skill levels can be adequately quantified, it should also be possible to specify the time and resources required to achieve desired skill levels for specified military occupational specialties and/or for particular weapon systems. The macro-level manager needs performance effectiveness data when the effectiveness of a training program is under review. Such occasions are most likely to occur as the result of complaints from the operating forces or as the result of changes in the training program. The training changes may be due to the introduction of new training techniques or technological innovations intended either to improve training quality or to save training resources while preserving training quality.

If "perfect" performance measures were available to the training manager, they could be used to establish training goals and periodically to verify training results. Once the goals were established or the results were satisfactorily verified, management interest could return to the Cost-Production function of training. Except when the effectiveness of training is in doubt, the macro-level manager's primary concern is to produce the necessary quantities of trained personnel for the least cost.

While the macro-level training manager's needs for performance effectiveness data are limited, the micro-level training program and course managers have a continual need for this kind of information. Performance effectiveness data provides micro-level managers with their most important quality control tool. By monitoring how well students perform during training, they can identify those who can progress to the next step or graduate, those who need additional training and those who should be dropped from the program.

The performance effectiveness data requirements can be divided into two categories: (1) data which relate the performance levels achieved through formal training programs to the skill levels and mixes required by the operating forces, and (2) data which relate post-initial-skills training activities such as flying hours to maintaining or improving skill levels while performing in the operational environment. Test scores and course grades satisfy part of the first requirement and they provide a basis for judging the effects of changes to the training program provided that the same tests are used to measure the training results. For the macro-level manager, the test data would be much more valuable if they could be directly equated to definable levels of apprentice or journeyman performance in the field. If equivalencies could be established then it would become possible to definitively establish the costs of training to specific levels of competence. The impact of either expanding or reducing formal training could be realistically predicted, thus giving the training manager a very powerful tool for developing and justifying policy decisions.

The data base should assist the training manager in evaluating the impact of post-initial-skills individual, team, and unit training activities. Studies have demonstrated that flying hours are directly related to skilled performances such as carrier landing performance and bombing accuracy. Other studies have shown that time-to-repair and net effectiveness ratings are useful measures for evaluating the effects of post-initial-skills training of maintenance personnel. Much of this kind of information is in existing data banks. Where feasible these data should be considered as candidates for the training data bank. However, much of the research establishing the relationships between post-initial-skills team and unit training and measures of performance effectiveness has yet to be done.

#### **D. DATA BASE OPTIONS AND STRATEGIES**

The options for building a data base to support the Performance Effectiveness aspect of a training system are constrained by the limited availability of the necessary kinds of performance data. Probably the best short-term option would be to build a training data base consisting of individual personnel selection data, training histories, and operational achievement data. This could be used to establish a historical baseline and would support at least limited analyses of the effects of the introduction of changes in training programs. It should also be possible to encourage studies that systematically extend the methodologies developed for the cost-effectiveness analysis of flight simulators to other simulation and training technology evaluations. This would serve to create a pool of cost-effectiveness data for estimating the training benefits to be expected from increased utilization of

technologically advanced training options. It would also assist in establishing guidelines for the routine collection of essential training cost-effectiveness data.

On an intermediate term basis it should be possible to encourage the collection of data to relate training course parameters (such as changes in course length or the introduction of enhancements to training courses) to students' test scores and changes in user satisfaction. The receiving commands could be tasked to provide feedback on training effectiveness with these students by routinely producing Net Productivity Ratings of first-term personnel assigned to the command. These ratings could be returned to the training commands and/or included in the individual's permanent records. This would provide a continuing supply of data for cost-effectiveness evaluations. This goal could be achieved through administrative action and would not require the development of any new technologies. A second intermediate option would be to identify and begin to collect data relating post-initial-skills training activities (e.g., flying hours or field training experience) to the maintenance or improvement of skills while performing in an operational environment. A better definition of the functional relationship between post-initial-skills training and both the short-term and cumulative effects on skilled performance would be very useful for developing and justifying training policy.

The most important long-term strategy must be to develop performance measures that relate training achievement levels to operational apprentice or journeyman skill levels. If this can be achieved, it will be possible to develop meaningful cost-effectiveness trade-offs for training. The previously discussed Net Productivity Ratings partially fulfill this objective. However, they have two limitations: (1) they require a minimum delay of 18 months to two years in assessing the effects of training programs on the quality of performance, and (2) student and supervisor productivity information are confounded, which partially masks the separate effects of training on student performance.

A scale relating training achievement to operational skill levels would provide immediate feedback. It could also be used to determine the costs of training to a specified skill level. This would make many training decisions more directly analogous to hardware cost-effectiveness trade-offs in which the costs of training to a specified criterion could be weighed against the anticipated operational benefits. The long-term strategy should also encourage the development and validation of highly aggregated measures of the effects of collective training (e.g., collective training as a force multiplier).

## VI. READINESS EVALUATION FUNCTIONS IN TRAINING

The effects of training on combat readiness (when demonstrable) would provide the most compelling basis for formulating training policy decisions. This aspect of the Training Management Model represents the effects of training on individual and group combat readiness. Readiness evaluation essentially verifies that the required numbers and types of personnel have been trained and that they are capable of performing their unit's specified mission. Readiness evaluations may be classified into two categories: prescriptive and empirical. The prescriptive readiness evaluations serve an essential administrative and accounting function because they seek to verify that the approved resources have produced the required training products. The empirical readiness evaluations seek to determine the effects of training upon how well an operational unit can perform its assigned mission. The current readiness reporting systems within DoD are predominantly verifications of prescriptive compliance. A unit is considered combat ready if the prescribed complement of personnel and materiel are in place and the formally prescribed individual and collective training courses and events have been completed. A unit's readiness status is a joint function of the resource and training status at the time of the evaluation tempered by an estimate of the amount of time needed to complete any unfulfilled resource and training requirements.

Empirical readiness measures which relate training to the quality of combat performance should have the greatest face validity and the greatest impact on training policy. A dramatic example of the effects of combat performance data on training policy is presented in the development of realistic air combat training programs in the Services. The Navy Fighter Weapons School (Top Gun) was established because of the relatively poor performance of American pilots in air combat during the Vietnam War.

Top Gun was extremely effective in training Navy fighter jocks for air-to-air combat. For the Navy, the air-to-air scorecard over Southeast Asia could be split into two segments: before Top Gun--2:1, and after Top Gun--13:1. (Skinner, 1984)

With the exception of some limited activity in the Persian Gulf, U.S. forces are not now engaged in active combat; consequently, it is no longer possible to evaluate the effects of this type of advanced realistic training on operational performance. Surrogate measures from war games, large scale simulations, and operational performance data are used to estimate the effect that training is likely to have on combat capabilities. Empirical readiness evaluations in the TTM serve the purpose of justifying the establishment or modification of training programs. Once established or appropriately modified, a training program is assumed to be effective unless proven otherwise. If effectiveness is assumed, then the major management concerns are throughput and cost. Questions of how many people are trained and how much it costs were presented in Chapter IV (Cost-Production). The Readiness Evaluation function of the TMM focuses on the effects of training on measures considered either representative or predictive of combat effectiveness.

The Readiness Evaluation function, like the Performance Effectiveness function, has some important limitations. Pate (1975) reviewed the historical development of the readiness reporting system with special emphasis on the impact of the readiness reports on the Army Reserve Components (RCs). Two of his comments are of particular significance to our present discussion. First, readiness evaluations in current use are subjective judgments of a unit's combat readiness as viewed by its commanding officer.

In its totality, force readiness is a subjective "judgment call" and not amenable to any form of statistical quantification."

Pellicci (1985) also refers to the subjective nature of reporting readiness.

The current measure of training status is subjectively derived. Commanders have little objective criteria on which to assess their overall unit training readiness, and inadequate methodology to ensure consistency...two identical units trained to the same proficiency standard could easily report totally different ratings.

Second, readiness evaluations do not apply to all of the units and organizations within the Services. With respect to the Army, Pate noted:

Roughly half of the Army's total manpower (the most costly recurring item in the Army budget) is committed to organizations and activities which do not even render unit readiness reports. (e.g., headquarters, supply, training, and R&D organizations).

The importance of readiness measures should not be underestimated even though they have some significant limitations. Collectively, they provide the single best estimate of the proportion of the armed forces that are considered to be fully capable of performing

their organizational role or function at any given point in time. Readiness evaluations are used by Congress to evaluate future needs and to assess past accomplishments. (A typical question from Congress takes the form of "How much money do you need next year and what did you do with the money that we gave you last year?") Data that could clearly establish a functional relationship between training resources and combat readiness would be of considerable value to the macro-level training manager.

The Readiness Evaluation function of training system operation is presented in Figure 6. The readiness evaluation function is represented by the box labeled "Readiness". In keeping with the character of readiness evaluations, there is more than one way to achieve "Readiness". The first route which is used for prescriptive readiness evaluations provides interconnections between "Requirements", "Resources", and "Readiness". The requirements specify the numbers and types of personnel and training programs; resources fund the needed personnel, facilities and equipment; readiness evaluation essentially verifies that the required numbers and types of personnel have been trained and are ready to perform their unit's specified mission. The requirements represent the assigned obligation and the readiness measures represent the current ability to accomplish that obligation. Any differences between requirements and readiness status will serve as an input to modify requirements.

The second route provides the linkage between training and empirical readiness evaluations. Part of the readiness evaluation is based upon the quality of personnel performance or at least upon the effects of the knowledge and skills gained through training. Any persistent and inherent shortcomings in performance are likely to be reflected back into a revision of the requirements (or perhaps in the development of better equipment). Since only part of the training will directly influence combat readiness (only part of the training effort is directed toward the development of combat and combat support skills), only part of the training output goes to the "Readiness" box while the rest provides direct input into the "Requirements" box.

While providing a source of potentially valuable information to the macro-level training manager, Readiness Evaluation functions primarily to supplement the Cost-Production function. In some ways it serves as a quality control system similar to the quality control functions discussed in Performance Effectiveness. If the Performance Effectiveness function can be thought of as representing the training producer's quality control efforts, the Readiness Evaluation function can be thought of as the consumer's quality control assessment.

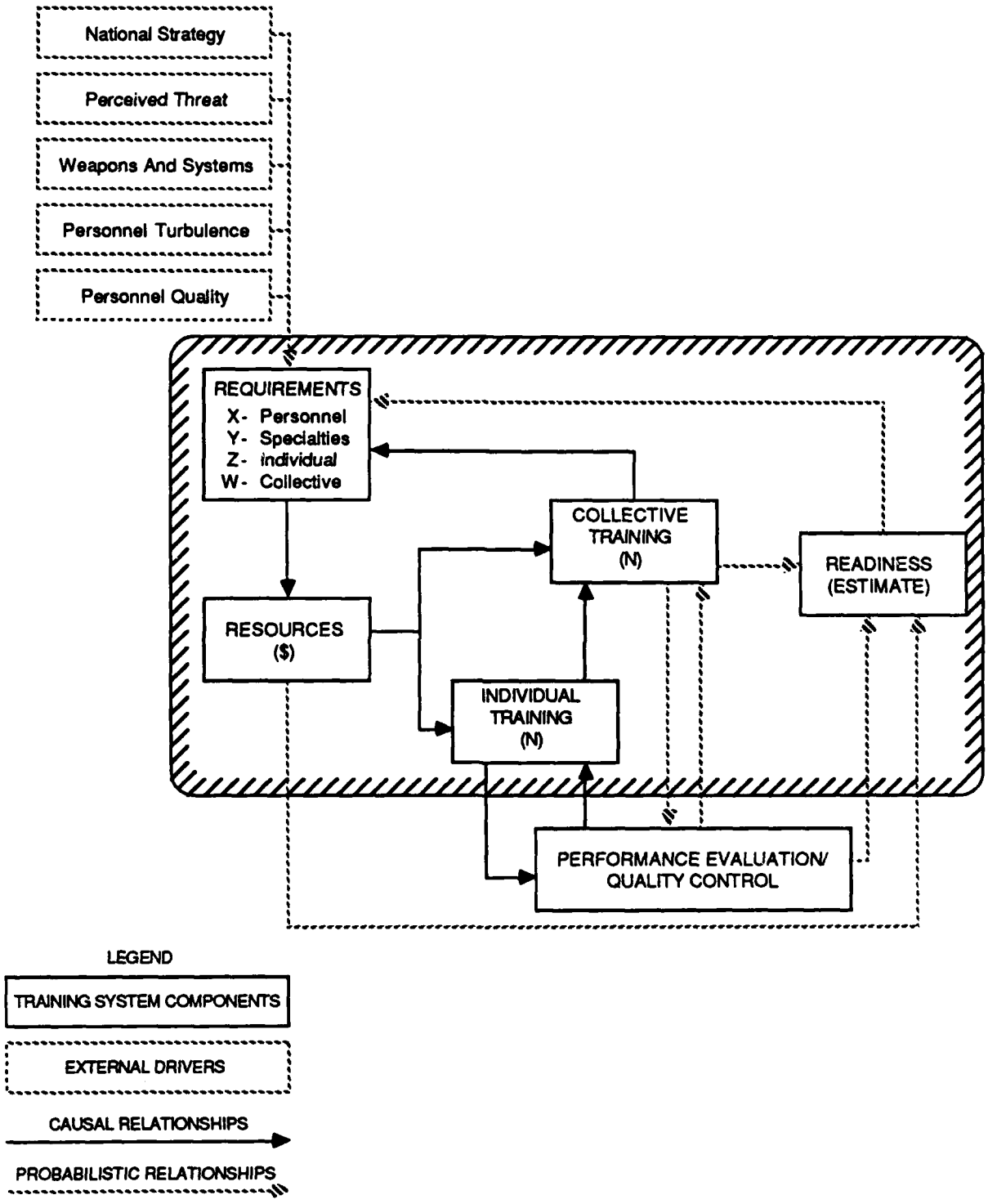


Figure 6. Readiness Evaluation Functions of Training

Data relevant to Readiness Evaluation will be presented in four categories:

1. Measures of readiness
2. Training inputs
3. Performance assessment
4. Effects of training on readiness.

## A. MEASURES OF READINESS

Ideally, measures of training effectiveness should document the functional relationship between training and the ability of a unit to accomplish its combat role or mission. Measures of effectiveness of training must ultimately be related to measures of military effectiveness and worth. A first step toward this kind of a goal can be achieved by relating training to measures of unit readiness.

DOD Directive 5100.30: Worldwide Military Command and Control System (WWMCCS) (1971) directs the National Military Command Center to maintain the current status of U.S. operational forces, including readiness posture. Cavalluzzo (1985), in discussing the Navy's procedures for reporting readiness status stated that

"The Unit Status and Identity Reporting System (UNITREP) is the official reporting mechanism used to convey timely readiness information to the Joint Chiefs of Staff. Readiness is reported in four dimensions: personnel, training, materiel condition and supplies on board. The UNITREP Combat Readiness Training Index (CRTRNG) is a composite measure, relative to prescribed requirements, of shipboard exercises satisfactorily completed, personnel who have attended formal schools, and personnel qualified to oversee watch-stations."

Pellicci (1985) noted that battalion commanders report their training readiness status to Headquarters, Department of the Army (HQDA) on a monthly basis via the Unit Status Report (USR). The estimate of training readiness is reported in terms of a combat readiness code ranging from C-1 (Combat ready) through C-4 (Not combat ready) (see Table 4).

Pate (1975), in regards to the Reserve Component capability assessment system, indicated that the time needed to get a unit "ready" should be compared to the time allowed for the same unit to get "ready" to determine whether the unit is at a satisfactory level of readiness. (Pate's time to get a unit "ready" includes the estimated time required to fill equipment and personnel shortages and to complete the prescribed unit training exercises.)

**Table 4. Combat Readiness Ratings<sup>a,b</sup>**

C-1	Combat ready
C-2	Combat ready, minor deficiencies
C-3	Combat ready, major deficiencies
C-4	Not combat ready

<sup>a</sup> Cavalluzzo, 1985.

<sup>b</sup> Pellicci, 1985

This is essentially a "ready enough" concept; i.e., a unit that is not scheduled for mobilization until 60 days after the start of hostilities should be considered ready enough if it can be brought up to C-1 status within 60 days.

The Standards in Training Commission (STRAC) was created to establish Army-wide gunnery training strategies. As part of this effort, units were classified on the basis of their deployment requirements as specified in the Army Mobilization and Operations Planning System (AMOPS). The STRAC Training Readiness Condition (TRC) classification system assigned units to one of four levels (A-D) based upon the number of days available until deployment. Combining the STRAC TRC ratings with the USR combat readiness structure produces a system which indicates the minimum combat readiness status that a unit should maintain based upon its deployment schedule. The interrelationship of the two classification systems is presented in Figure 7.

STRAC TRC	TRC A	TRC B	TRC C	TRC D
Days to Deploy	0-14	15-27	28-60	60+
USR C-Rating	C-1	C-2	C-3	C-4
Weeks to Train	1-2	3-4	5-6	6+

Source: Pellicci, 1985, p. 341

**Figure 7. Training Readiness Condition and Status Classification Systems**

(It should be noted that the time intervals used in the two systems differ in terms of their basic units of measure, days versus weeks, and that the specified time intervals diverge slightly over time.) Systematically relating training needs to deployment plans would seem to provide a basis for specifying the minimum kinds and amounts of training. Conceptually, at least, this kind of approach should also be useful for evaluating the effects of either increases or decreases in training resources.

## **B. TRAINING INPUTS**

Any systematic effort to relate training activities to readiness criteria needs some measure of training input. Most training inputs will be measured in terms of dollars, personnel, or time. While most of the training input measures have been presented in considerable detail in our discussion of the Production-Cost function, some aspects of the input measures merit further consideration in our discussion of the Readiness Evaluation function. The discussion of training inputs will be divided into the areas of individual and collective training. Attention will be focused on the value of relating training inputs to readiness goals.

### **1. Individual Training Inputs**

The DOD Force Readiness Report for FY 1984 (DOD, 1983) stated that the training readiness of air crews is affected by the proportion of billets filled by trained individuals (which is a function of the individual training process), and the level of unit proficiency obtained (usually measured as a percent of available combat-qualified air crews). Although this statement is concerned with the effects of individual training upon air crews, it seems reasonable to believe that individual training contributes equally well to the readiness status of other military groups or units.

The management of training is concerned with producing the appropriate numbers and types of personnel needed to satisfy readiness requirements. One of the first considerations for the macro level manager is to know how many and what kinds of trained personnel are being produced. The appropriate measure for this question is the student training load as reported for various categories. Student training loads are usually represented in terms of the total person-years of individual training contained in the Service budgets.

Once the amount of training in person-years is known, the next question usually is whether that is enough. In response to this question the measure of choice would appear to

be projections of personnel inventory, derived from projections for personnel needed for weapon systems, personnel rotation, and so forth. These projections add another dimension to the student load data by indicating whether the Services plan to support the training of enough people in needed skills.

Training readiness reports provide a snapshot of the training readiness of combat units. By tracking student training loads, personnel inventory projections, and readiness reports over time, it should be possible to identify functional relationships among the measures which could be used as training management tools. Knowledge of these functional relationships coupled with data from appropriately structured data banks would let the macro level manager formulate and answer a number of "What if" questions. For example, if training loads go down due to training cuts during one FY what happens to training readiness in the succeeding FYs?

## **2. Collective Training Inputs**

As has been previously discussed, the collective training inputs can be monitored in terms of flying hours, steaming days, and battalion training days. Of interest here is the potential benefit of tying the input measures to readiness goals.

Based on the literature reviewed, the relationship between collective training and readiness goals appears to be rather vague and nebulous. Cavalluzzo (1985) commented that prior to her exploratory work, no one from the analytical community had tried to measure the payoff of the collective training expenditures (steaming days) in terms of readiness. Her work does indicate that there was a positive relationship between nondeployed activity and training readiness.

The most extensive effort to relate collective training input to readiness appears to be the Army Flying Hour Program (FHP). As presented in the DOD Force Readiness Report for FY 1984 (DOD, 1983),

The Active Army Flying Hour Program provides the minimum number of flying hours to support individual training and to maintain unit level proficiency for TOE aviation units at their programmed manning levels.

Pellicci (1985) provided further insight into the structure and benefits of the FHP.

Gradually the program matured and expanded beyond meeting the published annual training requisites of the individual pilot and to embrace the full spectrum of requirements; at the individual, crew, unit and combined arms technical and tactical proficiency levels.

The benefits of relating training inputs to specific readiness requirements can be seen in some of the results of the FHP. Pellicci noted that

The FHP identified a serious flying hour and training readiness shortfall projected to worsen in the near term. The trend was reversed during the ensuing programming and budgeting cycle, and accelerated by a further Congressional add-on when the Army's model-developed requirements--for each type of aircraft--were laid out.

In those situations in which a strong and highly specific relationship can be established between a training input and a readiness goal, the likelihood of getting the necessary resources seems to be enhanced. While the availability of the right kinds of data may be limited, it would appear desirable to promote the development of training models and training data banks that would more systematically relate collective training inputs to training readiness objectives.

### 3. Performance Assessment

While the quality of individual performance unquestionably influences unit performance, the focus in any readiness evaluation is on the overall ability of the unit to accomplish its mission. Consequently, the primary concern in readiness evaluations is unit performance.

Although the Services have been refining their readiness evaluation systems for years, analytical attempts to relate training variables to readiness measures seem to have evolved only recently. This section will present some candidate performance measures related to readiness. Some of the results of trying to relate training data to readiness-related performance measures are presented next.

Horowitz (1986) identified and discussed a number of performance measures for possible use in formulating and supporting Navy manpower, personnel, and training (MPT) policies. Table 5 summarizes his list of Navy performance measures. Although his primary concern was with the Navy, he also suggested several performance measures for the Army. These included: data from the Army Training Evaluation Program (ARTEP), information from the National Training Center (NTC) combat exercises, and scores from the Skill Qualification Tests (SQTs).

While this list of performance measures is not exhaustive, it suggests that there are a number of ways in which training data might be related to some meaningful estimate of readiness.

**Table 5. Navy Inspections and Examinations as Potential Sources of Performance Data for Evaluating the Effects of Training on Readiness<sup>a</sup>**

Operational Performance	Maintenance Performance	Individual Performance
<p><u>Training Inspections</u> Source of information on the performance of units in combat-like situations.</p> <p>Operational Propulsion Plant Examinations (OPPEs)--an objective measure of ship performance in the area of mobility.</p> <p>Ship ASW Readiness Effectiveness Exercise (SHAREMs)---measure of ship proficiency in antisubmarine warfare.</p> <p>Operational Readiness Evaluations (OREs)--tests of operational performance.</p> <p><u>Selected Exercises</u> Evolutions performed by ships as part of their regular training syllabi.</p> <p><u>Excellence Awards</u> Scores on Selected Exercises are aggregated to help determine the winners of the mission-area-excellence awards held by squadron commanders.</p>	<p><u>Casualty Reports (CASREPs)</u> Whenever a ship suffers an equipment failure that adversely affects its ability to carry out its primary missions (and it cannot be repaired within 48 hours), it is supposed to file a casualty report.</p> <p><u>Unit Status and Identify Reporting System (UNITREP)</u> Periodic status reports of units in each of four resource categories: personnel, training, supply and material.</p> <p><u>Form 4855</u> Information on equipment logs for selected combat systems - when equipment was on, when failure was detected, and when failure was fixed.</p> <p><u>Board of Inspection and Survey (INSURV)</u> INSURV Board inspects 100 ships a year--the principal indicator of material readiness is the Materials Condition Index (MCI).</p>	<p><u>Scores on Advancement Examinations</u> To be promoted to any pay grade above E-3 an individual must pass an examination in the skills that must be mastered to perform successfully in that higher pay grade.</p> <p><u>Promotion Decisions</u> Whether or not someone is promoted is probably the best single summary measure of how highly he is regarded in relation to other individuals who are eligible for consideration.</p>

<sup>a</sup> Horowitz, 1986.

(Continued)

**Table 5 (cont'd). Navy Inspections and Examinations as Potential Sources of Performance Data for Evaluating the Effects of Training on Readiness<sup>a</sup>**

Operational Performance	Maintenance Performance	Individual Performance
<p><u>Bombing Scores</u> Attack squadrons keep track of the frequency and accuracy of different types of practice bomb runs.</p> <p><u>Tactical Aircrew Combat System (TACTS)</u> Air combat maneuvering ranges provide information on flight dynamics, weapon system states and weapon firing of each aircraft engaged in a training mission. (Data is held extremely closely.)</p> <p><u>Simulators</u> Information on the operational performance of units and personnel can be supplemented by data on their proficiency using advanced training devices.</p> <p>P-3 squadrons-- individuals and crews as a whole are graded on performance.</p> <p>ASW, AAW, and EW simulators could provide performance measures of ship teams.</p>	<p><u>Aircraft Maintenance and Material Management System (3-M)</u> Used to develop statistics on mission capable (MC) and full-mission capable (FMC) rates used to track the material readiness of aircraft.</p>	

<sup>a</sup> Horowitz, 1986.

#### **4. Effects of Training on Readiness**

In discussing the relationship of training to unit readiness, it should be remembered that training is only one component in the readiness equation. The effects of training may be inextricably confounded with the effects of personnel and equipment. The DOD Force Readiness Report for FY 1984 (DOD, 1983) noted that the level of programmed manning also has a direct impact on training readiness, because the ability of a unit to conduct meaningful collective training decreases rapidly as strength drops. This is particularly true for units that rely heavily on team skills (bomber and tank crews, infantry squads, ship damage control parties), where the absence of even a few members can severely degrade effective training.

However, in spite of limitations in the quality of data and the number of studies that have tried to relate training to readiness, there is just enough data to suggest that this would be a fruitful area for further investigation. As was discussed earlier, Cavalluzzo (1985) found a consistently positive relationship between flight hours and ORE scores. She also found that an increase in the number of days per quarter spent in training was associated with an increase in the number of ships that were combat ready when they began their deployment.

Using Casualty Report (CASREP) down time as their measure of personnel productivity and equipment readiness, Horowitz and Angier (1985) reported that the quantity of formal Navy training completed by the ship's maintenance personnel was a consistent predictor of ship readiness. Rowland (1985) reported that two weeks of experience in simulated interactive combat increased troop proficiency from an initial 50 percent level to the 95 percent level (measured in exchange ratios between casualties inflicted and taken).

While readiness data is not a component of training data banks, it appears likely that there may be a significant amount of readiness data kept in other types of Service data banks which can be used to verify the effects of training on readiness.

#### **C. DISCUSSION AND CONCLUSIONS**

In order for the data base to support policymaking efforts under the Readiness Evaluation function of training, it should be able to provide information concerning the degree that the prescriptive readiness requirements have been met or else provide

information concerning the effects of training on combat performance or other appropriate operational measures.

The Readiness Evaluation function of the TMM serves two functions: (1) it provides a means for determining how well the prescriptive readiness requirements have been met, and (2) it has the potential for providing the ultimate test of training effectiveness--an assessment of the effects of training or training changes on combat performance. However, like the Performance Effectiveness function, its prime purpose is to mandate or evaluate changes in the training program. Once the changes have been made and evaluated, the continuing assessment of training is primarily a Cost-Production issue.

The data base should assist the training manager in monitoring the training system's level of success in providing the required amounts of training. Measures of personnel readiness provide an indication of whether the system is producing adequate numbers of trained personnel. Measures of training readiness can indicate whether the training time and resources have been sufficient to complete the required number of collective training events. Ideally the training manager should have access to data which demonstrate the effects of training on combat performance. However, there is currently very little data available to establish the relationships between training and combat performance. Efforts in the areas of war games, large-scale simulations, networked simulations, and efforts to relate training to currently used achievement measures promise to improve significantly the ability of the training community to relate training experience empirically to performance in near-combat situations.

#### **D. DATA BASE OPTIONS AND STRATEGIES**

Building the data base needed for Readiness Evaluation of the training system faces some serious obstacles. The best short-term option would appear to be one which concentrates heavily on obtaining prescriptive readiness data. The data exist, they are collected, and they are used by the Services and DoD in reporting to Congress on the state of military readiness. Relating training budgets to the training-related aspects of readiness over time should provide a measure of the training system's effectiveness and the relationship between training budgets and readiness.

Developing a data base to evaluate the effects of training on the level of empirical readiness is severely limited by the availability of data. At the present time this is more of a research problem than a data base problem. In the short term an effort should be made to collect and summarize existing information on the relationship between training and

performance in combat or combat-like situations (possibly going back to WW I or earlier). This would at least allow the training manager to show situations in which training policy decisions have made a significant difference; e.g., the change in kill ratios before and after the establishment of the Navy Fighter Weapons School. In the intermediate time frame analytical efforts such as those suggested by Horowitz (1986) should be tracked and evaluated for use by training managers. On a longer term, efforts to assess more adequately the effects of training in simulated combat, networked simulations, and war games should be encouraged and supported.

## VII. SUMMARY AND CONCLUSIONS

The primary purpose of this paper has been to provide guidance for identifying the types of data that the Macro-Level Cost Data Bases should contain to be useful for making decisions in training policy. If the desired data base information can be specified, it will then be possible to assess whether the current data bases contain the needed information and to recommend necessary improvements. The Training Management Model (TMM) provides a global description of the functioning of the training system from the perspective of the macro-level training manager. Based upon the TMM and a survey of the available training performance data, the types of data required for the Macro-Level Cost Data Bases have been presented. When the various data base options and strategies are considered, the results will provide a master plan for macro-level training data base development.

The TMM describes the training system and emphasizes three of its main functions. Each of these, i.e., Cost-Production, Performance Effectiveness, and Readiness Evaluation, consists of sets of resource, training, and evaluation elements in a continuous feedback loop. These provide the manager with the data needed to be able to respond to specific types of problems that arise from time to time.

### A. COST-PRODUCTION FUNCTION

Policymaking efforts related to Cost-Production require information regarding the allocation of training funds, costs of training, levels of effort, and measures of training system proficiency. Data describing the funds allocated to training and training costs are available; however, whether they are the right kind or are in the appropriate formats has yet to be determined. Measures of levels of effort in the form of student training loads and inventory projections for individual training and flying hours, steaming hours, and battalion training days for collective training can be obtained. Some measures of system proficiency such as training program completions, productivity estimates and training readiness reports are either available or could be obtained.

The Cost-Production function of the TMM represents the normal management of the training system. Based upon approved sets of requirements, resources in the form of

budgets, facilities, and personnel are channeled into individual and group training programs which ultimately serve to fulfill or modify the existing requirements. Two assumptions are implicit in the Cost-Production function: (1) The training courses and events are effective in conveying the necessary information and skills to the personnel involved, and (2) Trained personnel, teams, and units advance the state of readiness and potential combat effectiveness of the armed forces. When these assumptions have questionable validity, the training manager needs to obtain appropriate performance or readiness data.

The macro-level training manager is also concerned with the management of the capabilities and capacities of the training system. This is the macro-level training manager's unique sphere of influence. Descriptive, trend, and functional relationship data are needed to manage present training capabilities and capacities and to plan for the future characteristics of the training system. There is a consistent need to be able to summarize capabilities, needs and trends in order to formulate and defend training policy.

## **B. PERFORMANCE EFFECTIVENESS FUNCTION**

The Performance Effectiveness function of the TMM supplements the more routine Cost-Production function in several ways: (1) Within training courses individual performance data support the training quality control process and provide the basis for deciding whether an individual should be continued into the next phase of training, graduated, recycled, or attrited. (2) Data on group performance within systems (training or operational) provide a basis for evaluating the effectiveness of training courses or techniques. A positive relationship between training and readiness and potential combat effectiveness is implicitly assumed.

The Performance Effectiveness function provides the macro-level training manager with information on the level of skilled performance produced by the training--initial skills training, on-the-job training, post-initial skills individual training, and team and unit training. The performance effectiveness data needed for policy development can be divided into two categories: (1) data which relate student achievement levels realized in formal courses to the skill levels required by the operating forces, and (2) data which relate post-initial skills training activities such as flying hours to maintaining or improving the skill levels of personnel while they are performing in the operational environment.

### **C. READINESS EVALUATION FUNCTION**

The Readiness Evaluation function of the TMM supplements the Cost-Production function by verifying that the required numbers and types of personnel have been trained and that they are capable of performing their their unit's specified mission. The macro-level training manager requires both prescriptive and empirical readiness data. The prescriptive data verify that the approved resources have been used to produce the required training products. The empirical readiness data verify the effects of training on the ability of operational units to perform their assigned missions. Since readiness evaluation data present acceptable proof of either the ultimate effectiveness or the inadequacies of training, they provide the most compelling basis for formulating and supporting training policy decisions. However, like the Performance Effectiveness function, the prime purpose of the Readiness Evaluation function is to initiate or manage the process of change in the training program. Once the changes have been approved, implemented, and verified, the assessment of training is primarily a Cost-Production issue.

### **D. TRAINING MANAGEMENT MODEL (TMM)**

The TMM provides a description of the operation of the military training system. It gives macro-level training managers a tool to help them specify the data and data bases needed to develop and support training policy decisions. Based on the TMM and a survey of the available training performance data, a series of data base options and strategies were presented. These provide the basis for the construction of a master plan for training data base development which is presented in the Recommendations section.

## VIII. RECOMMENDATIONS

The Training Management Model (TMM) and its three major functions provide the basis for identifying the types of data that a macro-level training manager will need to formulate and support training policies in the areas of the cost, effectiveness, and cost-effectiveness of producing trained personnel; the management of training system capabilities, capacities, and utilization rates; the effects of training on the quality of individual and unit performance; and the effects of training resources and activities on both prescriptive and empirical measures of readiness. The data base options and strategies developed within the TMM's functional guidelines are summarized in Table 6 as a Macro-Level Training Data Base Master Plan.

The proposed Macro-Level Training Data Master Plan identifies the types of data that the macro-level training data bases should contain and provides a road map for data base development with near-term, intermediate, and long-term objectives. The Plan provides a vehicle for judging the adequacy of the current Macro-Level Cost Data Bases by not only providing guidance on what they should ideally contain but also by providing guidance on the kinds of data that they might reasonably be expected to contain.

It should be noted that recommended data and data base development actions represent the TMM's projection of what the macro-level training manager should seek to develop as a data base that would support a wide range of policymaking activities. The Plan does not directly address either the technical or administrative feasibility of acquiring all of the necessary information. Generally the more future oriented items will also be the most technologically and/or administratively difficult to achieve. However, the accomplishment of any of the data base development goals will enhance the training manager's policymaking capabilities and general ability to compete for scarce resources.

The establishment of data bases to support the near-term goals of the Cost-Production function should receive the highest priority:

**Table 6. Macro-Level Training Data Base Master Plan**

TMM Functions/ Types of Data	Near-Term (1-2 yrs)	Intermediate (3-5 yrs)	Long-Term (over 5 yrs)
<p><b>COST- PRODUCTION</b></p> <p>Data types:</p> <ol style="list-style-type: none"> <li>1. Cost</li> <li>2. Effectiveness</li> <li>3. Cost-Effectiveness</li> <li>4. Training System Capabilities, Capacities, and Utilization Rates</li> </ol>	<p>Develop descriptive cost-effectiveness data bases capable of tracking and summarizing budget allocations for training, training costs, student loads, and inventory projections.</p> <p>Develop descriptive training system management data bases capable of summarizing and simplifying the available information about training capabilities, capacities, locations, and the levels of utilization of the training facilities, ranges, and equipment.</p>	<p>Develop census types of trend data by incrementing the data bases on an annual basis.</p> <p>Relate past levels of funding to current status and project current levels of funding to the future status of the training system.</p>	<p>Develop and verify key functional relationships which can be used to predict changes in the training system or the cost-effectiveness of changes in resources, personnel, or of training technology.</p> <p>Phase 1: Summarize functional relationships obtained from the data bases and from the research literature into a Training Management Information Dictionary.</p> <p>Phase 2: Build a data base collection of functional relationships that is sufficient to be able to simulate the operation of the training system or at least large parts of it.</p>

(Continued)

**Table 6 (cont'd). Macro-Level Training Data Base Master Plan**

TMM Functions/ Types of Data	Near-Term (1-2 yrs)	Intermediate (3-5 yrs)	Long-Term (over 5 yrs)
<p><b>PERFORMANCE EFFECTIVENESS</b></p> <p>Data Types:</p> <p>Performance quality measures obtained during and after training events which can be attributed to the training received by individuals and units.</p>	<p>Develop training data bases consisting of individual selection data, training histories, and operational achievement data in order to establish a historical baseline that would support analyses of the effects of changes in the training program.</p> <p>Extend the methodologies used to assess the cost-effectiveness of flight simulators to other simulation and training technology evaluations as a first step in establishing guidelines for the routine collection of cost-effectiveness data.</p>	<p>Establish a system that would require the production of Net Productivity Ratings on all first-term personnel assigned to the command to provide a uniform measure of training effectiveness.</p> <p>Collect data relating post-initial-skills training activities to the maintenance or improvement of skills while performing in an operational environment.</p>	<p>Develop performance measures that relate training achievement levels to operationally meaningful skill levels.</p> <p>Develop and validate highly aggregated measures of the effects of collective training (e.g., collective training as a force multiplier).</p>

(Continued)

**Table 6 (cont'd). Macro-Level Training Data Base Master Plan**

TMM Functions/ Types of Data	Near-Term (1-2 yrs)	Intermediate (3-5 yrs)	Long-Term (over 5 yrs)
<p style="text-align: center;"><b>READINESS EVALUATION</b></p> <p>Data Types:</p> <p>Prescriptive—data used to verify that approved resources have provided the required numbers of trained personnel and that both the personnel and the operational units have received the prescribed courses and training events.</p> <p>Empirical—data used to evaluate the effects of training on the ability of an operational unit to perform its assigned mission or to perform mission-related tasks.</p>	<p>Collect and summarize existing information on the relationship between training and performance in combat or combat-like situations. This will enable the training manager to support training policy decisions with instances in which training changes made a significant impact; e.g., the change in kill ratios after the establishment of the Navy Fighter Weapons School.</p>	<p>Concentrate on collecting prescriptive data relating training budgets to the levels of training accomplished in terms of the levels of training required.</p> <p>Relate training budgets to the training related aspects of readiness over time to provide a measure of the effects of budgets on the training system's ability to fulfill its mission and define the nature of the functional relationship between training budgets and readiness.</p>	<p>Develop better ways to assess the effects of advanced collective training efforts such as simulated combat training on instrumented ranges, networked simulations, and war games. Use these data to establish the necessary linkages between training and needed combat capabilities.</p>

- (1) Develop descriptive cost-effectiveness data bases capable of tracking and summarizing budget allocations for training, training costs, student loads, and inventory projections.
- (2) Develop descriptive training system management data bases capable of summarizing and simplifying the available information about training capabilities, capacities, locations and the levels of utilization of the training facilities, ranges, and equipment.

Recommendation is based on the importance of these kinds of data to the every-day functioning of the macro-level training manager and the fact that they should generally be more available for collection and inclusion in a data base.

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