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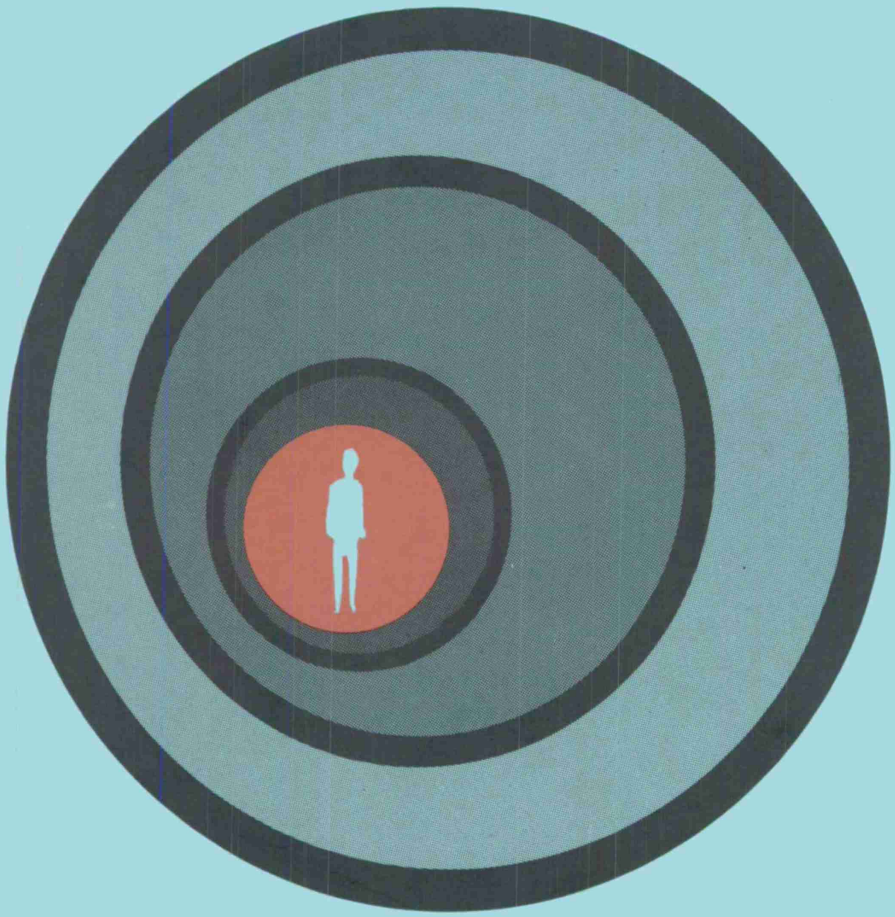
TAEG REPORT NO. 28

DESIGN OF TRAINING SYSTEMS PHASE III REPORT



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SEPTEMBER 1975

TRAINING ANALYSIS AND EVALUATION GROUP
ORLANDO, FLORIDA 32813

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The Phase III Final Report summarizes the results of the Design of Training Systems (DOTS) contractual effort, Contract No. N61339-73-C-0097, through the completion of that Phase. Phases I, II and III were accomplished by the IBM Federal Systems Division with the Training Analysis and Evaluation Group, Orlando, Florida, providing technical guidance and support. The overall DOTS' objective is to provide Naval Education and Training Command (NAVEDTRACOM) management with additional tools in the

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form of computerized mathematical models to assist in predicting the quantitative impact of training resource decisions. The planning process will be enhanced by providing decision makers with the capability to economically and rapidly consider a wider range of alternatives.

Phase I was a study and definition effort resulting in a complete functional description of the NAVEDTRACOM; a strategic definition of the social, political, economic and technological environments pertinent to Naval education and training system in the 1980's; a list of existing and potential models amenable to computerization and to improving the decision-making process. Phase II was devoted to the selection and development of three mathematical models from the Phase I list of potential candidates. The three were the System Capabilities/Requirements and Resources (SCRR), the Educational Technology Evaluation (ETE), and the Training Process Flow (TPF) models.

During Phase III, the three models were installed at an operational test bed (Fleet Training Center, Norfolk, Virginia) using a time-sharing tele-processing system. Based upon real-world data, the management application of the models was evaluated by a Test and Evaluation (T&E) team comprised of representatives of the Chief of Navy Education and Training (CNET) and CNET functional commands, led by the Naval Personnel R&D Center (Washington Branch).

In summary, the T&E team concluded that the DOTS models established, beyond reasonable doubt, the feasibility of applying modeling techniques to Navy training problems. The team recommended that the next step should be a field test proving the validity of the DOTS' models at the functional command level. It was also recommended that the name of the ETE model be changed, and as a result it is now entitled the Individualized Training System Simulation (ITSS) model.

TAEG REPORT NO. 28

DESIGN OF TRAINING SYSTEMS PHASE III - FINAL REPORT

This Study Was Performed By

International Business Machines Corporation

for the

Training Analysis and Evaluation Group

September 1975

Alfred F. Smode

ALFRED F. SMODE, Ph. D., Director
Training Analysis & Evaluation Group

FOREWORD

The Design of Training Systems (DOTS) project objectives are in consonance with the requirements of Advanced Development Objective ZPN07 (formerly ADO 43-03X), Education and Training Developmen. ZPN07 includes a number of projects concerned with demonstrating and evaluating the technical, operational and financial feasibility of applying advanced technological applications to improving the training process.

The Bureau of Naval Personnel initiated the original ADO in 1966 to make Naval training more responsive to the changing times. As one project under this effort, DOTS was designed to improve the process of managing training resources through application of the techniques of system analysis and system simulation as accomplished through mathematical modeling. The end objective is a family of computerized mathematical models enabling training management to more rapidly predict the impact of changes in training resource availability or requirements.

The majority of education and training was reorganized in 1971 under one command, Chief of Naval Education and Training (CNET). Because of this change, DOTS responsibility was transferred to CNET in March of 1972, more specifically to the Training Analysis and Evaluation Group (TAEG), Orlando, Florida. The new CNET organization greatly increased the potential benefits to be gained from the increased application of new management techniques and, therefore, from the DOTS' R&D effort. Accomplishment of DOTS began in February of 1973 with the majority of tasking being assigned to the International Business Machines Corporation, Federal Systems Division, Cape Kennedy Facility, located at Cape Canaveral, Florida.

In conducting the Phase I study and definition effort, the TAEG/IBM technical team conducted multi-level interviews at some eighty activities or training related groups within the Naval Education and Training Command (NAVEDTRACOM). The willing and competent participation of all personnel contacted is gratefully acknowledged. Special recognition is due the Fleet Training Center, Norfolk, Virginia, which was selected as a test bed for the DOTS' models. All levels of the command were exceptionally cooperative and willing to contribute significant time and interest to the implementation of the models and their subsequent test and evaluation during Phase III.

The SCRR, ETE, and TPF models were developed by Mr. R. Yanko, Mr. H. Bellamy, and Mr. K. Branch, respectively. Systems Programming support was provided to the modelers by Mr. J. Chapman and Mr. J. Staley. Mr. C. Edison developed and implemented the Phase III training program. All team members participated in the Phase III documentation effort, with Mrs. D. Gardner, Mrs. L. Girard, Mrs. C. Reilly and Mrs. E. Taylor providing editorial and secretarial services. Mr. R. Hallman was Project Manager.

The Training Analysis and Evaluation Group, Dr. A. Smode, Director, project team members Mr. H. Okraski, Mr. T. McNaney and Mr. W. Lindahl, complemented the contracted effort by providing guidance and establishing organizational interfaces.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

BACKGROUND

The Department of Defense (DoD) is faced with maintaining a strong national defense posture despite declining allocations and the impact of world inflation. The increasing cost of complex weapons systems and support manpower is significantly increasing the challenge of meeting national defense objectives.

Approximately 14%[1] of the DoD annual budget is allocated to some form of education or training. This represents about 25% of DoD's total manpower budget. Obviously, a major strategic thrust of the military services is to reduce education and training costs to a minimum, while maintaining the required level of effectiveness.

The majority of Naval training is under the command of the Chief of Naval Education and Training (CNET). The CNET is responsible for providing the training support required to maintain fleet readiness within the constraints of available funding. The Design of Training Systems (DOTS) project is intended to assist the Naval Education and Training Command (NAVEDTRACOM) in achieving this goal.

The overall DOTS' objective is to provide NAVEDTRACOM management with additional tools in the form of computerized mathematical models to asssist in predicting the quantitative impact of training resource decisions. The planning process will be enhanced by providing decision makers with the capability to economically and rapidly consider a wider range of alternatives. The project stresses a step-wise progression from system analysis, through development of computer-based test models of selected sub-elements within the NAVEDTRACOM, to recommendations for making the models operational.

Phase I of the DOTS project was completed in December 1973. It included: (1) a comprehensive functional analysis of the NAVEDTRACOM, (2) development of a set of strategic assumptions describing the environmental elements expected to affect the NAVEDTRACOM in the 1980's, (3) development of recommendations leading to an idealized training system in terms of the projected needs of the 1980's, and (4) creation of a candidate list of potential computer-based mathematical models to permit selection of a maximum range test configuration. If further information is desired, consult the DOTS Phase I Final Report[2].

Phase II was completed in October 1974. It included: (1) selection of three test models, from the candidate list developed during Phase I, representing

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[1] Defense Space Daily, 17 January 1974, Page 92.

[2] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, December 1973.

a range of subsets of the NAVEDTRACOM resource planning and management process, (2) development and logical validation of the selected test models, (3) identification of those areas within the NAVEDTRACOM which could not be modeled nor well defined, suitable modeling techniques do not exist, or data for model input or testing is not readily available, (4) development of a hypothetical cost avoidance analysis projecting the impact of modeling tools operating within a modified NAVEDTRACOM management system, (5) development of the design for verification studies to be carried out during Phase III. The three selected test models were the System Capabilities/Requirements and Resources (SCRR), the Educational Technology Evaluation (ETE), and the Training Process Flow (TPF) models. Additional information may be obtained from the DOTS Phase II Final Report[3].

Phase III was completed in October 1975. Phase III included development of the unique software required to implement the DOTS' models in the Norfolk test bed, the orientation and training of operating personnel and members of the Government Test and Evaluation (T&E) team, support of the T&E, and final user and maintenance documentation.

The majority of the technical data concerning the three DOTS models is contained in the previously mentioned documentation. A brief description is presented in SECTION IV, PHASE III PRODUCTS. The emphasis of this Phase III report will be on describing the T&E task, summarizing its results and suggesting recommendations for future DOTS direction.

[3] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, December 1974.

PROBLEM STATEMENT

The direct result of the DOTS effort, as implied by its objective, is envisioned as a family of computerized mathematical models providing a new capability to predict the quantitative impact of training resource decisions. The indirect result will be the use of model outputs by training managers to significantly increase the number of alternatives considered in arriving at resource decisions. The overall resultant will be more efficient use of training resources.

The three DOTS models were selected as representing a cross-section of the significant planning decisions addressable by computerized mathematical models. Using the selected models as test vehicles, the T&E of Phase III was concerned with their evaluation within two problem areas:

- NAVEDTRACOM Decision Process

  The first problem area was concerned with the control and planning of requirements and resources. The Department of Defense (DoD) Programming, Planning and Budgeting System (PPBS) is the primary NAVEDTRACOM driver. As the result of various PPBS actions, the NAVEDTRACOM resource planning and control process is directly impacted with appropriate management actions being initiated at multiple levels. These "appropriate management actions" are based on information flowing from both lower and higher levels of organization.

  The T&E team was tasked with determining the degree of capability of the DOTS models for assisting the decision process within the framework of this system. In addition, recommendations as to level and techniques of application were to be developed.

- NAVEDTRACOM Operational Environment

  The second problem area was concerned with the practical implications of implementing computerized mathematical models in terms of financial feasibility and the operational impact on support personnel.

  The T&E was tasked with evaluating the DOTS models based on observations as they were operated in the Norfolk FLETRACEN test bed.

Within the context of these two problem areas, the Phase III T&E provided guidance to the future direction of DOTS as well as to an assessment of the three models. The T&E results are summarized in SECTION III, TEST AND EVALUATION RESULTS.

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SECTION II

TEST AND EVALUATION APPROACH

OBJECTIVE

The T&E team objective was a very significant one in relation to the overall DOTS' R&D effort as represented by Phases I, II and III. Through the team's assessment of the three DOTS models, conclusions and recommendations were drawn pertinent to the two problem areas defined under SECTION I's PROBLEM STATEMENT subsection. The T&E results also provided a basis for making more general recommendations pertinent to the application of managerial science, operations research, and mathematical modeling techniques to the NAVEDTRACOM planning and decision process.

In support of the overall DOTS' objective, Phase III's major tasks were:

- To develop and document conclusions pertinent to the DOTS' hypothesis which states that the application of managerial science, operations research, and mathematical modeling techniques could significantly enhance the planning and decision process within the NAVEDTRACOM resulting in a significant gain in efficiency.

- To develop recommendations giving direction to future DOTS' R&D efforts as well as possible operational implementation of DOTS type models.

Using the outputs of Phase II, validated test models and a selected test bed, Phase III activities of the IBM technical team required to achieve the above were:

- To design and develop the unique software required to support implementation of the DOTS' test models at the test bed, Norfolk Fleet Training Center (FLETRACEN).

- To accomplish orientation and training of Fleet Training Center personnel and members of the Government Test and Evaluation Team.

- To develop sufficient technical documentation to permit continued development or modification of the DOTS' models beyond Phase III.

The activities of the Government T&E Team are implied by the Problem Statements previously described. The Team's objective was to provide an evaluation and/or judgmental assessment of the :(in order of descending priority)

- Potential of the DOTS type mathematical model and the systems approach for enhancing the management of resource and requirements within the total NAVEDTRACOM.

- Technical validity of the three test models.

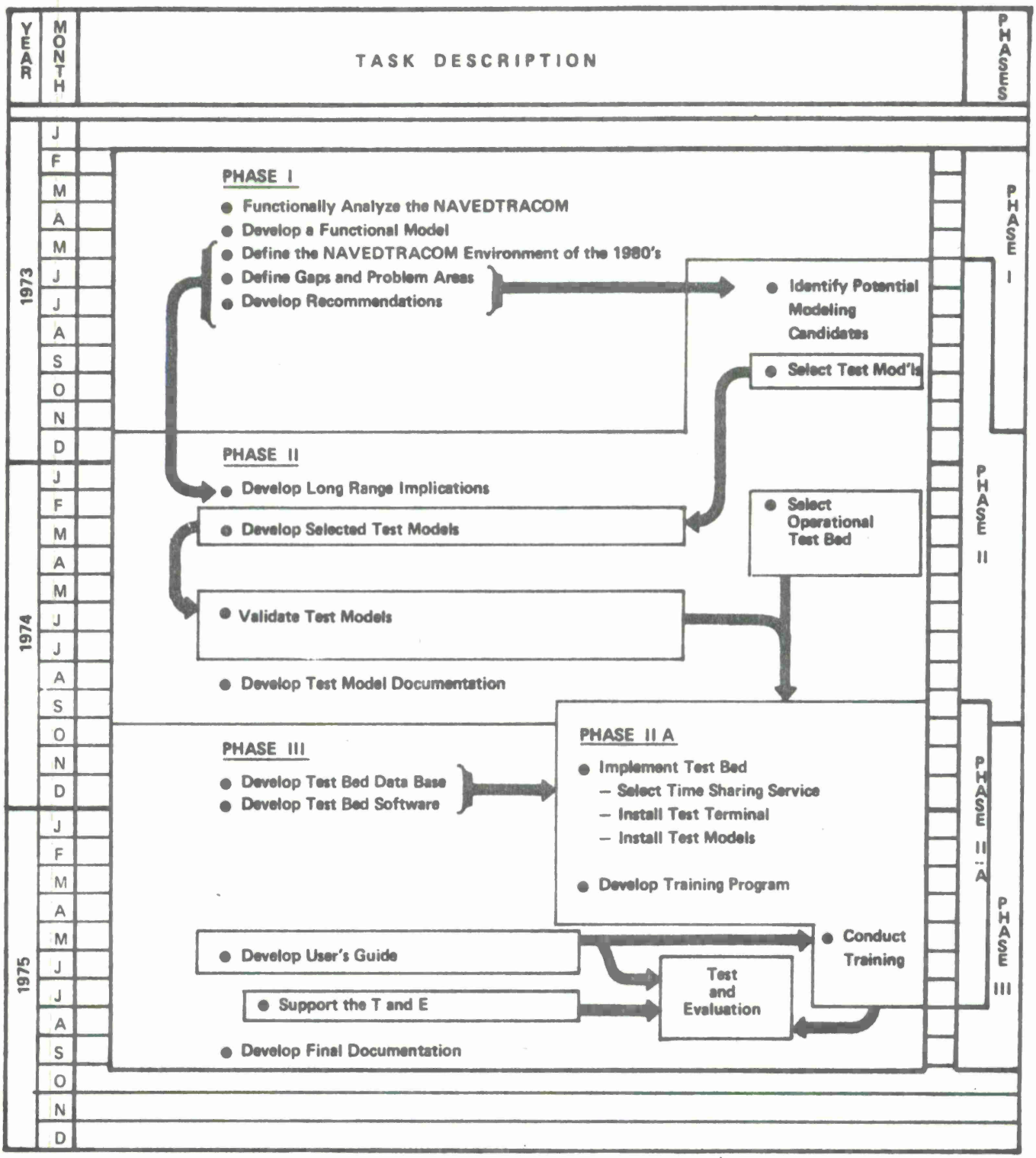
- Value of the model's capabilities, assuming reasonable modifications to the present management system.

- Operational practicality and financial implications of the DOTS models operating in the Norfolk FLETRACEN.

Based on the T&E, conclusions and recommendations were developed and are summarized in this report. The potentially operational by-products of the testing process were documented in two separate volumes: a User's Manual and a Program Maintenance Manual. These are described in Section IV of this document.

SUPPORTING TASKS

To give perspective to the Phase III tasks, this subsection will present an overview of the DOTS' tasks accomplished during Phases I and II but pertinent to the Phase III T&E. The following chart will assist in maintaining a time reference.



DOTS Test & Evaluation Supporting Tasks

Phases I, II and III

T&E, Phases I and II Supporting Tasks (Cont'd)

The T&E related tasks were:

- Select Test Models (Phases I and II)

  The details of the test model selection process are covered in the Phase I Report[4] and will not be repeated here. The three selected models, Educational Technology Evaluation (ETE), Training Process Flow (TPF) and System Capabilities/Requirements and Resources (SCRR), met two selection principles of permitting an assessment of the DOTS hypothesis, amenable to extrapolative analysis, and of providing a potential operational capability. The greatest weight was given to selecting models most supportive of the DOTS test objectives.

  The selected test models are intended to be complementary. Three models, as opposed to one, were selected to facilitate DOTS hypothesis evaluation across a broader spectrum of operation, as well as of multi-level application. Although none of the three test models is time restricted, each has been designed to emphasize a range of operational, near horizon, or long-range planning. The types of requirements addressed by the test models were common to all levels of the NAVEDTRACOM and, therefore, extrapolation of results beyond the actual test bed was feasible.

- Develop Test Models (Phase II)

  The three test models were developed during Phase II to an operational test installation level and are described in the Phase II Final Report[5]. The designs were based on operational needs identified during Phases I and II.

- Validate Test Models (Phase II)

  The purpose of the validation task was to objectively demonstrate that all sub-elements of the three test models would perform the functions they were designed to do. In short, did the models logically perform as intended?

  The validation was performed in a laboratory environment, i.e., validation runs were made on a computer and with data remote from the ultimate test bed. Validation should not be confused with verification. Validation proves the basic design logic of a model, verification proves the accuracy of a model's predictions or its ability to simulate a process or environment.

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[4]Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, December 1973, Pages VII-1 through VII-33.

[5]Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vols. 2 and 3, December 1974.

T&E, Phases I and II Supporting Tasks (Cont'd)

Phase II's validation task is described in the Phase II Final Report[6]. The three test models were successfully validated.

- Select T&E Test Bed (Phase II)

Based on the original DOTS' plan, Phase III verification was to have taken place in the same laboratory environment as the Phase II validation. To increase accuracy, it was decided to actually perform this task in an operational test bed. The approach offered a secondary benefit; if the models did demonstrate utility, the potential for more immediate practical application would be enhanced.

The change to an operational test bed also permitted expansion of Phase III's scope to encompass potential human factors pertinent to operational use as well as technical verification of the test model's fidelity.

Based on the empirical observations of Phase I, there seemed to be little doubt that mathematical models could be developed providing valid predictive information for the NAVEDTRACOM planning and decision process. Phase II's validation of the three test models subsequently offered empirical support to this supposition. The most difficult issue had to do with the operational implications of various management levels actually using the models within the existing organizational, procedural and motivational system. This issue spanned a wide range of concerns from the practical data processing support required to the support of DOTS concepts by various management levels.

Plans for Phase III's formal T&E were changed to permit evaluation in an operational test bed rather than experimentally in a laboratory environment. By making use of an existing commercial time-sharing service and installing a teleprocessing display terminal and printer in an operational test bed, the formal T&E evaluation could be based on observation in an operating environment closely resembling a projected real-world situation.

Based on the above, a task was added to Phase II to select a viable operational test bed. The Norfolk FLETRACEN was selected from a number considered since it most closely matched the entire span of considerations and was of a size permitting installation of the DOTS' models within the scope of available resources. More specifically, Norfolk:

- Had an extensive mix of "A" and "C" schools.
- Supported a fairly broad combination of ratings.

[6]Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 2, December 1974, Pages II-30-60, III-19-32 and IV-22-32.

T&E, Phases I and II Supporting Tasks (Cont'd)

- Was subjected to unpredicted requirements for new courses, new quotas, etc.
- Was responsible for all functions in the training development cycle between course design and course implementation.
- Was involved in the implementation or planning of new instructional techniques such as Individualized Learning.
- Had acceptance of scientific management techniques at the command level and a desire to participate in the DOTS' T&E.
- Was general enough in level and type to be representative of a significant fraction of Navy training.
- Was of a size, permitting development of a data base within the scope of the DOTS' effort.

The three test models were selected based on their potential for evaluating the original DOTS' hypothesis and not for their immediate value to the Norfolk FLETRACEN. To partially compensate Norfolk for its interest and effort in supporting the test and evaluation, some limited software was developed to permit access to the DOTS supplemental data base required to drive the test models.

The selection, development, and logic validation of the test models, and the operational test bed selection, were accomplished during Phase II. The following tasks supportive of the T&E were completed during Phase III:

- Test Bed Implementation

  This task included selection of a time-sharing service and supporting terminal, development of Fleet Training Center, Norfolk (FLETRACEN, NORVA), unique software and data base, training of operational personnel, and initial operational support of model use.

- Support Navy Test and Evaluation

  The Navy T&E team was tasked with the actual T&E. IBM was tasked with the development of the T&E plan and a training program for the T&E team members.

- Support Documentation

  IBM developed sufficient documentation during Phase III to assure continuity of the project, whether the intent was additional R&D or projects leading to operational implementation of the models. These documents are described in SECTION IV, PHASE III PRODUCTS.

T&E, Phases I and II Supporting Tasks (Cont'd)

- T&E Results Analysis

  The Government T&E Team devoted considerable effort and time, after their Norfolk training and test, to results analysis and documentation. Its output was a Final Report which is summarized in SECTION III, TEST AND EVALUATION, TEST AND EVALUATION SUMMARY.

TEST AND EVALUATION

The Government T&E Team was formalized in April of 1975 and consisted of:

F. DiGialleonardo - Team Leader - NPRDC - Washington
LCDR R. J. Biersner, Code N-214 - CNETS - Pensacola
Lt. R. N. Brooks - TRALANT - Norfolk
CDR J. D. Davis, Code 015 - CNTECHTRA - Memphis
LCDR T. L. Ferrier, Code N-31 - TRAPAC - San Diego
Mr. J. T. Finnigan, Code N-31 - TRAPAC - San Diego
Mr. E. Scheye, Code N-336 - CNET - Pensacola
Mr. D. S. Thomas, N-215 - CNTECHTRA - Memphis

The T&E Team was supported by the following IBM and TAEG personnel:

Mr. William Lindahl - TAEG - Orlando
Mr. Thomas McNaney - TAEG - Orlando
Mr. Harold Bellamy - IBM - Cape Canaveral
Mr. Kenneth Branch - IBM - Cape Canaveral
Mr. Charles Edison - IBM
Mr. J. D. Staley - IBM - Cape Canaveral
Mr. Ronald Yanko - IBM - Cape Canaveral

In April, the T&E team was provided an IBM-developed test plan[7] and goals. However, under direction of the team leader, a unique plan and goals were developed prior to initiation of the formal T&E. Generally, the differences were in degree of emphasis rather than in areas and concepts to be tested.

Both plans were based on the results of a joint Norfolk FLETRACEN/TAEG/IBM problem identification workshop held in December of 1974. After being introduced to the problem solving capabilities of the DOTS models, requirements and problem statements were solicited from FLETRACEN management personnel. The solicitation was not restricted to only those problems addressed by the models. Responses ranged from requests for specific data items to requirements for sophisticated analysis of interrelationships between personnel characteristics and academic potential. The problems identified were concerned with such areas as:

- Impact of student load changes on instructor requirements.
- Relationship of contact hours to the number of instructors.
- Impact of various factors on the attrition rate.
- Correlation of instructor capabilities to potential cross-training.
- Relationship of personnel cuts to student load.
- Relationship of convening frequency to such areas as utilization, capacity, convenience, attritition, etc.

[7] Design of Training Systems, Preliminary User's Test Guide, TAEG, Section III, 31 March 1975.

Test and Evaluation (Cont'd)

The schedule of formal Phase III T&E events was as follows:

- 4 June through 6 June 1975: Training by IBM of the Norfolk FLETRACEN staff.
- 16 June through 20 June 1975: Training by IBM of the T&E team.
- 23 June through 27 June 1975: T&E team model analysis at the Norfolk FLETRACEN.
- 30 June through 5 September 1975: Visits to various functional commands by the T&E team leader, accompanied by a member of the Project Office, and documentation of the final results.

The approach used during each of these phases was as follows:

- Training at the Norfolk FLETRACEN Staff

  Training course design was based on the assumption that there were three types of personnel concerned with model application. These were the executive or decision-making level, the analyst who could provide the model capability interface between executive and system, and the operator who would actually perform mechanical interface operations such as data update or calling forth the models. These three levels did not include the responsibility of technical maintenance of the models since it was assumed that, if the models were subsequently implemented operationally, maintenance would take place at a central location remote from the operational user.

  The executive level received a limited formal introduction to the DOTS system with the objective of simply creating an awareness of the DOTS capability.

  The analyst level received two days of intensive orientation. The emphasis was on what the models would do rather than how they did it. Operator training concentrated on the more mechanical aspects of system manipulation. It should be remembered that the purpose of training the Norfolk personnel was to permit the T&E team to assess the operational feasibility of implementation of DOTS type system in a "real-world" environment and using existing operational personnel.

  The original Preliminary User's Test Guide was significantly expanded to be used in support of this training as well as the subsequent T&E. This final User's Test Guide[8] included sections on the mechanical operation of the models, diagnostic validation tests for

[8]Design of Training Systems, User's Test Guide, TAEG, 30 May 1975.

Test and Evaluation (Cont'd)

each model to permit revalidation, and projected cost factors pertinent to using the models.

- Training of the T&E Team

As previously indicated, the team was provided information in the form of a preliminary guide and goals. In addition, prior to formal T&E training, the team members were provided comprehensive guidelines by the team leader. These guidelines will be summarized in the next sub-section. The team entered the formal training session at Norfolk with an understanding of these documents.

During formal sessions, the T&E team members were given executive, analyst, and some operator level training. This broader scope was included to permit a more valid assessment of the operational considerations to be evaluated.

- T&E Team Model Analysis

The week following T&E training was devoted to analysis at Norfolk. The IBM team was available for technical assistance during this week. The T&E team analysis was organized around three major assessment areas. These were operational, technical, and financial feasibility of the DOTS models. It was understood that the main emphasis of the week of analysis would be on operational feasibility, although initial data for the technical and financial areas would be identified.

To accomplish the above, the T&E team was divided into five discussion areas, each managed by a leader. These areas and their sub-areas were as follows:

Potential Model Contributions

At the activity level
At other levels

Ease and Practicality of Use

User knowledge requirements
Update requirements
Response time
Output form

Data Requirements

Nature of the data utilized by models
Data availability
Data accessibility
Data management
Future data problems

Test and Evaluation (Cont'd)

Organizational Implementation

Prospective levels of application
Relationship of models to existing policies and structures
Implementation support

User Investment

Personnel resources
Hardware
Method of operation

The T&E team completed their analysis week with a preliminary position that was refined and expanded during the follow-on analysis to be described in the next sub-section.

- Functional Visitation

  Following the week of analysis at Norfolk, and extending to September, the various members of the T&E team and TAEG conducted a number of functional visitations and reviews pertinent to the preliminary results of the June analysis.

  Final documentation[9] was completed during this period. A summary and selected excerpts from this final report are covered in the next SECTION III. The T&E Report should be considered as one of the major products of the three-phase DOTS' effort since it represents an assessment of the practical value of mathematical modeling techniques to the NAVEDTRACOM.

In order to accomplish the T&E at Norfolk, it was necessary to provide the Norfolk FLETRACEN with access to a computer. A Command and Control Center (CCC) was installed consisting of an alpha/numeric display terminal and printer linked via dial-up telephone lines to a commercial time-sharing computer service, National CSS, Inc., located in Norwalk, Connecticut. NCSS provided the following equipment at Norfolk:

- One Hazeltine 2000 Video Display Terminal. The Hazeltine 2000 displays 25 lines of 80 characters each and operates at a 30 cps transmission rate.

- One Hazeltine Impact Printer Model 300. The Model 300 prints at 30 cps, has a carriage width of 118 characters, and employs a tractor-type paper feed.

- One Hazeltine Dual Magnetic Tape Cassette Unit, having a 400 bpi storage density and a capacity of approximately 125,000 characters. The Cassette Unit, which can operate in either an off-line or on-line mode, serves as a storage unit for later display of data on the Video Display Terminal and for editing text inputs to the system.

[9] DiGialleonardo, F., Design of Training Systems, Test and Evaluation Final Report, NPRDC, September 1975.

Test and Evaluation (Cont'd)

The CCC configuration was intended to provide a full complement of terminal capabilities for evaluation of model usability in an operational environment. The NCSS accounting system also provided specific costs for each interaction as input to the financial feasibility assessment of the T&E.

In summary, the T&E was directed toward the assessment of a wide range of considerations, as opposed to simple verification of model design. As previously indicated, it could be assumed that models could be identified, designed, and developed that would work. The key question had to do with the practicality of models in the unique NAVEDTRACOM environment.

The T&E team did not assess the various sub-task results, Phases I and II, leading to test model selection or general recommendations. The T&E Final Report specifically excludes the following:

- Comprehensive functional study of NAVEDTRACOM.
- Strategic assumptions for the 1980 decade.
- Delineation of technological gaps in the training system.
- Development of the Educational Technology Assessment Model (ETAM).
- Audio-Visual aids for orienting Navy training managers to the nature and use of management science techniques.

The first three items are covered in the Phase I Final Report; the fourth (ETAM) is currently under development; the fifth is a set of tape/slide presentations providing an orientation tutorial pertinent to the three DOTS models.

SECTION III

TEST AND EVALUATION RESULTS

TEST AND EVALUATION SUMMARY

The purpose of this section is to provide a summary of the DOTS' Test and Evaluation, Final Report[10] and IBM comments pertinent to the T&E's positions. A summary may highlight key conclusions but it cannot substitute for an in-depth review of the actual report. Although every attempt was made to avoid bias in this summarization, it is possible that the intended emphasis was inadvertently shifted. As appropriate, direct quotes from the T&E Report will be included. In every case, these quotes are outlined in a separate box.

The T&E Final Report is organized as follows:

- Part One - Summary of Results and Recommendations
- Part Two - Technical Feasibility
- Part Three - Operational Feasibility
- Part Four - Financial Feasibility
- Appendices - A through G

Generally, this summary will follow the same format. Abbreviated summary statements will be followed by selected quotes and the quotes by a commentary. Report page numbers are provided.

All members of the IBM technical team reviewed the T&E Report and were given an opportunity to respond to its conclusions. Generally, there was agreement with the conclusions and commendation for the report's thoroughness and professionalism.

The chart on the next page provides a summary of the T&E Statements as well as SECTION III page locations.

[10] DiGialleonardo, F., Design of Training Systems, Test and Evaluation Final Report, NPRDC, September 1975.

DESIGN OF TRAINING SYSTEMS
PHASE III TEST AND EVALUATION SUMMARY STATEMENTS

QUOTATIONS SECTION III			IBM COMMENTARY	
From Page	To Page	T&E SUMMARY STATEMENTS	From Page	To Page
III-3	III-4	General Conclusion--------Considering technical, operational and financial factors, it is feasible to apply mathematical modeling techniques to the NAVEDTRACOM planning and decision process.	III-4	III-5
III-6	III-9	Technical Feasibility--------The three DOTS models are logically valid (function as designed) and feasible. It was not proven (nor disproven) that they accurately simulate or predict actual situations.	III-9	III-10
III-11	III-17	Operational Feasibility--------The DOTS models are operationally feasible at the schoolhouse and functional command (COMTRALANT and COMTRAPAC) levels considering operational personnel required for implementation, current management structure and practices, existing operational and planned automated data systems, and DOTS data requirements.	III-18	III-18
III-19	III-21	Financial Feasibility--------The three DOTS models were not proven (nor disproven) to be financially feasible, based on either current operational tasks displaced or costs avoided through model application. Based on empirical observation, costs of implementation appear to be minimal and, therefore, could probably be justified on the basis of probable benefits.	III-21	III-22.
III-24	III-25	Recommendations--------While the DOTS effort appears to be complementary to existing and planned NAVEDTRACOM applications of Automated Data Systems (ADS), there is a need for significantly increased management and coordination of the composite ADS by CNET. This increase must take place if maximum benefit is going to be derived from any data base or modeling effort.	III-25	III-28
III-29	III-30	Criticism ------The three DOTS models were not verified during Phase III.	III-30	III-31
III-32	III-33	Criticism -------Utility of the DOTS test models has not been proven.	III-33	III-33
III-34	III-35	Recommendation -------Maximum utility of mathematical models can only be achieved through application to higher command levels than that represented by the Norfolk Fleet Training Center.	III-35	III-38
III-39	III-39	Criticism ------The Phase II benefit/cost analysis is not valid.	III-39	III-43
III-44	III-44	Recommendation -------There is a need for establishment of a NAVEDTRACOM-wide program, under direction of a CNET agent, devoted to the development and coordination of management science techniques.	III-44	III-45
III-46	III-46	Criticism -------The cost of developing the three test models appears excessive.	III-46	III-46

- General Conclusion (Part 1 - T&E)

Statement - General Conclusion

Considering technical, operational and financial factors, it is feasible to apply mathematical modeling techniques to the NAVEDTRACOM planning and decision process.

Quotes: (T&E Report)

Page 5 *...It is the conclusion of this analyst that the DOTS models have established beyond reasonable doubt the feasibility of applying modeling techniques to Navy training management problems. This general finding is a composite of the elements of technical, operational, and economic feasibility...*

Page 6 *...The SCRR model demonstrates the technical feasibility of providing training center managers with more accurate and multi-dimensional assessments of their training capabilities...*

...In its current non-statistical form, the TPF has shown that it can be a useful tool in the hands of training managers by taking full advantage of presently available data and certain operationally utilized, if still ill-defined, planning factors extant in the current training environment...

Page 7 *...No particular faults could be found with the composition of the ETE. Its primary problem is that while none of the models were strictly field tested, the ETE was the least tested of the lot...*

...The results of this validation, while thoroughly documented, do not provide insights to how useful the model can be to actual users...

...This resulted in substantial proof that the ETE, despite its generality, could perform in superior fashion to a system specific model in a given case. It does not tell anything about whether there will be much opportunity for use of such a model given the nature of the EDTRACOM's operations. A more meaningful test of the appropriateness of the ETE to current or future Navy training problems was apparently limited by the unavailability of appropriate subject courses...

Page 10 *...Opportunities for applying the models at the TRACOM level look exceedingly good. Both COMTRALANT and COMTRAPAC seem receptive to application of the models in their respective organizations...*

Page 50 *...The potential for contribution by the DOTS models in the overall planning area is its most significant feature...*

Statement - General Conclusion (Cont'd)

> *...DOTS is envisioned as a possible device to effect the changes required in these various systems to provide a truly reliable and accurate MIS with the added ability to model...*
>
> *...If the DOTS concept did nothing more than precipitate an investigation and realignment of the current morass of Training Command MIS(s) it would be of value. Given that it will provide capabilities to model and simulate and therefore project as well, it is potentially of great value...*

Commentary:

The quotes above provide positive support to the General Conclusion Statement. However, they should be tempered with those included in the Criticism and Recommendation sub-section, which will follow the next three sub-sections.

The T&E supported the following conclusions from the DOTS Phase II Final Report[11]:

> Conclusions (Quote from the Phase II Final Report)
>
> The Naval Education and Training System can improve the effectiveness of its decisions pertinent to resource planning and control through use of computerized mathematical models...
>
> The SCRR, ETE, and TPF models are logically valid and do perform as designed...
>
> Sufficient historical and operational data are available in existing records to enable operational implementation on the DOTS' models...

As will be repeatedly stressed in this SECTION, the T&E team was charged with assessing the DOTS' test models as they apply to the current NAVEDTRACOM decision and planning process. The T&E team's endorsement should not be extrapolated to include the DOTS Phase II conclusion that, to gain maximum benefit from mathematical modeling, changes will be required in the decision and planning process. The Phase II Final Report stated, "This can be accomplished with reasonable changes to the current management system and practices." SECTION IV of this report will address the question of change.

Also, the endorsement of model logic and design should not be interpreted as applying to model fidelity. The T&E team did not feel that the ability of the models to accurately simulate or predict actual events had been proven or disproven. The subject of historical verification will be covered in the next sub-section concerning Technical Feasibility.

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[11] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 1, December 1974, Page V-1.

Statement - General Conclusion - Commentary (Cont'd)

The T&E team approached its evaluation on the assumption the three DOTS' test models would be applied within the existing planning and decision structure, procedures, and motivational environment. The original test model and bed selections were made on the assumption that the existing structure, procedures and motivational environment would be subjected to "reasonable change." This dichotomy should be considered in reviewing the T&E results.

- Technical Feasibility (Part 2 - T&E)

Statement - Technical Feasibility

The three DOTS models are logically valid (function as designed) and feasible. It was not proven (nor disproven) that they accurately simulate or predict actual situations.

Quotes: (T&E Final Report)

SCRR

Page 16 ...*The SCRR was developed to meet four specific types of management problems. These are discussed below...*

...*Assessment of long-term training demand...What it can do is take near or long-term training demand projections as input, and then operate to determine whether such requirements can be feasibly met given current or projected resources and procedures. In this sense, given sufficient lead time, it can aid in training resource planning and capabilities assessment...*

Page 17 ...*Assessment of short-term demand fluctuation arising from unscheduled events (e.g., a Ship repair operation, reserve activation, unusual seasonal recruitment levels). Here different resource and demand configurations can be tried out to assess the impact of such perturbations, minimizing their dysfunctional effects and maximizing the responsiveness of training, through better allocation of available resources...*

...*Assessment of training resource utilization ...Using current demand, SCRR can compute an optimum resource combination...*

...*Comparison of alternative resource allocation strategies... This is a case of the model in which multiple strategies are evaluated, given known performance and requirements characteristics. This is one of the best used of the linear programming capabilities of the models and could precipitate substantive changes in present procedures for developing plans and programs as well as justifying and revising the same...*

Page 21 ...*Model Validation ...The basic LP technology and the MPSX software are, of course, not in need of validation due to their standardized nature. The validation documented by the model developer (TAEG Report 12-2, Vol. II, pp II-30-60) demonstrate that the model is functioning properly. The model's ability to accurately represent the real world is not demonstrated. This must be done with historical data or under field test conditions. In the absence of such information, the SCRR is judged to be a useful and practical representation of the training complex...*

Statement - Technical Feasibility (Cont'd)

...This judgment is a function of (1) feedback from prospective users obtained in the user T&E and other discussions, (2) a comparison of the model's formulation with a description of the training complex operation...

TPF

Page 22 *...The objective of the TPF is to provide a means for simulating the flow of students through a training complex...*

...Given inputs such as maximum or average course capacity, number of convenings, and demand, the TPF computes course utilization, backlog, AOB, etc., showing these on a quarterly basis through time...

...The variables currently dealt with by the TPF have been screened from a larger set of variables on the basis of statistical analyses. An original objective of the TPF was to develop statistical parameters from these analyses which could be included in the model for the purpose of predicting training results as a function of student profile data. Correlations resulting from these statistical analyses were not of sufficient significance to warrant inclusion in the model and therefore were not incorporated...

...the TPF, as a simulation, mathematically represents the mechanics of the training center scheduling function from a deterministic rather than probabilistic basis...

...The magnitude of original potential payoff from this model is substantially reduced as a result of its present inability to statistically relate student profile data to student behavior within the training system and the consequent inability to gauge the potential impact of such factors...

Page 24 *...student profile data and the results of the statistical analysis of that kind of data are not incorporated into the model...*

...the idea of formulating a model to predict impact on the training process from various types of student inputs remains intuitively desirable...

Page 25 *...Model Validation. The validation procedures for the TPF as described by the model developer (TAEG Report 12-2, Vol. II, IV, pp 22-30) do not constitute a true validation. The model is simply exercised in a number of conditions and its deterministic processes are allowed to respond accordingly. It is clearly demonstrated that the model is in operating order. However, there is no basis for judging how well the model*

Statement - Technical Feasibility (Cont'd)

simulates the real training process flow. All that can be said is that the factors utilized in the TPF appear to be reasonable since they are drawn from those which are commonly used by the training managers...

...Thus we know that the TPF is a useful automated version of the kind of scheduling that is presently being carried out at the FTC. We have a more flexible and quick means for developing schedules and assessing demand impacts. It has not been demonstrated that we have a more precise or accurate means for making such developments or assessments...

ETE

Page 26 *...The ETE is an entity flow simulation model for ILS course design and management. Like the TPF and SCRR, this model is intended to answer questions concerning capabilities (capacity), utilization, and resource requirements as well as course completion time. It has the capability to evaluate, in compressed time, the effects of real or projected changes in resources or demand. Since equipment and personnel can be costed external to the model, the model can be used in making cost-effectiveness determinations of different ILS course designs...*

Page 27 *...The validation was not in terms of how well the ETE simulation represented actual course behavior, but rather to the extent that results replicated those obtained from the application of a previously developed special purpose simulation model of the EW school...*

...it is only known that the ETE is as good as or better than another simulation model as applied to the EW school use. Nor does this validation procedure establish the generality of the ETE as implied by the model developer (TAEG Report 12-2, Vol. II, pp 23-24)...

...With the exception of the model validation procedure (which may have been a necessity) the ETE appears to have been soundly developed from a technical viewpoint. However, this technical soundness is as of yet, not bulwarked by a clearly demonstrated utility (i.e., a utility determination arrived at through interaction with actual ILS designers and managers)...

General

Page 28 *...In general, the quality of the validation procedures for the DOTS models conducted during both model development and the T&E, suffers from the lack of a legitimate field test...*

Statement - Technical Feasibility (Cont'd)

> *...Present conditions for field testing of the SCRR and TPF appear to be very good at both the COMTRALANT and COMTRAPAC sites. Furthermore, prospects for usable end products emerging from such testing are sizable...*

Commentary:

The three DOTS models were designed and developed by three individuals. Each reviewed the T&E Final Report and, although there was limited disagreement on some of the Report's minor positions, the modelers felt the key points and conclusions were accurate and thoroughly assessed.

As was indicated in the T&E Report, the Team evaluated the models against their application within the current organization and procedural process for planning and control of resources and requirements. Although the majority of the T&E was concentrated on a pragmatic analysis of the models as operational tools, some attention was given to their assessment as subsets to test the DOTS' recommendations evolving from Phases I and II[12]. The following quotes are presented in the Commentary sub-section since, to a certain degree, they address those DOTS' recommendations pertinent to higher levels of models and institutional change.

Quotes: (T&E Final Report)

> Page 7 *...The SCRR and TPF models were developed in a fleet training environment. Here the demand is characteristically unprogrammed. It is reasonable to believe that in other Navy training sectors where demand is much more programmable (e.g., technical training), the potential for effective model development is at least as great if not greater than has been demonstrated for the fleet environment...*

> Page 9 *...The models themselves neither require nor warrant such incipient aggrandizement. They are good examples of how basic management science technologies can be utilized to assist in the solution of specific management problems. As such, they imply that establishment of a program, chartered to utilize management science techniques in the support of Navy training management would be well founded. Such a program should not operate on the basic assumption that there is a total integrated solution to the training management problem, but rather on the objective of achieving incremental improvements in management effectiveness by providing useful solutions to important management problems, regardless of their limited generality...*

[12] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 1, December 1974, Page V-1.

Statement - Technical Feasibility - Commentary (Cont'd)

> Page 32...*In addition to more effective performance of the training management function as currently practiced, the models have the potential for introducing new management techniques and supporting certain types of decision making not currently practiced. The DOTS developments are seen as contributing in two distinct but interdependent modes. First, as a management information system by virtue of the data base management capabilities developed to support the models. This was not a direct objective of DOTS but was a prerequisite to producing models which can effectively function in the operational environment. Second, as a management decision support system to be used in the kinds of functions noted above. More specific evaluation of potential model contributions is presented further below...*
>
> Page 36 ...*Several participants viewed the bulk of model potential to lie in application at the "functional" level and above (i.e., "models and necessary support may not be worth it at schoolhouse level"). On the other hand, participants with "schoolhouse" level experience expressed the view that considerable opportunity exists to utilize model potential, given "a little managerial imagination." A concise assessment of actual contribution can only be obtained via a field test (which FTC, Norfolk, was not)...*
>
> *...A possible hindrance to vertical expansion of model application is the plethora of overlapping management systems which reside at the upper management levels. While the integration of these systems is not within the scope of DOTS, higher level implementation of DOTS development may be jeopardized nevertheless. Coping with this dilemma remains a future challenge to the DOTS project management...*
>
> Page 43 ...*DOTS is not primarily an information collecting/collating system, but instead provides optimization of information output from other systems (i.e., NITRAS). The three DOTS models evaluated should be viewed as subsystems within a TRACOM MIS...*

Within the boundaries of the T&E, technical feasibility was established. As indicated previously, this statement should be tempered with those included in the Criticism and Recommendation which concludes this SECTION.

Except as reflected in the quotes above, it should be emphasized that the T&E did not assess the implications of an integrated management system, nor was the team tasked with this responsibility. Therefore, endorsement of technical feasibility by the T&E should not be interpreted as including all of the main points of the DOTS Phase II Conclusions and Recommendations.

- Operational Feasibility (Part 3 - T&E)

Statement - Operational Feasibility

The DOTS models are operationally feasible at the schoolhouse and functional command (COMTRALANT and COMTRAPAC) levels considering operational personnel required for implementation, current management structure and practices, existing operational and planned automated data systems, and DOTS data requirements.

Quotes: (T&E Final Report)

SCRR - TPF

Page 6 ...(SCRR)...*Like the TPF, it takes advantage of existing planning factors such as the student/instructor ratios which reflect basic requirements formulas in order to determine organizational requirements on the basis of the interaction of resources and capabilities. When more precise planning factors become available in the future (e.g., through the SHORSTAMPS program), they can be easily assimilated into the model...*

...The SCRR, in a sense, is an automation of what is currently being done mentally by instructors and training managers. This is viewed as a plus. Using the SCRR, within the course of an hour it might be possible to develop as many resource allocation alternatives as a training manager could develop in two weeks. This advantage, of course, would be multiplied many times over considering frequency of occurrence. Add to this the capability for optimizing across resource allocation alternatives and one can see that the SCRR presents the potential for some very real and immediate payoffs for the training manager...

Page 7 ...*The SCRR and TPF models were developed to be consistent with data currently being collected. Inputs to the NITRAS data base (which are supplied to CNET) were used to comprise a common data base for the two models. Certain additional data elements were collected directly from the FTC; however, these comprise only a small portion of the total data base. All of the data used by these models are both available and accessible within CNET. About 90% of the data must be collected for reporting to the NITRAS, regardless of model requirements. The situation is not just peculiar to FTC, Norfolk, but is true throughout the CNET commands...*

Page 8 ...*In general, members of the User T&E team viewed the models as operationally feasible at the TRACOM and schoolhouse level. Additional feedback later obtained from*

Statement - Operational Feasibility (Cont'd)

COMTRALANT and COMTRAPAC reinforced this finding. However, feedback obtained from CNTT claimed that the operational feasibility and desirability of the models had not been demonstrated at Norfolk...

Page 9 *...Phases II and III of DOTS have shown that meaningful and useful models can be constructed for the benefit of training management. It has also revealed that the most effective residence for such models in fleet training may be at the TRACOM level...*

...In no way can this line of reasoning be extended to say that the models thus far developed are appropriate to CNTT's most critical management problems...

Page 10 *...Both commands (TRALANT and TRAPAC) have the necessary equipment for supporting interactive management models...*

...Update requirements for the data base were not excessive...

...Actual operation of the models was possible with a minimum of training. The interactive nature of the model and data base programming contributed highly to the ease of use. Approximately two weeks would be a reasonable time for training an operator using basic skill types presently available on the organization's staff...

...Considerably more time would be required to fully educate training managers in potential uses of the model, if for no other reason than that it would be best to extend such training overtime thereby allowing real and current problems to serve as examples in the training...

...The present documentation is satisfactory and should serve well in future utilization of the models. Though a user's guide has been documented, there still remains a need for an operator's manual which fully explains model options, error messages and corrective measures. It is understood that such a manual is presently being prepared by IBM...

Page 12 *...The time-sharing cost per usage of each model is well within reason (User Test Guide Appendix V, 30 May '75). Time-sharing, of course, obviates the need for large initial investments in ADP hardware, thereby putting the models on a largely "pay as go" basis. It does not appear that additional staff would be necessary to support the models in TRACOM operation. Modifications should not prove extensive for TRACOM application. All in all, these factors point to a very low cost for implementation and operation in the projected TRACOM application. As a result, it would not require very much "benefit" to break even in such a project...*

Statement - Operational Feasibility (Cont'd)

Page 16 ...(SCRR)...*The model could be run in a planning mode under a number of different demand assumptions. A range of training capabilities and resultant impacts could thus be assessed...*

...Another product of the SCRR relevant to this aspect is the "optimized convening rate." This is the number of course convenings per course that yields maximum student throughput...This Optimal Convening Rate would seem to have very limited utility...

Page 17 ...(SCRR)...*This usage seems quite desirable given the existence of frequent perturbations in demand. Limited usage at FTC, Norfolk, seems to indicate that a rather minimal level of model analysis can yield information of broad and recurring utility to the training manager. Yet usage of the models by managers seems to need at least initial stimulation...*

...The decision to develop an LP model to assess capabilities and allocate resources in the training environment was sound...

Page 19 ...*Any misconceptions that a "requirement" model introduced to this environment provides better basic requirements information than previously available, must be carefully avoided. Yet, in the particular case of the SCRR, there is little doubt that modeling has demonstrated the potential for increasing the quality of management information at the FTC as well as for the functional command level above it...*

Page 20 ...*The segmentation of resources and requirements within the SCRR limits its ability to optimize across the training center. While this convention enables most candidate FTC problems to be fit within reasonable computer storage limitations, it appears to be a less than accurate representation of what is possible within the real training environment. It may be that some of the greatest management payoffs within the FTC are to be gained from optimizing resources and requirements across schools...*

Page 22 ...(TPF)...*This simulation is intended to enable managers to assess the effects of changes in the primary variables of the training complex and its immediate environment. The model operates on two categories of data, those pertaining to students (10) and those pertaining to courses (15)...*

...Straightforward proportionality figures are currently used by the TPF to assess the effects upon the training system of changes in demand, scheduling, or capacities. Failure rate, no-shows, disenrollments, etc., are not presently forecasted by the model on the basis of student profile data...

Statement - Operational Feasibility (Cont'd)

...The choice of a process flow model was a good, if perhaps obvious, selection (and as such did not depend greatly on the results of Phase I). The course scheduling problem is one which both lends itself to modeling and at the same time represents a significant training management problem. The flow also offers a complementary capability to the resource allocation model (SCRR) that was concurrently developed...

Page 23 *...Another restrictive factor is the apparently limited opportunity which training managers at the FTC level have to utilize such a model in a proactive manner. This mostly stems from the fact that fleet training demands are at the same time hard to predict and hard to deny. On the other hand, the more reactive capabilities of the model (e.g., to answer "what if" questions) do not appear to be in high demand at the FTC level, though they may be periodically of substantial value to that level. It is important in considering this to keep in mind the DOTS models were selected on the basis demonstrating the feasibility of an approach for CNET and not on the basis of what models/techniques would yield the highest payoff to FTC, Norfolk, in particular...*

...(SCRR & TPF)*...answers from either model would be partially naive without those of the other. This prompts the question of why select and separately develop two models, neither of which is sufficient by itself, rather than develop one integrated model from the beginning. The answer to this question, I believe, lies in the initial orientation of the project - it has been technology oriented rather than problem oriented (i.e., "test the feasibility of applying new decision-making technologies"). Developing two separate models provided a more secure approach to that problem. Furthermore, the original concept of the TPF (i.e., to forecast training complex impact as a function of student profile data) lent it more viability as a separate model concept...*

Page 36 *...A major consideration in the realization of model potential was determined to be the level and manner of model use. While operation of the model mechanisms per se (e.g., terminal operation) is not complex, use of model results requires all of the skills of the experienced training manager. Typical model support requirements (e.g., documentation, ease of use) were viewed as essential to potential realization. (See "Ease of Use" and Organizational Implementation" selections that follow.)...*

Page 37 *...Specifically, DOTS presents a way for effectively utilizing the vast NITRAS data base in a proactive way...*

Page 38 *...Training in use of the DOTS model will be needed*

Statement - Operational Feasibility (Cont'd)

at all training command levels, though to varying degrees. Essentially three levels of training are required. These are familiarization for upper management, system analysis for translating upper management or command training problems into model parameters, and a systems operation for training those who would operate hardware components of DOTS...

...In most cases (except at center configuration management level), system analysis and system operation would be collateral duty for the personnel involved...

Page 40 *...It was difficult to evaluate this area (Data Base Update Requirements) because sufficient new problems were not used in the T&E. Program (model) updating/ modification would probably be rare for routine (local command) report generation. A more extensive program update requirement would probably exist at upper management levels for resolving projected ("what if") problems...*

Page 42 *...Basic data collection/verification/input to the master data base would be responsibilities of local commands (centers). These procedures are more acceptable than with other current information because local commands would have direct access to central system. These commands would also have to manage problem-solving requirements unique to the command or center...*

...The T&E Team did not think the programs and data base associated with the SCRR&TPF models would be frequently updated in the operational phase...

Page 43 *...The T&E Team believed that neither master data base nor program modifications would be difficult if proper justification for making these modifications could be demonstrated (through findings of R&D or training effectiveness evaluations)...*

...Inasmuch as DOTS is primarily a projection/management system which provides information for "what if" questions, its use as an information/report-generating system would be redundant, and would represent gross underusage of the system...

...If used as an information gathering system only, DOTS would not substantially improve on response times associated with other available systems...

Page 46 *...The core of the data base is NITRAS data which, as "raw data," is relatively valid, reliable and accurate...*

(IBM Note: Exceptions were noted in the T&E Report.)

Statement - Operational Feasibility (Cont'd)

...The data are presently available, largely without additional cost...

...The data is not presently either easily or regularly accessible... (From the DOTS Data Base - extraction programs required.)

...Data base is manipulatable in a very impressive way; however, the system for accomplishing this manipulation is not Navy owned and is equipment specific...

Page 47 *...The usability of data to be accessed by the DOTS family of models relates directly to the NITRAS/NAVTIS problems; such problems as validity, accessibility, availability, etc., hinge on NITRAS and other systems (e.g., SHORSTAMPS SHOROC, etc.) either operational or under development of being implemented. The DOT models must be viewed as a capability/application consistent with the total Training Command MIS and not as a separate system...*

ETE

Page 26 *...The ETE is a general purpose simulation model and is thus not structured around a specific type of course. Its data base would not normally even approach the complexity of that of the TPF and SCRR. The data for a typical model run can be entered by the user at the start of a model session (and then stored for later recall or modification). Theoretically, the ETE could at present be applied to any ILS course or group of courses, regardless of location or even if the course is yet to be convened...*

...Factors favoring the development of this model included the following: (1) increasing numbers of ILS courses throughout EDTRACOM, (2) increasing resource constraints, (3) existence of previous work in simulating ILS in the Navy, (4) prospects for a general purpose model that could immediately be put to use throughout EDTRACOM, (5) emphasis of other models on training process, as opposed to course design...

Page 36 *...This problem area currently exists to a major degree in CNTT and will do so in the future at the TRACOMS. Present methods are seen as inadequate most of the time with substantial to great opportunity for improvement (million dollar area). Moderate to substantial changes in present organization/policies are seen as necessary to effect improvements...*

Page 7 *...and theoretically has applicability wherever ILS courses are designed, modified, or where a significant number of such courses must be managed given some commonality of resource requirements...*

Statement - Operational Feasibility (Cont'd)

Page 51 ...*While the ETE and highly conceptual ETAM models would appear to have the least impact external to the Command, they might have the greatest impact within. The magnitude of the individualization effort within CNTT alone, and the projected savings from this effort, would support continued R&D of these models...*

Page 42 ...*Although the data base of the ETE model might require frequent update, this should not present much of a management problem because the master data base would not be involved (only scratch disc). The ETE model per se would probably not be frequently updated...*

Page 8 ...*The data required for the ETE are fairly simple in comparison to those needed by the other two models and their supply seems to present no operational problem...*

Page 26 ...*All of the major ILS decision variables can be represented and considerable user flexibility is provided. The ETE is generally formulated so that the user can formulate a specific model to represent a given ILS. The estimated time for such formulation (3-5 days) is acceptable...*

General

Page 49 ...*Specific level(s) and degree of application of the DOTS models cannot be defined at this time. The considerations which preclude such definition are essentially the lack of costing information and lack of experience based on application beyond FTC, Norfolk...*

Page 52 ...*The group's consensus was that no additional personnel would be needed. That while some training could be necessary, present staff can learn to use the models/results...*

...This variable (additional personnel) is largely unknown at this point. It is, however, directly related to use which is a function of the acceptance and utility of the models themselves...

...Many existing hardware configurations now in place at potential user sites could be used for DOTS. The minimum requirements (i.e.,keyboards/printers) would suffice in many cases. CRTS and other more sophisticated peripherals would not be necessary in many locations. In a good many cases, communicating magnetic card typewriters could fulfill all the hardware requirements for access to the DOTS system, without significant impact on present use of this equipment...

Statement - Operational Feasibility (Cont'd)

Commentary:

The above quotes support the position that the three models are operationally feasible, considering the current NAVEDTRACOM organization, personnel, resources and decision-planning practices. This support is qualified by a T&E concern for the lack of an operational verification during Phase III. In short, under operational conditions, do the models predict or simulate actual events accurately and, equally important, do they have significant utility to the appropriate users? This concern will be addressed under Criticism and Recommendations.

The above position represents a T&E majority opinion, but it should be noted that the Naval Technical Training Command took serious exception to it. Their position will be stated in the CRITICISM AND RECOMMENDATIONS sub-section.

- Financial Feasibility (Part 4 - T&E)

Statement - Financial Feasibility

The three DOTS' models were not proven (nor disproven) to be financially feasible, based on either current operational tasks displaced or costs avoided through model application.

Based on empirical observation, costs of implementation appear to be minimal and, therefore, could probably be justified on the basis of probable benefits.

Quotes: (T&E Final Report)

Page 12 *...As for proving the financial feasibility of applying modeling techniques in general throughout the EDTRACOM, it is not believed that this could presently be established...*

Page 11 *...Numerous attempts were made during the T&E to trace back from the application of the models to real problems emanating from the FTC and, in turn, to assess the benefits of supporting the solution of those problems. None of these attempts resulted in very useful information...*

Page 87 *...On the benefit side, perhaps the most meaningful indicator revealed in the T&E was provided by comments from the User T&E team that the modeling and MIS capabilities demonstrated by DOTS would be worth at least two billets at the training center level of implementation. As the technical feasibility section of this report pointed out, a field test is necessary to precisely identify a measure of benefit. However, the costs as estimated above are low enough to make application of the models a low-risk proposition, especially at the TRACOM level...*

...The greater question of financial feasibility concerns to what extent the results of DOTS can be extrapolated to assess the feasibility of applying such management techniques throughout the EDTRACOM in general. Since the techniques employed by the DOTS models (e.g., LP, simulation) are a fair sample of the field from which they are drawn, it seems reasonable to generalize the order of operating costs estimated above...

Page 12 *...Applications can differ so markedly with respect to cost and payoffs that any specific application hardly provides a basis for extrapolation of feasibility for the general case. The history of management science is strewn with examples of very good general models which never were implemented. Situational factors for each case seem to override any generalizations that might be made...*

Page 11 *...With the dearth of information on the benefit*

Statement - Financial Feasibility (Cont'd)

side of the feasibility question, it is best to focus on cost factors. Here it can be seen that the future cost of developing and operating the models may prove to be effectively less than even assessed by the contractor in his analysis. This position can be supported because of two concurrent developments to DOTS. First, the data base necessary for future model development is, in the main, being compiled regardless of DOTS. Thus, the cost of that data acquisition and maintenance need not be attributed to the DOTS models. Secondly, the TRACOMS either have or are in the process of procuring the necessary hardware to support DOTS type models, again regardless of DOTS. For example, TRAPAC already has in operation a terminal with full telecommunications capability from which the models have already been accessed. Thus, it is doubtful that users would need to purchase equipment that they would not have procured otherwise...

Page 49 *...Throughout the T&E we have been hampered by a lack of costing data. We are unable to predict, with any degree of validity, what this capability might cost in any of its terms (hardware, software, personnel, telecommunications, site prep.) much less as a whole. This is not a criticism in that derivation of systems costs was not a goal of the effort to this point, but rather a statement of fact. This fact does serve to highlight the other issue, however, in that while activity level usage might be great in terms of numbers of interactions, does the utility warrant the investment? We cannot say at this time. The most we can say is that if continued evaluation is directed, that a portion of the evaluation must address the economics of the system and that the economic evaluation must address alternative methods of application as well as levels...*

Page 53 *...Given findings in first (hardware configuration) and fourth (number of ultimate weeks) discussion areas, what might be a "ballpark" cost per incidence of usage ratio. $20K a year estimate by IBM seems excessive if hardware is largely in place...*

Page 86 *...As a result of discussions with members of the user T&E team and visits to various EDTRACOM sites, it can be validly assumed that utilization of computer-based models like those of the DOTS project will not require special data or equipment acquisitions of a significant nature. From this it can also be assumed that the basic skills needed to operate the models will also be present at most sites. Since model operation and data maintenance which does not replace existing procedures is estimated to consume a very small number of manhours, it is not anticipated that support personnel cost will be appreciable. There will be a training cost. On the basis of training conducted prior to the*

Statement - Financial Feasibility (Cont'd)

> *on-site user T&E, this is estimated at about four man-weeks per site (2-4K). Data pertaining to time-sharing cost for the models were obtained from actual model operation at FTC, Norfolk (see TAEG Report 30 May 1975, User's Test Guide, Section V). Using these cost data and a somewhat arbitrary estimate of the extent of usage, an estimate of $10K per year was obtained (using all three models). With some amortization of training cost, this results in a total yearly cost that can be safely estimated at under $15K, allowing for some equipment depreciation (or rental cost allocation) and model maintenance...*
>
> Page 49 *...Discussions regarding systems costs and economy of operation centered, in the main, on whether or not school-house level implementation could ever be shown to be economically feasible or even justifiable. This argument centered on the premise that the unavailability of precise costing data notwithstanding, the thrust of implementation should be toward the functional level in that only at this level would the magnitude and complexity of problems warrant the capability to apply modeling techniques...*
>
> *...Counter-arguments stated the premise that costs would, in all likelihood, be minimal to the point that they would not be the primary deterrent to systems implementation; and, further, that there were many ways in which the models could (should) be used at the activity level. That the amount of usage and attendant benefits to be derived from such use is limited only by the imagination and resourcefulness of the activity itself...*

Commentary:

The IBM technical team agrees with the T&E Report:

> Quote (T&E Final Report):
>
> Page 11 *...It appears that a reasonable benefit/cost analysis of the models can only be derived from a valid field test. It must be established to what extent the models supplant existing procedures or personnel and what additional capabilities are provided - even more importantly what these capabilities buy in the way of greater effectiveness...*

This conclusion supports one of the recommendations evolving from a hypothetical benefit/cost feasibility exercise, based on theoretical assumptions, conducted during Phase II. That recommendation was:

Statement - Financial Feasibility - Commentary (Cont'd)

Quote (Phase II Final Report):[13]

> A decision to implement the DOTS models at the eighteen user locations identified in the preceding Projected Operational Responsibility sub-section, should be based on a thorough cost versus savings and avoidance justification. That justification and decision should not be made prior to the completion of DOTS Phase III and an assessment of actual operating results at the Norfolk Fleet Training Center test site.
>
> The Phase II DOTS validation exercise did provide sufficient indicators for a preliminary projection of cost savings and avoidances. Necessarily, this analysis had to be based primarily on subjective opinion and assumptions, due to lack of objective operational data.

It should be noted that the referenced exercise during Phase II was based on the assumption that NAVEDTRACOM management practices would be modified to achieve maximum benefit from mathematical models, whereas the T&E team was tasked with assessing the DOTS models' financial implications as applied in the current environment. However, the Phase II recommendation that the cost justification take place after Phase III is equally valid for either assumption.

The T&E Final Report expressed serious concerns pertinent to the Phase II projection of costs and avoidances hypothesized for an integrated NAVEDTRACOM modeling-management system. Since the T&E team specifically excluded the concept of institutional change from its evaluation, these concerns should not be considered as pertinent to this statement of financial feasibility. However, the T&E team provided strong support for the Phase II recommendation that a definitive cost avoidance exercise take place after Phase III.

The T&E team's concerns will be addressed in more detail under the CRITICISMS AND RECOMMENDATIONS sub-section to follow.

[13] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. I, Section IV, December 1974, Page IV-19.

- Criticisms and Recommendations (Parts 1-4, T&E)

  The T&E Final Report contained a very comprehensive technical critique of the three models. This sub-section will not attempt to duplicate or summarize that technical material but will emphasize those criticisms and recommendations pertinent to the general DOTS' conclusions and long-range implications.

  Elimination of the technical critique does not imply disagreement. The IBM technical team felt the technical critiques and recommendations were valid and should be considered in any future DOTS effort.

  The format used in this sub-section is similar to that of previous ones. A statement, based on a consolidation of comments distributed through the T&E Report, is presented, followed by the actual quotes and that by an IBM commentary. Each quote is coded as follows:

  O - Observation

  C - Criticism

  R - Recommendation

  As previously indicated, consolidation of dispersed quotes to support any given position statement can introduce a certain degree of bias. However, as long as the reader is aware of this approach and relies on the T&E Report for a more detailed analysis, this summary should highlight the key T&E concerns and recommendations.

Statement #1 - Criticisms and Recommendations

While the DOTS' effort appears to be complementary to existing and planned NAVEDTRACOM applications of Automated Data Systems (ADS), there is a need for significantly increased management and coordination of the composite ADS by CNET. This increase must take place if maximum benefit is going to be derived from any data base or modeling effort.

Quotes (T&E Final Report):

Page 47 (O)

...From specific and general comments by attendees to this T&E, a strong display of feeling was evident that the EDTRA Command is in dire need of management in the area of systems development and coordination. Specifically, there is the current problem of a lack of coordination of systems development and interfacting. There is a requirement for an overall information systems management/development function that is independent from the operational administration of the ADP facilities in the EDTRACOM. Some form of information systems study/development function has to exist that addresses the needs of all levels of the Command, not just CNET...

Page 41 (R)

...Update/modification requirements in the case of upper management may center around problems involved in integrating DOTS with other information systems. A serious effort should be undertaken to determine complementary functions among these information systems if redundancies are to be minimized and efficient integration and upper management usage are to be attained. This effort is not part of the current DOTS mission or tasking...

Page 37 (O)

...A recurrent theme of the T&E discussions centered on the NITRAS data system (i.e., its shortcomings). The complementary characteristics of the DOTS data base management system was recognized...

Page 14 (R)

...The results of the DOTS project, primarily the application of data base management technology, should be integrated more closely with the work of the NETISA organization in the development of the NITRAS data base...

Page 50 (O)

...The central point is that DOTS is not to be another system separate and distinct from those already in being. It must

Statement #1 - Criticisms and Recommendations (Cont'd)

> *not be competitive. It must be complementary to a total MIS established from the myriad of (unintegrated) systems that now exists. Similarly, DOTS (as a function of the total Training Command MIS) must interface with those systems external to the Training Command, such as SHORSTAMPS, that will impact on the Command...*
>
> Page 87 (O)
>
> *...However, a plus factor for products such as the DOTS models is the current state of management information systems (MIS) within the EDTRACOM. These are currently emergent and embryonic. Since the models are very complementary to the MIS development process, a fairly consistent MIS benefit might be projected from one development site to another. This underlying benefit might be capable of covering most risks associated with the more sophisticated utilities of models...*
>
> Page 50 (O)
>
> *...The need for accurate, timely planning is well recognized and there are several systems now operational or under operational development and implementation which purport to provide this capability (none appear totally satisfactory be it a function of scope of concept or of performance)...*

Commentary - Statement #1:

The above quotes emphasize a major concern of NAVEDTRACOM planners at all levels. That concern has to do with the lack of timely and accurate data required to respond to both operational and planning requirements. A related complaint, frequently voiced, was that lower levels provided significant amounts of data to higher ones but were unable to benefit from that effort through subsequent retrieval.

Although specifically excluding an evaluation of the DOTS Phase I effort from its assessment, the T&E team conclusions did support one of that Phase's major recommendations. The recommendation can best be described through the following random quotes extracted from the Phase I Final Report:

> Quote (Phase I Final Report):[14]
>
> Page VI-328 ...It is important that methods be available to track key attributes of the system. For example, report accuracy and timeliness were observed to be a problem in a number of instances; however, there did not appear to be

[14] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, December 1973.

Statement #1 - Criticisms and Recommendations - Commentary (Cont'd)

any pressing management concern since backup systems were available. In the ideal system for managing training resources, quality, reliability/availability, timeliness, and usefulness of data would not only be available to measure the system, but they would also be integral to objective setting and measurement of training managers. Also, before the system effectiveness can be evaluated in terms of its role as a part of the overall resource management system, these data must be available...

Page VI-341 ...Closely related to the preceding items is the need for faster access to resource data. This capability is especially important for detecting and analyzing variance, costing training plans, responding to queries, etc...

Page VI-340 ...Resource management reports need to be made more timely, more accurate, and more relevant to the command level at which they are used. Performance reporting (actual vs plan) should have increased emphasis in terms of automated and timely feedback to reduce the reliance on manual logs and analyses...

Page VI-304 ...Several locations were noted to have systematically defined their data needs, others were in the process of defining systems to make more effective use of the existing data bases and to reduce the amount of manual activity in the preparation of reports...In an idealized training system there should be greater standardization and integration of methods, procedures, and equipments used in the development and processing of management information...

Page VI-302 ...Resource and technical data must be supplied to the various systems throughout the reporting period so that meaningful data can be reported back to the activity for control purposes...a substantial amount of manual activity was noted. This was apparently due to the timing and accuracy of the basic reporting documents. It would seem from the comments that there are excessive errors contained in the input data which promulgates throughout the system. Thus, there is a real question as to how good a job is done to verify the reasonableness and/or accuracy of input data... However, an important aspect of increasing the effectiveness of resource control is to have resource managers assured that their reports are highly accurate...

Page VI-343 ...Paperwork. It appears that a high percentage of the manual activity devoted to preparing basic documents could be more fruitfully applied in the analysis and solution of resource management problems. This, of course, implies either the elimination or the automation of much of it. Some of both appears desirable...

Statement #1 - Criticisms and Recommendations - Commentary (Cont'd)

Page VI-74 ...Another facet of an ideal system is consistency and uniformity of designating an instructional organization. The large difference in the size of training - centers, schools, detachments, units - presents a most confusing picture. The origin of such differences is understandable since the present more centralized training structure picked up a number of relatively disparate elements. However, there is a need for a realignment of current terminology and organizations...

Page VI-102 ...The idealized system requires optimal planning. Aspects of "optimum" include: uniformity in planning across organizations, use of equal cost/usage and other factors, capability to include contingencies, and the capability to project into a future time period...An initial requirement is a set of common planning factors for use by all elements of the NETS. Such factors must be centrally developed, maintained, and controlled. In addition, uniform procedures for the utilization of these factors must be developed and made mandatory for all organizations...

Page VI-340 ...The number of ways in which resources are categorized, i.e., by program element, function sub-portions, budget classification code, element of expense, etc., seems unduly complicated for the most effective application of the system at all levels...

Page VI-104 ...Factors should, as applicable, be expressed in terms of ranges or sets with associated assumptions to permit the planner to develop alternatives or to revise plans...

Page VI-341 ...Realistic costing means the availability of historical costs and planning factors as well as a system for modifying them to the needs of any new costing exercise...

Page VI-340 ...A more well-defined accounting unit is needed for planning, tracking, and controlling training. Present units, such as average under instruction, average on-board, and student man-months, are subject to varying interpretations which preclude an accurate measurement of actual training...

Page VI-340 ...Greater and more uniform automatic data processing capability is required to adequate service all command levels. The non-uniformity and the absence of sufficient processing capability, however, is especially noticeable at the lower command levels...

These Phase I recommendations and observations were based on assessment of the NAVEDTRACOM in support of the overall DOTS' thrust which envisioned an integrated multi-level system of mathematical models operating in a modified

Statement #1 - Criticisms and Recommendations - Commentary (Cont'd)

management environment. A Phase I task was to identify the modifications required to achieve maximum benefit from such an approach. Lack of data was one of the major institutional gaps identified.

That same gap is proving a serious concern in the day-to-day planning process. The IBM recommendations in SECTION IV of this report will amplify and support the T&E Report in this area.

Statement #2 - Criticisms and Recommendations

The three DOTS models were not verified during Phase III.

Note: DOTS' documentation defines validation as proving that the models did work as designed and verification as proving they accuractely simulated or predicted actual events. In the quotes to follow, verification should be substituted for validation. The T&E did support the Phase II validation but not verification, as was originally planned for Phase III.

Quotes (T&E Final Report):

Page 21 (O and C)

...(SCRR)...*The basic LP technology and the MPSX software are, of course, not in need of validation due to their standardized nature. The validation documented by the model developer (TAEG Report 12-2, Vol. II, pp II-30-60) demonstrate that the model is functioning properly. The model's ability to accurately represent the real world is not demonstrated...*

Page 25 (O and C)

...(TPF)...*The validation procedures for the TPF as described by the model developer (TAEG Report 12-2, Vol. II, IV, pp 22-30) do not constitute a true validation. The model is simply exercised in a number of conditions and its deterministic processes are allowed to respond accordingly...However, there is no basis for judging how well the model simulates the real training process flow. All that can be said is that the factors utilized in the TPF appear to be reasonable since they are drawn from those which are commonly used by the training managers...*

IBM Note: The logic validation of Phase II is confused with the intent to verify in Phase III. The referenced report does contain a logic validation description which did prove the model operated as designed. The above quote is correct in indicating that no proof of fidelity in simulating actual conditions (verification) was provided.

Page 28 (O)

...These conditions did not rule out validity testing using historical data. Unfortunately, the historical data available would not have been complete enough to allow even this type of testing...

IBM Note: "These conditions" refer to those conditions precluding a meaningful field test.

Statement #2 - Criticisms and Recommendations (Cont'd)

Page 25 (O)

...a true validation would have entailed the use of historical conditions and the matching of model output to actual outcomes in the training environment resulting from those conditions. There appears to have been no attempt at such a procedure. (Of course, this would be more of a validation of the planning factors used by the model than of the mechanics of the model per se.)...

Page 27 (O and R)

...In the absence of ILS at FTC, Norfolk, the ETE was validated on the basis of a proposed consolidated EW school at Corry Station...

...the ETE remains for the most part in an unvalidated state. It may be that, as the model developer states, there are no NAVEDTRACOM ILS applications that are presently suitable for use in validation. If this is still true, the condition should not prevail for long. The ETE should be validated against a number of different actual ILS cases as soon as possible...

Commentary - Statement #2:

The T&E Report is correct; very limited verification was performed in Phase III. The original DOTS plan projected a major verification effort during this Phase. It was to have taken place in a laboratory environment, i.e., verification runs by the IBM technical team on the IBM System/360 Model 40GF located at their Cape Kennedy Facility. Data was to have been historical. Twelve months were planned for this task, and that task was to "...verify the models developed during Phase II using real-world data and operational situations."[15]

Based on an assessment of Phase I results, a significant change in approach was indicated early in Phase II. There were three factors indicating need for change. One, there seemed to be little need to expend R&D resources in proving that mathematical models could be designed which could accurately simulate the types of conditions reflected by Phase I's candidate model list. Two, only limited historical data was available in a form amenable to the proposed experimental verification effort. Any conclusions based on a verification using the available data would have been subject to so many qualifications that its value would have been very limited. Three, the most important questions had to do with operational feasibility. Would models have value when applied to the real world of planning and decision-making? If they had value, could they be applied in the general environment considering human factors?

[15] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, December 1973, Page I-2.

Statement #2 - Criticisms and Recommendations - Commentary (Cont'd)

Based on these three considerations, the Phase III verification in a laboratory environment was changed to a feasibility assessment of the three test models implemented in an operational test bed. The number of tasks required to install the models in a time-sharing system, develop the required supporting software, and to train the test bed staff precluded also undertaking any significant verification effort. To have reasonable validity, such a task would have required most of the planned twelve months.

In no way does the above contradict the T&E team's recommendation for some form of verification. Whether the final decision is to implement the three DOTS' test models as is, modified versions, or totally different models, a historical verification should take place in a field test environment.

The next Statement addresses such a test for the DOTS models.

Statement #3 - Criticisms and Recommendations

Utility of the DOTS test models has not been proven.

Note: Utility has to do with the frequency the models would be applied to current planning and operational needs by a user, and the ultimate value of that application.

Quotes (T&E Final Report):

Page 57 (C)

...Throughout the T&E there had been a dearth of feedback as to FTC, Norfolk, reactions to the specific utility of the various model information products, though some general reactions had been provided by the FTC DOT and the TRALANT T&E representative. It was determined that while the FTC application was not a field test per se, the level of model development and opportunity for application was such that specific examples of model utility using actual (if historical) problems, along with FTC management reactions, should have been produced in the course of DOTS Phase III...

Page 28 (O)

...an issue for the T&E is whether or not a field test should have been conducted in Phase III. It is the judgment of this T&E that such a field test could not have been comprehensively performed in Phase III.

...It would not have been possible to obtain the user commitment necessary for proper field testing without first being able to demonstrate that the models were in working order, that they could be made to operate in the training environment, and that they addressed substantive training issues in a useful and meaningful manner...

Page 55 (R)

...The next phase of DOTS should include field test(s) of the developed models, under operational conditions...

Page 12 (R)

...Initiation of data collection and review for TRALANT/TRAPAC application and field test of SCRR-TPF. This should include a clear assessment of opportunities for model contributions at these commands...

Page 13 (R)

...Presentation of the ETE model to the core of ILS course

Statement #3 - Criticisms and Recommendations (Cont'd)

> *developers in the EDTRACOM. This to be followed by field testing of the model in several cases of actual course design. An assessment of the benefits of the model should be made following these tests and the model should be further developed, revised, or put on the shelf for operational use as appropriate...*
>
> Page 28 (R)
>
> *...This field testing should, at a minimum, fill in some of the blanks left from this T&E evaluation regarding more precise estimates of cost, accuracy, and utility. A suitable field test site for the ETE model is not so evident but must be pursued. It would not be wise to put that model on the shelf and wait for 1980 to happen...*

Commentary - Statement #3

The IBM technical team agrees that utility has not been proven and should be demonstrated through additional field testing.

Statement #4 - Criticisms and Recommendations

Maximum utility of mathematical models can only be achieved through application to higher command levels than that represented by the Norfolk Fleet Training Center.

Note: The issue of level was a major one during the T&E with CNTECHTRA taking the strongest position.

Quotes (T&E Report)

Page 8 (O and C)

...The essential pitfall of the models as viewed by CNTT is that they "have been primarily designed to help that level of management least requiring assistance in decision-making" (i.e., the schoolhouse). CNTT construed this view as being supported by the acting Director of Training at FTC, Norfolk, who reported to the T&E team that the need to answer "what if" questions was rare (i.e., 5 or 6 times a year) at the FTC level. (Of course the Director also had many good things to say about the models. He recommended their continued development at the TRACOM level and hoped that the FTC could have continued access in the models on a periodic basis.)...

...Comments on User T&E Results: While CNTT's point is sound in its premise (i.e., that the FTC site is atypical of the greater EDTRACOM), it has deviated somewhat in its conclusion (i.e., that the operational feasibility of modeling has not been demonstrated)...

Page 42 (R)

...A functional flow chart should also be developed for the TRACOM showing scope and frequency of decision-making information/problem solving required at all levels, including specific examples of problems and methods/flow used to resolve these problems...

Page 54 (R)

...A general agreement evolved during discussion of user requirements to the effect that expansion of the prototypical modeling system to TRAPAC and CNTT activities is justified. Such expansion would address a wider variety and greater frequency of training decision-making conditions, explore the interfaces necessary to complement existing and developing systems, expand the data base, increase familiarity with modeling as a technique, potentially improve collection of related data, and provide better indications of system potential than would an extensive effort to go operational at this time...

Statement #4 - Criticisms and Recommendations (Cont'd)

Page 55 (R)

...The thrust of DOTS should be modified to include the investigation of applications at higher levels (i.e., beyond FTC) within CNET...

Commentary - Statement #4

Statement #4 is compatible with the recommendations of DOTS Phases I and II. The test model selection process, based on the Phase I study, illustrates this compatibility. The twenty-one potential test models were rated against nine criteria, one of which was:

Quote (Phase I Final Report):[16]

Page VII-13-14...The organizational level, i.e., CNET, functional, or activity, which will benefit from the development of each candidate model was taken into consideration in rating this criterion. In some cases, a single model or simple modifications of that model may benefit several levels of training management. A high correlation should exist between organizational level and savings potential, in that decisions made at higher management levels will generally impact a larger portion of the total training budget or of the total training population. Thus, models designed to assist in management decisions at several organizational levels received the highest rating. Models to be implemented at the CNET level received the next highest rating, while models to be implemented at the lower echelon level received the lowest rating...

The DOTS Phase II report recommended an evolutionary implementation of mathematical models to encompass three general levels of organizational and/or modeling complexity.

Quotes (Phase II Report):[17]

Page IV-7 ...The long-range thrust of Technical Development Plan P43-03 (P01A) is towards the integration of computerized mathematical models into all appropriate areas of the CNET's

[16] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, December 1973, Pages VII-13-14.

[17] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 1, December 1974, Page III-48.

Statement #4 - Criticisms and Recommendations - Commentary (Cont'd)

> decision analysis process. This thrust implies change in the way decisions are currently being made if the total decision process is to derive maximum benefit from the models. Therefore, an orderly and logical implementation of both the models and changes to the decision process itself are essential if the ultimate results are to be accepted and effectively used...
>
> ...For purposes of estimating the resources required for the design, development, validation, and implementation of a total CNET's decision analysis system, models were arbitrarily divided into three levels. The hierarchy was based more on the functional use of the models than on the level of training command using the results of the models, although the two do tend to equate...
>
> ...The SCRR, ETE, and TPF models are examples of the first level. They are primarily concerned with the projection of training resources and student flow. The development of a multi-level DOTS modeling system was initiated at the first level, since the horizontal implementation of these models across the Naval Education and Training System will require standardization of a basic data base and associated procedures. Such a standard will be essential to the support of higher level models. This same advantage will apply to the evolution from the second to the third level...

The above quotes should only be interpreted as supporting the premise of Statement #4. The T&E Report took strong exception to the Phase II hypothesis that significant benefit could be achieved from an integrated multi-level modeling system operating within a modified management environment.

Quotes (T&E Final Report):

Page 14 (O)

...It is a conviction here that, at least for the present, the successful application of management science technology is much more likely through many small scale applications...

Page 9 (O and C)

...In fairness to CNTT, it should be said that their alarm that someone might try to spread these particular models across the waters of EDTRACOM is not without cause. Much of the DOTS documentation concerning "projected operations" of the models invites this kind of fear (e.g., TAEG Report No. 12-2, Vol. I, Phase II Overview, pp IV-15 through IV-19). Such pre-

Statement #4 - Criticisms and Recommendations - Commentary (Cont'd)

> *sentations seem to imply that the three models, with a minimum of modification, could be applied in a very systematic manner through much of CNET. This sort of thinking was further embellished by verbal presentations from IBM which emphasized that there would have to be fairly significant changes in the present Navy training organization in order to take full advantage of the models...*

The T&E's concern for Phase II's long-range recommendations and hypotheses will be addressed in the Commentary for Statement #5. The CNTECHTRA concern for the selection of Norfolk as a test bed is understandable since the T&E approached the models primarily as operational tools, as opposed to R&D test vehicles. This is not a criticism of the T&E team since their operational orientation and approach significantly increased the validity of the DOTS conclusions and recommendations as they apply to the current environment. In any event, the CNTECHTRA concern for the selection of Norfolk as a test bed merits an explanation.

Two general principles guided definition of the final test environment. These were:

1. The environment must permit a reasonable assessment of the DOTS' hypothesis. Although only a limited subset, its evaluation must permit extrapolation of conclusions to other sets or subsets of the system.

2. The test environment and models selected, in addition to supporting hypothesis assessment, must provide potential for immediate practical return on the R&D investment. Test models, whether functional or mathematical, were to be selected considering their operational implications if this consideration would not be detrimental to achievement of DOTS' R&D objectives.

The Norfolk FLETRACEN was selected during Phase II as an operational test bed for the following reasons:

- The FLETRACEN management was agreeable to providing support for the test effort.

- Although small compared to other possible test locations, the management activities and functions resident at the Norfolk FLETRACEN represented all of the test areas to be explored.

- Due to its size, the additional data elements, beyond those provided by NITRAS and other sources, could be developed within the scope of the DOTS' effort.

It must be emphasized that the priority DOTS' R&D objective was to assess the potential benefit, if any, to be derived from the application of manage-

Statement #4 - Criticisms and Recommendations - Commentary (Cont'd)

ment science, operations research and mathematical modeling techniques to the total NAVEDTRACOM planning and decision process. To achieve this, a limited subset was to be modeled and the results evaluated. Extrapolations were to be drawn from this evaluation. Recommendations were to be developed which would complement the Strategic Assumptions evolving from Phase I which projected the NAVEDTRACOM environment through the mid-1980's.

It became obvious during Phase I that test models could be selected that would serve as R&D test vehicles as well as providing more immediate value to existing operational management. However, the three test models were primarily selected based on their potential for evaluating the original DOTS' hypothesis and not for their immediate value to the Norfolk FLETRACEN. To partially compensate Norfolk for its interest and effort in supporting the test and evaluation, some limited software was developed to permit access to the DOTS' supplemental data base required to drive the test models.

Statement #5 - Criticisms and Recommendations

The Phase II benefit/cost analysis is not valid.

Note: No benefit/cost analysis, appropriate to the application of the three test models in today's management environment, was conducted by IBM. The T&E Report refers to a hypothetical projection of an integrated management/modeling system based on Phase I and II's strategic analysis and recommendations.

Quotes (T&E Final Report):

Page 11 (C)

...A benefit/cost analysis was attempted in TAEG Report No. 12-2. A shortcoming is its assumption that the models as presently configured could be widely applied throughout CNET. As pointed out above, this premise must be rejected. There are other reasons why the benefit/cost analysis provided by the contractor is not acceptable. These will be identified in the detailed T&E Report...

Page 86 (C)

...The results of Phases II and III in no way warrant the usage assumptions made in that analysis. As a consequence, the resulting cost benefit conclusions are not viewed as acceptable...

Page 54 (R)

...If this system progresses to a recommendation for operational implementation, system specifics should be left to further determination during the procurement process and be done in such a way as to ensure investigation of all possible configurations with attendant costs...

Commentary - Statement #5

Notes from Pages 11 and 89 of the T&E Final Report assume that a definitive cost justification was attempted during Phase II. IBM did not attempt such a justification and recommended, at the end of Phase II, that one not be attempted until after Phase III. The following quotes from the Phase II exercise should put it in perspective:

Quotes (Phase II Final Report):[18]

Page IV-7 ...The long-range thrust of Technical Development

[18] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. I, December 1974.

Statement #5 - Criticisms and Recommendations - Commentary (Cont'd)

> Plan P43-03(P01A) is towards the integration of computerized mathematical models into all appropriate areas of the CNET's decision analysis process. This thrust implies change in the way decisions are currently being made if the total decision process is to derive maximum benefit from the models...
>
> Page IV-9 ...a forward pricing analysis was performed in Phase II, projecting the costs of a horizontal extension of the SCRR, ETE, and TPF models to form an integrated CNET modeling system...
>
> ...Due to the number of variables and lack of operational experience, this pricing exercise must be considered highly speculative. DOTS' Phase III will provide experience in an operational environment, enabling a more precise definition. However, the projected costs presented here should be sufficiently accurate to support tactical planning...
>
> Page IV-19 ...A decision to implement the DOTS' models at the eighteen user locations identified in the preceding Projected Operational Responsibility sub-section should be based on a thorough cost versus savings and avoidance justification. That justification and decision should not be made prior to the completion of DOTS' Phase III and an assessment of actual operating results at the Norfolk Fleet Training Center test site...
>
> Page IV-21 ...As previously stated, this exercise should be repeated after more objective data have been developed during Phase III predictive validation of the three models...
>
> Page IV-16 ...In developing recommendations, it was assumed that the decision command levels identified currently have, or will be granted, the authority to make the training resource decisions supported by the models...

The Phase II analysis was not based on the assumption that the test models would be implemented without design change or, what is more important, change to the process by which the NAVEDTRACOM manages resources.

In addition to developing and validating (did the models work as designed) the three test models, Phase II was tasked with developing the hypothetical impact of implementing a multi-level NAVEDTRACOM integrated modeling system concurrent with initiating change in the total command-management process to achieve maximum benefit. This task was predicated on a Phase I Strategic Working Assumption (SWA).

Statement #5 - Criticisms and Recommendations - Commentary (Cont'd)

Quote (Phase I Final Report):[19]

"A confluence of factors will result in a significant reduction in the resources available to accomplish the NETS* training mission. Although a current concern, the degree and scope of resource restriction will become increasingly severe through the mid-1980's and will result in major changes to the NETS* resource control approach and structure."

"Economic necessity will dictate a reduction in the total resources required to accomplish the training mission as well as a reduction in the unit cost of training for any given task. All command levels of NETS* will experience increasing levels of inquiry and control from higher government sources. The following change statements are pertinent to this reduced resource availability:

1. There will be an increased capability for cost effectiveness quantification, measurement and control.

2. More systematic and comprehensive cost justification methods, techniques, programs, etc., will be developed and implemented.

3. There will be an improved capability for marginal cost identification.

4. Increased application of computer technology will result in a need for more uniform and consistent data bases."

*Note: "NETS," Naval Education and Training System, is now currently designated as NAVEDTRACOM..

This SWA was based on eighteen Strategic Assumptions[20] also developed and analyzed during Phase I. Phase II's analysis was an attempt to make this general hypothesis more specific and amenable to empircal analysis. The key to the Phase II analysis is the Phase I assumption that severe resource restrictions "will result in major changes to the NETS resource control apprach and structure."

[19] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, Vol. 1, December 1973, Pages IV-17 and 18.

[20] Design of Training Systems, Phase I Final Report, TAEG Report No. 12-1, Vol. 2, December 1973, Pages A II-90 and 91.

Statement #5 - Criticisms and Recommendations - Commentary (Cont'd)

The change projected by the SWA was formulated as a recommendation during Phase II. This was stated as:[21]

> "Concurrent with model implementation, make the changes to the management system required to permit effective implementation of resource decisions. This implies granting various levels of training officials more authority over the use of training resources than they now have."

The Phase II change assumption envisioned increased involvement of all NAVEDTRACOM commanders in the inspection and challenge of resource plans and decisions. Mathematical models were considered as both management tools to support this change and as change agents for facilitating its incorporation.

To assist in an initial cost speculation, twenty potential users were identified at eighteen geographic locations[22] within the NAVEDTRACOM. Costs were extrapolated from Phase II experience with the three test models.

The projected savings were based primarily on the change in management, philosophy and not on the application of the three test models in today's environment. Although it was assumed that an integrated modeling system would require a minimum of eighteen users, this was not the driving cost avoidance consideration. The driving hypothesis was:

> By increasing the degree of involvement by all training command levels in the resource planning and decision process, and by supporting that involvement with an integrated system of mathematical modeling tools, up to 2.1% of annual specialized training costs (student and NAVEDTRACOM) can be avoided.

This 2.1% potential is projected as the "best case" condition, and even that is not projected until the fifth year after the management change and implementation of an integrated modeling system. Worst case projects .2% the first year and 1.5% in the fifth year, as compared to a best case of .3% the first and 2.1% the second.

Based on the more significant savings achieved in industrial training through application of similar techniques, the Phase II analysis should be considered extremely conservative.

During the T&E, the team expressed a serious concern that the Phase II hypothetical analysis would be used to justify implementation of an integrated modeling system across the NAVEDTRACOM prior to a valid justification. Their concern is a reaonable one considering the number of systems and educational innovations that have been sold on the basis of just such hypotheses. This same concern was considered in documenting Phase II. The speculative nature

[21] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 1, December 1974, Page V-1.

[22] Design of Training Systems, Phase II Final Report, TAEG Report No. 12-2, Vol. 1, December 1974, Page IV-17.

Statement #5 - Criticisms and Recommendations - Commentary (Cont'd)

of the analysis was repeatedly stressed, as well as the strong recommendation that a definitive cost justification take place after Phase III.

The T&E team also expressed some concern for the feasibility of a change in management practice. This will be discussed in SECTION IV, Conclusions and Recommendations.

Statement #6 - Criticisms and Recommendations

There is a need for establishment of a NAVEDTRACOM-wide program, under direction of a CNET agent, devoted to the development and coordination of management science techniques.

Quotes (T&E Final Report)

Page 13 (R)

...At the conclusion of the TRAM application/field test, a program should be established devoted to the use and development of management science techniques to support training management throughout CNET. The agent for this program should reside within the CNET community but have close ties with the R&D sector. This group would serve as a two-way funnel for both translating CNET R&D requirements and for implementing advancements emanating from R&D. More importantly, the group would have the capability to directly address management support requirements as possible within the state-of-the-art. This group could provide an invaluable element of continuity and consistency in the solution of such problems within CNET. The DOTS Phase I products, as corrected or amended, should provide an excellent foundation for this program. The models developed thus far would be the start of a "tool kit" of models or other techniques that could be applied to problems as they arise within the training community...

Page 47 (O)

...Additionally, the strong possibility exists that by and large the systems now under development or proposed are essentially designed to serve only the CNET level of need and are of little or no utility to the operational levels and functional levels of the EDTRACOM, except in several unique cases. Very little effort appears to be directed towards the development systems like DOTS which have the inherent capacity to become viable planning tools (i.e., for forecasting, modeling, etc.) or as tools for evaluating various approaches to resource utilization...

Commentary - Statement #6

The Phase I recommendations provide strong support for Statement #6. Although intended to apply to all NAVEDTRACOM R&D requirements, the following summary quote is pertinent:

"The approach to training research requires integration. The current fragmentary approaches do not yield the best results for the expenditure of funds. Central control under the leading

Statement #6 - Criticisms and Recommendations - Commentary (Cont'd)

> element in naval training (CNET) is essential. This must include systematic definition of problems, assignment of priorities, and prior commitment to implement effective results."

Statement #6 is a sound recommendation. Additional reinforcement is provided on Pages VI-362-364 of the Phase I Final Report.

Statement #7 - Criticisms and Recommendations

The cost of developing the three test models appears excessive.

Quotes (T&E Report):

Page 87 (O and C)

...The costs incurred to develop the DOTS models appear inordinate and probably not supportable at anything less than command level implementation. But those costs included many one-time items necessary to initiation of the project...

Page 14 (O and C)

...As a final remark, it should be noted that while the objective of the DOTS ADO is viewed as being achieved, the magnitude of expenditures that were required should be a lesson in the pitfalls of setting up projects which are a priori tasked with pleasing everybody...

Commentary - Statement #7

If DOTS is viewed as simply providing data processing solutions to current problems, Statement #7 is correct. However, this was not the intent of the DOTS effort, and costs during all three phases reflect its R&D objectives.

The T&E team's comment appeared to be based on the assumption that all DOTS' Phases II and III expenditures were devoted to the selection, development and validation of the test model.

The actual test model development took place during Phase II along with numerous other tasks related to the DOTS R&D goals. Phase III was more concerned with data base development, data base software support, command and control center installation, and training course development. Only a small percentage of Phase III resources were devoted to test model development.

Although a precise breakdown is not possible, actual model development consumed less than 40% of resources expended during Phases I and II.

General Comments - Criticisms and Recommendations

The statements in this sub-section reflect the very constructive and substantial critique performed by the T&E team. Once again the team's detailed technical critique was not included, but was of equal quality and even greater scope.

The only discontinuity resulted from the very pragmatic operational orientation of the T&E team as it addressed the more hypothetical areas of command and management philosophy reflected in the conclusions and recommendations of Phases I and II.

SECTION IV

PHASE III PRODUCTS

CONCLUSIONS AND RECOMMENDATIONS

Based on the experience gained through Phase III and the conclusions of the T&E Team, the following general conclusions can be made:

- The Phase III Test and Evaluation demonstrated that DOTS type models have significant potential for improving the NAVEDTRACOM decision and planning process.
- The NAVEDTRACOM Functional Levels will gain the greatest benefit from application of DOTS type mathematical models.
- DOTS type models can probably be implemented using existing personnel and without an increase in billets.
- The cost of model application will probably be significantly offset by improved planning decisions. (This was not proven during Phase III and should be verified through additional field testing.)
- It is probable that the three DOTS test models, modified as suggested in the T&E Report's technical recommendations, will have utility value. (However, utility was not proven during the T&E and should be accomplished through a field test.)
- The three DOTS models probably accurately simulate or predict actual conditions since they are based on the same planning parameters used by current planners. (Phase III did not produce an experimental verification of model fidelity, and this should be considered in a more extended field test.)
- Two negative factors will initially retard acceptance. One, training managers are not able to quickly obtain needed data required for meeting their basic planning and decision responsibilities, and this will have to be resolved prior to implementation of sophisticated models. Two, models could be improperly used by higher level management to justify arbitrary resource decisions. Since no model can include all of the judgmental factors considered by the lower level decision maker, this improper use could have serious implications.
- Proper training of all impacted managerial and operational personnel is essential to achieving acceptance and use of mathematical models. Training must be supported by a guided period of practical use in addition to formal theory and laboratory sessions.

The following recommendations are divided into two major areas. The first will address possible operational enhancements to the DOTS test models, and also desirable tasks for enhancing operational use and acceptance. The second area will cover possible institutional changes that could lead to a significant increase in the benefits to be derived from mathematical modeling.

- Operational Recommendations

  The following represents a summary of the operational and technical recommendations identified during the Test and Evaluation:

  1. Initiate data collection and review for TRALANT/TRAPAC application and field test of SCRR-TPF. This should include a clear assessment of opportunities for model contributions at these commands. Each command should designate an individual from its staff who will be the primary interface point in model development and have a clear responsibility for seeing that the models get put to real and practical use with the command to the extent possible.

  2. Modify the SCRR model as necessary in order to apply it at the TRACOM level.

  3. Review and modify the TPF model in terms of the following considerations:

     - Capabilities of a DBMS (e.g., RAMIS) to supplant the TPF in its current functions (given that no satisfactory statistical parameters can be developed).

     - Possibilities for more efficient model design given that the week-by-week simulation is equivalent, in effect, to successive transformations of course parameters using vectors of proportionality factors on a quarterly basis.

     - The possibility for alternative approaches to the development of statistically based model parameters.

     - Modifications as necessary to accommodate TRACOM level application.

  4. Design and conduct field tests of the SCRR-TPF at TRALANT and TRAPAC.

  5. Present the ETE model to the core of ILS course developers in the EDTRACOM. This is to be followed by field testing of the model in several cases of actual course design. An assessment of the benefits of the model should be made following these tests and the model should be further developed, revised, or put on the shelf for operational use as appropriate.

  6. After verification of fidelity and utility, conduct a cost/benefit analysis.

7. If operational implementation is indicated by the field test, it should be preceded by an in-depth training program and a period of closely supervised practical application.

- Institutional Recommendations

The Government T&E was primarily concerned with the application of the three test models in the current NAVEDTRACOM decision and planning process. In addition, IBM was tasked with extrapolating the use of mathematical models into a modified NAVEDTRACOM process. This Phase III Report will not duplicate the Phase I Functional Recommendations, but will expand and qualify those Phase II recommendations having to do with changes to the NAVEDTRACOM management process.

Phases I and II identified the following assumptions about the way the NAVEDTRACOM manages training and training resources.

- Generally, training plans and decisions are formulated by the technical staffs and approved by the appropriate command level.

- As long as these plans and decisions fall within acceptable fiscal and other resource limits, and are responsive to user needs, there is seldom a challenge from the authorizing commander concerning alternative possibilities.

- Under the conditions described above, for all practical purpose, there is never a challenge from higher command echelons forcing consideration of alternatives by the approving commander.

- Challenges do take place at all command levels when there is a need to withdraw resources from a training organization or when an organization requests additional resources.

- Generally, the catalysts precipitating the challenges described in the previous assumption are such stimuli as changes in allocations, training requirements, or other unanticipated system drivers.

- There is a natural tendency, as in any organization, for any given level of command to limit precise visibility to higher levels of its resource utilization and inventory.

The resultant of these assumptions is a lack of command pressure to achieve efficiencies through systematic challenges as long as the NAVEDTRACOM can meet training requirements within a given funding level. This also represents the major difference between the way training functions are managed in industry as compared to the military. In industry, whether supervisory or executive level, management is required to become very involved in resource as well as people management. Traditionally, the military services have separated command (getting things done through people or tactical resources) and resource management (planning and control of costs and non-tactical resources). Most military commanders at any level, in fact, avoid those tasks associated with resource management or "bean counting" based on the assumption that to do so would reduce their effectiveness in achieving primary missions.

It cannot be automatically assumed that application of those management techniques used by industry to reduce training costs should be applied to the NAVEDTRACOM. Also, the assumptions previously stated should not be automatically construed as criticisms of the NAVEDTRACOM management staff. However, if the NAVEDTRACOM is to achieve the maximum potential benefits in terms of cost effectiveness through application of mathematical modeling, all levels of command will be required to adopt their industrial counterpart's techniques of systematic challenge and analysis of resource plans and decisions.

The following three recommendations are based on this assumption:

1. Revise current management practices and motivational approaches to create an environment amenable to acceptance and use of the recommended management techniques. These revisions are envisioned as being reasonable ones, but will require changes in some sensitive areas. As examples: commanders at all levels will need to become more knowledgeable of the training planning process and its results; Fitness Reports will need to emphasize this shift in approach; commanders will have to become more comfortable with some of the more hypothetical exercises of managerial science and operations research; etc.

2. Provide increased multi-level visibility of training resource utilization and inventory to all appropriate levels. Current projects within the NAVEDTRACOM, under general direction of the CNET Naval Education and Training Information Service Agency (NETISA), should eventually provide a basic informational capability. It must be emphasized that this capability is not only essential to successful implementation of the DOTS' institutional recommendations, but also to those concerning the implementation and application of mathematical modeling tools in the current environment.

3. Develop mathematical models and other management tools based on the data capability recommended under the second recommendation, and designed to support the first recommendation's management practices.

In developing these recommendations, the distinction between "command" and "management" was recognized. It is understood that if these recommendations are implemented, commanders will be required to practice certain managerial approaches they now leave to their technical staffs. It is also recognized that this shift may not be considered as one of "reasonable change" by the commands impacted. However, the recommended managerial practices applied without the direct force of command authority, inspection and control, will have limited value except as they assist the technical staffs to meet the procedural requirements of the Planning, Programming and Budgeting System.

It should be stressed that the T&E Team, although not rejecting the DOTS' hypothesis of "reasonable change," did imply that it would require changes too significant to be considered reasonable. The

team's conclusion was not based on an assessment of the DOTS' institutional recommendations as a formal part of the T&E, but was a general observation.

In support of the T&E Team's position, there is a growing concern within the military for the current trend towards equating command to management. This is best illustrated through quotes from an article[23] by General Lucius D. Clay, USAF:

> "Management has a proper place in operation of a military service, but management must be recognized for what it is - a system of bookkeeping that is primarily associated with statistics."
>
> "Command is the relationship between people. People do things."
>
> "...let us not usurp the traditional functions of the commander under the banner of management."

General Clay makes an excellent point. However, if the DOTS strategic assumptions pertinent to severe resource restrictions through the mid-1980's have validity, military command may be forced into the resource management role. If this happens, mathematical models and their associated data bases may become essential tools for all command levels as well as for those staff levels concerned only with resource planning.

[23]Clay, Gen. Lucius D., USAF, Management Is Not Command, Air Force Magazine, Sept. 9, 1975, Page 63.

PHASE III DOCUMENTATION

In addition to the T&E and this Phase III Final Report, which together constitute documentation of Phase III's R&D outcomes, two additional manuals were produced during Phase III.

This sub-section will provide a brief description of those documents, developed during DOTS Phase III, describing the three test models and providing sufficient operating procedures to permit exercising the models and revalidating their logic designs. The documents are entitled USER'S MANUAL and PROGRAM MAINTENANCE MANUAL. The Phase III documentation task was intended to provide sufficient technical information to permit future testing and possible model revision and development for inclusion in an operational environment.

Some limited data base capabilities were developed to support the DOTS' test effort. These are also described.

The DOTS test bed included installation of the models in a commercial time-sharing environment. To reduce the cost of establishing a simulated operational test environment, as well as reducing the cost of actual model development, maximum use was made of existing program products. Documentation supporting these is not included in the Phase III documentation, but adequate references are provided as appropriate.

A description of each of the two Phase III manuals follows. It should be noted that these manuals supersede those volumes of the DOTS Phase II Final Report covering model operations and programming description.

- PROGRAM MAINTENANCE MANUAL (TAEG REPORT NO. 29)

The Program Maintenance Manual provides detailed information on the level of the three DOTS models and the DOTS data base at the end of Phase III. The level of information is sufficient to provide a base for programmers intending to install or modify the DOTS models.

The manual is organized around the four major DOTS sections, the DOTS data base, the Educational Technology Evaluation (ETE) model, the System Capabilities Requirements and Resources (SCRR) model, and the Training Process Flow (TPF) model. The three models function independently and the data base (although it serves both the SCRR and TPF models) can also be considered as an independent sub-system. Therefore, each of the models and the data base are discussed in a separate section of the manual.

Within each section, the sub-system being discussed is subdivided into its major components. Each section contains a sub-system description and macro-level flow, detailed flows and program listings of the sub-system components. For FORTRAN and PL/1 programs, the detailed flow charts were generated using the Autoflow II* System.

The manual is sub-divided as follows:

I. INTRODUCTION

A. Purpose

B. Organization

II. DOTS DATA BASE

A. Introduction and Top Level Description

1. Top Level Flows

B. Data Base Sub-system A

1. Sub-system Top Level Flows
2. Sub-system Program Description
3. Autoflow Diagrams, Executive Flows
4. Program Executive Listings

III. EDUCATIONAL TECHNOLOGY EVALUATION MODEL

A. Sub-system Top Level Flows

B. Sub-system Program Description

C. Autoflow Diagrams, Executive Flows

D. Program Executive Listings

*Autoflow II is a product of Applied Research, Inc.

IV. SYSTEM CAPABILITIES/REQUIREMENTS AND RESOURCES MODEL

(Same as Section III)

V. TRAINING PROCESS FLOW MODEL

(Same as Section III)

- USER'S MANUAL (TAEG REPORT NO. 30)

The primary purpose of the User's Manual is to provide the DOTS model user with sufficient information to procedurally execute the models and take advantage of the supporting data base. In addition, test procedures are provided for each model to permit user retesting of functional validity.

The manual also provides an overview of model architecture and logic. Descriptions of input parameters and outputs are included.

The manual is subdivided as follows:

I. INTRODUCTION

A. Purpose

B. Organization

C. System Overview

D. General System Procedures

II. DOTS DATA BASE

A. Architecture

B. Maintenance

1. Administrative Procedures
2. Operational Procedures

C. Inquiry Procedures

III. EDUCATIONAL TECHNOLOGY EVALUATION MODEL

A. Model Architecture

1. Model Description
2. Assumptions and Logic Design

B. Input Parameter Description

C. Output Parameter Description

D. Operational Procedures

E. Operational Test

IV. SYSTEM CAPABILITIES/REQUIREMENTS AND RESOURCES MODEL

(Same as Section III)

V. TRAINING PROCESS FLOW MODEL

(Same as Section III)

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