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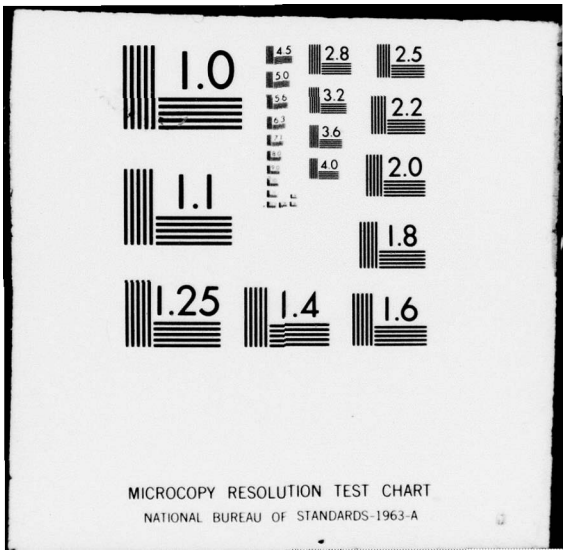
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TESTING, EVALUATION, AUGMENTATION AND IMPROVEMENT OF AN INTEGRATED SIMULATION EVALUATION MODEL PROTOTYPE (ISEM-P) OF THE AIR FORCE MANPOWER AND PERSONNEL SYSTEM

Contract Number F49620-78-C-0001

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Contract Number F49620-78-C-0001

Prepared for:

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This research involved the testing, evaluation, augmentation, and improvement of the Integrated Simulation Evaluation Model Prototype (ISEM-P), a computer program simulating the basic planning activities and decision-making procedures involved in the Air Force Manpower and Personnel System (AFMPS). During the period between 1 November 1977 and 30 November 1978, accomplishments of this research included: installing

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a fully operational version of the model on the Air Force Human Resources Laboratory (AFHRL) computer; establishing an "ISEM Working Group" of Air Force personnel actively involved in planning and administering the manpower, personnel assignment, and training functions within the AFMPS; developing a set of "scenario problems" to test the validity of the model; creating improved output reports for displaying the results generated by the model; executing simulation runs for two selected "scenario problems" and a baseline situation; and modifying the model to eliminate certain identified inconsistencies between the simulation results and observed AFMPS behavior. Changes undertaken as a result of this process involved incorporating the concepts of "equal promotion opportunity," cross-training, the "worldwide manning level," "Time-on-Station" and "Time-in-CONUS," and the rated supplement into the ISEM-P model structure.

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1.0 INTRODUCTION

The Integrated Simulation Evaluation Model Prototype (ISEM-P) is a computer program, written in the SIMSCRIPT II.5 language, which simulates the basic planning activities and decision-making procedures involved in the Air Force Manpower and Personnel System (AFMPS). The ISEM-P design is based on a modular representation of the AFMPS in which long-range force structure planning, training program requirements, short-range personnel assignment planning, and actual personnel flows are simulated as integrated activities for the purpose of evaluating force structure responses to various mission and policy changes. The basic purpose of the project discussed in this report is to investigate the feasibility of using this simulation approach to predict and analyze the impact of changes in policies, procedures, and environmental conditions on the performance of the AFMPS as a whole. This report summarizes CONSAD's efforts to fulfill this purpose in the context of Air Force Contract Number F49620-78-C-0001 during the period 1 November 1977 through 30 November 1978.

2.0 RESEARCH OBJECTIVES

At the initiation of the contract, the objectives of the research project were:

- To install the ISEM-P model on AFHRL computer facilities to permit its continued development;
- To establish a user panel or working group to posit scenario problems, to evaluate model results, and to recommend needed modifications to the ISEM-P logic structure;
- To analyze scenario problems developed by the "ISEM-P Working Group," and to generate reports conforming to user specifications;
- To perform "logic stress tests" to stress the model's logic up to and beyond its design limits to permit corrective actions to be taken which will assure an undistorted evaluation of the scenario problems, and to define the "practical" limits of application of ISEM;
- To detail thoroughly the actual ISEM-P computer program; and
- To provide information on the scenario testing process.

In the course of pursuing these objectives, several fundamental limitations of the ISEM-P model were discovered. To eliminate these limitations, the project's research objectives were expanded to include:

- To develop within ISEM-P an improved internal personnel assignment procedure reflecting new and broadly detailed understanding achieved during intensive review sessions with the "ISEM-P Working Group";

- To implement within ISEM-P a more realistic supply-driven promotion procedure which also accommodates cross-training activities and, thereby, describes actual Air Force practices more accurately;

- To add a newly conceived Time-on-Station (TOS) memory capability to ISEM-P to provide substantially more realism and flexibility in the modeling system's structure; and

- To evaluate an augmented procedure for reflecting within ISEM-P the complex impacts of the rated supplement in the "real" Air Force.

3.0 RESEARCH ACCOMPLISHMENTS

This section summarizes the status of the project relative to its research objectives as to 30 November 1978, and discusses the significant accomplishments achieved in attaining this status.

3.1 Installation of ISEM-P on AFHRL Computer Facilities

At the beginning of this project, the ISEM-P program was installed and operational on a CDC 6600 computer located at Wright-Patterson Air Force Base. The initial task of this project was to transfer the program to the Air Force Human Resources Laboratory (AFHRL) computer facility -- a UNIVAC 1108 computer located at Brooks Air Force Base.

To accomplish this task, CONSAD first secured and arranged for the installation of a SIMSCRIPT II.5 compiler for the AFHRL computer. Then, the source code and associated data files of the ISEM-P program were modified to accommodate the differences in word size, naming conventions, storage management procedures, and arithmetic operations that exist between CDC and UNIVAC equipment. In addition, on several occasions, modifications of the ISEM-P source code were performed to overcome a number of errors that existed in the UNIVAC SIMSCRIPT II.5 compiler in early 1978. These compiler errors were

later corrected by the compiler vendor. At the conclusion of these activities, a fully compiled version of the ISEM-P model had been established on the AFHRL computer.

At this juncture, CONSAD attempted to execute an operational run of the model and discovered that the AFHRL computer system did not have enough primary memory available to accommodate ISEM-P. Therefore, CONSAD restructured the program's use of primary memory to permit it to fit within the limited address space available on the AFHRL facility. In fact, staying within the limits of the system's primary memory proved to be a continuing problem as the model was revised and its capabilities were expanded. The corrective actions taken to overcome these capacity limitations included the elimination of obsolete data structures, the tighter packing of arrays, and the transferring of data between primary memory and disc storage as feasible and necessary. As a result of these efforts, a fully operational version of ISEM-P was installed on the AFHRL computer by early March, 1978. This version contained essentially the same logic, inputs, and outputs included in the CDC version that existed at the outset of the project.

3.2 Establishment of an "ISEM Working Group"

As required by the contract, an "ISEM Working Group" was established to develop scenario problems which should be simulated by the model to determine its validity, to recommend modifications of the model's logic that would make it more representative of actual AFMPS behavior, to specify the kinds of output that should be generated by the model, and to suggest specific potential users of the model in its final form. The members of the working group were all Air Force personnel actively involved in the planning and administration of the manpower, personnel assignment, and training functions within the AFMPS. Thus, group members were drawn from several organizations within AFMPS, including the Air Force Military Personnel Center (AFMPC), the Air Force Management Engineering Agency (AFMEA), and the Air Training Command (ATC).

Through the end of November 1978, four meetings of the "ISEM Working Group" were convened at AFHRL. These meetings were held on 1 June 1978, 22 June 1978, 27 July 1978, and 29 November 1978. At each meeting, the group members were familiarized with the existing structure, operation, and output of ISEM-P; and their comments and suggestions were solicited concerning each of the topics listed above.

As a result of these discussions, a set of "scenario problems" was developed to test the validity of the model. Each of these "scenario problems" specified a particular change in external (environmental) conditions or internal (policy) parameters to which the AFMPS had to respond at some time in the past. The full set of "scenario problems" delineated by the "ISEM Working Group" included:

- Decreases in year-end-strength ceilings,
- Opening or closing an Air Force base,
- Phasing in or phasing out a weapons system,
- Changes in the retention of rated personnel,
- Changes in accession rates,
- Changes in retention rates,
- Combinations of decreases in year-end-strength ceilings, changes in accession rates, and changes in retention rates,
- Changes in weapon system crew ratios,
- Changes in the standard length of overseas tours,
- Changes in on-the-job training rates,
- Changes in the mix of personnel in the rated supplement, and
- Decreases in available flying hours.

Thus, for example, the first "scenario problem" specifies a decrease in the total USAF personnel authorization, or year-end-strength ceiling, in one or more years relative to the authorization for the previous year.

Such authorizations are legislated by Congress and, hence, are part of the environment within which the AFMPS functions.

The particular "scenario problems" included in the set were selected because working group members knew how the AFMPS had actually behaved in such situations and, hence, would be able to evaluate the ability of ISEM-P to reproduce that behavior if the model were run with similar conditions and parameter values. In addition, the set of "scenario problems" helped to exemplify the kinds of contexts in which the results produced by ISEM-P might serve the interests of AFMPS analysts and planners.

Finally, the selection of previously observed situations as bases for "scenario problems" also had the beneficial effect of defining a useful collection of output reports. To compare actual and simulated behavior, it is necessary to use the same types of descriptions of that behavior. Prior to the meetings of the "ISEM Working Group," the primary outputs generated by ISEM-P focused on only one of the 91 airmen and officer skills included in the model. These outputs comprised essentially a list of the transactions that affected personnel having that skill throughout the simulation run. While these outputs were useful for debugging the ISEM-P computer program, the detailed transactions report, describing several hundred personnel transactions per month throughout the sixty months contained in a five-year simulation run, did not provide the type of information most useful for analysis

or evaluation. To rectify this situation, the members of the "ISEM Working Group" identified a number of variables, and combinations of variables, whose values they wished to see for each year during the simulation run. CONSAD then designed, installed, and implemented seven new reports, and associated data assembly and manipulation routines, to supply the requested information.

3.3 Analysis of Simulation Results

From the set of "scenario problems" listed above, the first two were selected for initial analysis: decreasing year-end-strength ceilings and closing an Air Force base. Several additions to the model were required to permit ISEM-P to simulate these scenario problems. Most notably, it was necessary to develop a way to represent the particular sequence of events through which the AFMPS closes a base. The information needed to accomplish the required modification of the model was acquired at the second meeting of the "ISEM Working Group." Then, simulation runs examining the two selected "scenario problems," as well as a baseline situation, were performed. In the baseline situation, no environmental conditions were changed during the course of the simulation run. Thus, in essence, the baseline situation describes an environment in which Congressional authorizations of USAF personnel are constant over time.

The results of the three simulation runs were presented to the "ISEM Working Group" at its third meeting. In general, the members of the working group expressed support for the extent to which actual AFMPS decision-making processes were captured in the model. Yet, several notable inconsistencies between ISEM-P outputs and observed AFMPS behavior were identified at the meeting. Intensive discussions between CONSAD staff and the members of the working group isolated the sources of the inconsistencies, and revealed that the selected "scenario problems" had stressed the model's logic beyond its design limits. In particular, the discussions disclosed that the model did not contain adequate representations of the actual AFMPS procedures in the following areas:

- Airman promotions, where ISEM-P failed to incorporate the Air Force's "equal promotion opportunity" policy;
- Airman cross-training, where the model relied excessively on mandated reductions in force;
- Choice of personnel for overseas assignments, where the model failed to recognize Time-on-Station and Time-in-CONUS constraints on personnel movements;
- Selection of personnel to relieve imbalances between base supplies and authorizations, where ISEM-P did not include the "worldwide manning level" as a decision criterion;
- Designation of CONUS assignments for personnel returning from overseas tours, where once again the "worldwide manning level" was not considered by the model;

- Assignment of technical school graduates, where ISEM-P projected graduations for an excessive time horizon and, then, attached improper priority to CONUS bases as assignment locations;

- Allocation of personnel authorizations for personnel in training, where the model directly offset trainees against the year-end-strength ceiling; and

- Calculation of manpower requirements for bases supporting different types of missions, where a programming error precluded the transferring to a base any type of mission which did not previously exist at the base.

To determine the precise model formulation appropriate to correct ISEM-P's representations of these procedures, CONSAD conducted numerous telephone interviews with Air Force personnel responsible for the establishment of manpower requirements, the implementation of manpower utilization policy, the management of reenlistment, the development and application of promotion policy, the establishment of training requirements, the implementation of training and cross-training policy, the setting of recruiting quotas, and force programming. The specific Air Force personnel contacted, and their areas of expertise within the AFMPS, included:

- Captain Mike Robards, MPC, assignment operations,

- Captain Bud Dailey, MPCMA, reenlistment policy,

- Captain Roy Smoker, AFMEA, manpower planning,

- Mr. Lou Catrow, ATC/TTPP, technical training programming,

- Captain David Harrington, MPXOP, airman promotions,
- Lt. Colonel Jim Mollicone, ATC/RSOPM, airman procurement,
- Major Chris Summers, MPPPN, first-term management,
- Sergeant Jean Breeden, MPPPN, force programming, and
- Major Bill O'Connor, MPPPN, trained personnel requirement and reenlistment.

The insights obtained in the interviews of these personnel were incorporated into designs for modifications of the model and, then, transformed into computer code for inclusion in the ISEM-P program. As of 30 November 1978, CONSAD had accomplished the implementation of modifications to the model structure describing a supply-driven promotion mechanism consistent with the Air Force's "equal promotion opportunity" policy, and identifying the skills providing supplies and demands for cross-training. In addition, designs had been completed for the inclusion of the "worldwide manning level" as a decision criterion in the assignment algorithm, the incorporation of cross-flows and cross-training within the model structure, the consideration of "Time-on-Station" and "Time-in-CONUS" constraints in the assignment process, and the appropriate planning and execution of assignment of technical school graduates. Finally, the programming error discovered in the calculation of base manpower requirements had been corrected; and

efforts had been initiated to design, and examine the feasibility of implementing, procedures describing the essential characteristics of the Air Force's management of the rated supplement.

4.0 PROFESSIONAL PERSONNEL ASSOCIATED WITH THE PROJECT

The CONSAD professional personnel who participated in the project discussed in this report during the period between 1 November 1977 and 30 November 1978 included:

- Dr. Charles D. Laidlaw, Vice President and Project Director,
- Mr. Charles Eisele, former Project Manager,
- Dr. Frederick H. Rueter, current Project Manager,
- Mr. Donald Kosy, Program Designer and Analyst,
- Mr. Michael Shefler, Computer Systems Analyst, and
- Ms. Deborah Kahn, Systems Analyst.

5.0 INTERACTIONS

On 31 May 1978, CONSAD presented a briefing describing the existing status, operation, and results of the ISEM-P model at the Deputy Director Research and Engineering (DDR&E) Topical Review on Manpower Modeling in San Antonio, Texas. In attendance at this meeting were numerous members of the Department of Defense, Air Force, and Navy research communities.

In addition, as mentioned in Section 3 of this report, meetings of the "ISEM Working Group" were convened at Brooks Air Force Base on 1 June 1978, 22 June 1978, 27 July 1978, and 29 November 1978.

To date, no manuscripts related to the project have been published or submitted for publication.