Contract No. MIPR 90MM0503

TITLE: INTEGRATION AND VERIFICATION OF MAN-MACHINE MODELING TOOLS

PRINCIPAL INVESTIGATOR: SAMUEL G. SCHIFLETT, PhD

PI ADDRESS: USAF ARMSTRONG LABORATORY
SUSTAINED OPERATIONS BRANCH
BROOKS AFB, TEXAS 78235-5104

FINAL REPORT DATE: 31 DECEMBER 1992

INCLUSIVE DATES: 01 OCTOBER 1991 TO 30 SEPTEMBER 1992

TYPE OF REPORT: ANNUAL

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Frederick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for public release; distribution unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.
This annual report of progress provides a summary of work accomplished in support of the Office of Military Performance Assessment Technology. The objective of this effort is to integrate and verify man-machine modeling tools to provide a user with software to generate task decomposition structures that are transportable to sequential network models. A microSAINT model of the weapons system director's commit task was completed. Several technology transfers are discussed.
### General Instructions for Completing SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

<table>
<thead>
<tr>
<th>Block 1. Agency Use Only (Leave Blank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.</td>
</tr>
<tr>
<td>Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).</td>
</tr>
<tr>
<td>Block 4. Title and Subtitle. A title is taken from DOE See authorities the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.</td>
</tr>
<tr>
<td>Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:</td>
</tr>
<tr>
<td>C - Contract</td>
</tr>
<tr>
<td>G - Grant</td>
</tr>
<tr>
<td>PE - Program</td>
</tr>
<tr>
<td>Element</td>
</tr>
<tr>
<td>Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).</td>
</tr>
<tr>
<td>Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.</td>
</tr>
<tr>
<td>Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.</td>
</tr>
<tr>
<td>Block 9. Sponsoring/Monitoring Agency Names(s) and Address(es). Self-explanatory.</td>
</tr>
<tr>
<td>Block 10. Sponsoring/Monitoring Agency Report Number. (If known)</td>
</tr>
<tr>
<td>Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with..., Trans. of ..., To be published in .... When a report is revised, include a statement whether the new report supersedes or supplements the older report.</td>
</tr>
<tr>
<td>Block 12a. Distribution/Availability Statement. Denote public availability or limitation. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR)</td>
</tr>
<tr>
<td>Block 12b. Distribution Code.</td>
</tr>
<tr>
<td>Block 13. Abstract. Include a brief (Maximum 200 words) factual summary of the most significant information contained in the report.</td>
</tr>
<tr>
<td>Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.</td>
</tr>
<tr>
<td>Block 15. Number of Pages. Enter the total number of pages.</td>
</tr>
<tr>
<td>Block 16. Price Code. Enter appropriate price code (NTIS only).</td>
</tr>
<tr>
<td>Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.</td>
</tr>
</tbody>
</table>

Standard Form 298 Back (Rev. 2-89)
CONTENTS

FOREWORD .................................................. iii
INTRODUCTION ................................................. 1
METHODS ...................................................... 1
RESULTS ....................................................... 1
CONCLUSIONS ................................................ 3
APPENDIX ....................................................... 4

Plans ............................................................ 5
Reports ........................................................... 6
Presentations ................................................ 7
Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by the U.S. Army.

Where copyrighted material is quoted, permission has been obtained to use such material.

Where material from documents designated for limited distribution is quoted, permission has been obtained to use the material.

Citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.

In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Animal Resources, National Research Council (NIH Publication No. 86-23, Revised 1985).

For the protection of human subjects, the investigator(s) have adhered to policies of applicable Federal Law 32 CFR 219, and Subparts CB, C and D.

In conducting research utilizing recombinant DNA technology, the investigator(s) adhered to current guidelines promulgated by the National Institutes of Health.

In the conduct of research utilizing recombinant DNA, the investigator(s) adhered to the NIH Guidelines for Research Involving Recombinant DNA Molecules.

In the conduct of research involving hazardous organisms, the investigator(s) adhered to the CDC-NIH Guide for Biosafety in Microbiological and Biomedical Laboratories.

Samuel D. Schiffner 12/31/92
Principal Investigator's Signature Date
FY 1992 ANNUAL REPORT
INTEGRATION AND VERIFICATION OF
MAN-MACHINE MODELING TOOLS

INTRODUCTION

This annual report of progress provides a summary of work accomplished in support of the Office of Military Performance Assessment Technology (OMPAT). The objective of this effort is to integrate and verify man-machine modeling tools to provide a user (principal investigator) with an expanded capability to access widely accepted modeling methodology and to share common data bases with other investigators. Of primary importance in this project is establishing the utility of commercially available software to assist in the generation of task decomposition structures and the "seamless" translation of task describing functions into sequential networking modeling software. The end goal is to develop and validate a set of military relevant, operator performance risk criteria based on models and part task simulation data.

METHODS

A wide variety of off-the-shelf, commercially available software was assessed in the formative stages of this project. The methods used and results of those evaluations were attached to last year's Annual Report. The final recommendation for graphically based, task analytical software was IDEF and the choice of sequential task modeling software was SAINTplus. The predominant amount of time in FY92 was spent developing hierarchical task decompositions of graphically based representations of an AWACS weapons air controller commit task. The task was then translated from SAINTplus into a microSAINT format and verified using previously collected data from earlier simulation studies sponsored by OMPAT. The microSAINT models run on IBM 386 compatible hardware under DOS 3.0 or higher rather than the VAX version of SAINTplus.

RESULTS

An abrupt end to operation Desert Storm and a decrease in data analysis and reporting commitments diminished our involvement considerably with wartime crisis management. This allowed our staff to return to the efforts of this project in the first quarter of FY92 (Oct-Dec 1991). An on-site programmatic review of current and pending work was discussed in January 1992 with Dr. Fred Hegge, Dr. Tim Elsmore and LtCOL Dave Penetar to revise our schedule. A detailed plan of action was agreed upon

1
to renew efforts to reduce and analyze the AWACS data to develop individual measures and team performance measures. A total of seven outcome measures have been defined in a top-down approach from the generalized team performance measures. Software has been completed to extract individual variables of interest such as drug, day, workload, cognitive skills, and personality traits. The individual measures will also include a comparison of individual performance scores on the cognitive task battery.

A descriptive model for experienced, average, and naive weapon system directors based on performance outcome measures was tested with simulation data from a prior study conducted in 1990. The model of human activity was developed by a subject matter expert using SAINTplus a software product from Micro Analysis and Design, Inc. that runs on the VAX line of computers. The software development has since been discontinued and is distributed by a secondary vendor. The predictive results of the model were disappointing since a number of variables were not included which artificially constrained the decision making task i.e., anticipation and distraction. The model will be enhanced to include an updated version using microSAINT software instead of SAINTplus.

A major portion of the year was spent developing an integrated task analysis methodology system to identify and derive synthetic tasks that are representative of the critical decision making processes of weapon systems operators performing "real world" missions using high fidelity simulators. A reductive task analysis approach developed by Dr. Gerald Chubb, Ohio State University, was used to identify the essential cognitive components necessary to commit friendly forces against enemy forces in an air defense scenario. The basis of this technique applied by our subject matter experts was a study sponsored by the Air Force Office of Scientific Research to evaluate the reliability of using R.B. Miller's Task Strategies to formulate a part-task decomposition.

Technology Transfers

The functional part-task decomposition was completed in March 1992 from structured interviews of 14 AWACS weapon system operators that participated in Operation Desert Storm. These "wartime validated" task structures have greatly enhanced the operational value of our descriptive models. We were able to use these revised task structures to design a more effective and efficient display format for the AWACS Weapons Director's console for the E-3 AWACS aircraft. Dr. Gary Kline and his associates conducted a simulation study in the summer of 1992 in the Aircrew Evaluation Sustained Operations Performance (AESOP) facility at Brooks AFB, TX to evaluate situational awareness of Air Controllers using the new versus old displays. This was a direct technology transfer, to operational commands within the Air
Force, of an OMPAT product that will enhance the crewstation interface in the AWACS E-3 aircraft. The report is presently being prepared for final publication.

In 1992 NASA funded a secondary spin-off of OMPAT technology (microSAINT) to support Space Station Freedom's assembly tasks (tele-robotics grappling arm). The microSAINT model dynamically describes a satellite retrieval task verified from ground-based simulation training exercises at Johnson Space Center. It is planned that this model will be expanded to include human operator characteristics to predict the effects of microgravity on retrieving the Hubble telescope scheduled for December 1993. This work, in conjunction with future studies, will serve as the foundation for developing an integrated set of methodologies for the evaluation of human performance and behavior in extended duration spaceflight missions necessary to assemble Space Station Freedom.

CONCLUSIONS

Significant progress has been made in integrating and verifying man-machine modeling tools. A microSAINT model of the weapons system director's commit task was useful in evaluating task decomposition software. Several technology transfers were completed using software products from the Office of Military Performance Assessment Technology.
APPENDIX

Plans, Reports, and Presentations
PLANS

Since 1993 is the last year of the four year effort a final report will be prepared to summarize all experimental results and document all work completed from 1990 through 1993.

The final report on the comparative effects of antihistamines on individual performance measures of AWACS weapon directors will be completed and submitted for review in Spring of 1992. This is the last report in that series of studies conducted in 1990.

After Alpha software testing is completed for the Synthetic Task (SYNTAS) workstation under MIPR 90MM0502, formal Beta testing will begin. Several applications are planned for SYNTAS that will highlight the unique features of this new OMPAT product.

Near-term plans for late summer of 1993 include conducting a large scale continuous operations study using the SYNTAS workstation on the DARPA Distributed Simulation Internet. We will transfer SYNTAS technology to DOD Thrust 6 - Synthetic Environments for Modeling and Simulation. The long term plans for the SYNTAS workstation will be used to emulate critical job functions of military personnel that are subjected to radiation exposure (anti-emetic drug development) during nuclear attack.
REPORTS


Interim Reports:


PRESENTATIONS


Briefings to Distinguished Visitors:

DOD

Dr. Monetta, Director of Research & Advanced Technology DDR&E
Dr. Bachkosky, Deputy Director, DDR&E
RAdm Kollmorgan, DARPA/SIMNET
Dr. Neyland, Director WARBREAKER
Dr. Young, HDQ DNA/RARP

Army

Dr. Hegge, Director OMPAT
Dr. Elsmore, Deputy Director OMPAT
LtCOL Penetar, AMRDC
Maj Curling, USANCA

Air Force

Lt. Gen. Searock, Vice Commander AFMC
Brig. Gen. Anderson, Commander, Human Systems Center
Dr. Welch, Director, Armstrong Labs
Col. Schwender, Commander, Armstrong Labs
Dr. Abrahamson, USAF Chief of Science & Technology
Dr. Moore, Chief Scientist, Armstrong Labs
Dr. Wolbers, Chairman, AF Scientific Advisory Board

Navy

RAdm Hugh Scott, Director, OP932, Pentagon
Capt Flynn, USN, Commander, NMRDC
Capt Chaput, USN, Navy ASBREM Secretariat
Capt Mateczun, USN, Commander, NAMRL

Foreign

Air Vice-Marshall John Ernsting, England