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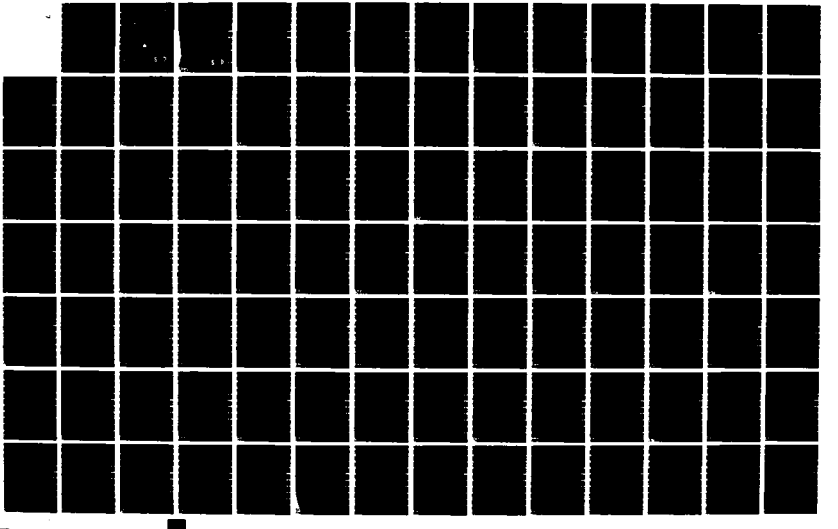

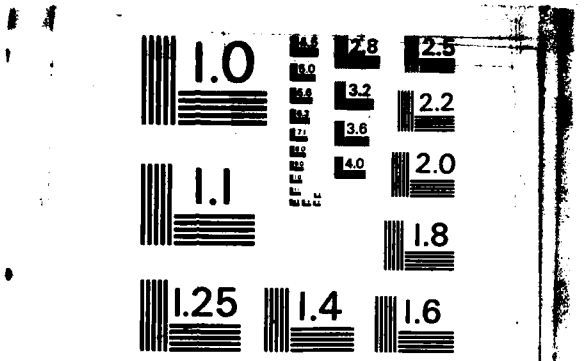

DEAN OF FACULTY

UNITED STATES AIR FORCE ACADEMY, COLORADO

Annual Research Progress Report No. 11

July 1976

COVERING PERIOD

1 July 1975 - 30 June 1976

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Covering Period

1 July 1975 - 30 June 1976

This is the fifth published Annual Research Progress Report; the editions previous to 1972 were published as Semi-Annual Progress Reports. Further information desired on any project may be obtained by writing to the department listed for the principal investigator, USAF Academy, Colorado 80840

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1. Aerodynamic Characteristics of Glide Bomb Configurations

Principal Investigator: Lt Col William A. Edgington, Department of Aeronautics

Associate Investigators: Maj Robert G. Lorenz, Department of Aeronautics; Cadet William R. Vrastil, Class of 1976

Sponsored by the Air Force Armament Laboratory, Eglin AFB, Florida

The possibility of using a folding, flexible wing on a glide bomb is attractive from the viewpoint of storage volume; however, there are questions as to whether aerodynamic and stability penalties would be incurred as a result of using a flexible planform. Tests were conducted in the USAFA 2' x 3' subsonic wind tunnel. The results indicate that use of a flexible wing will result in some degradation in L/D and that the angle of attack for $(L/D)_{max}$ is unacceptably high. No appreciable stability penalties were noted.

2. Glide Bomb Aerodynamics

Principal Investigator: Capt Frederick M. Jonas, Department of Aeronautics

Associate Investigator: Cadet Michael Woodman, Class of 1976

Sponsored by the Air Force Armament Laboratory, Eglin AFB, Florida

The Air Force Armament Laboratory is currently conducting research into Maneuvering Air-to-Surface Submunitions (MASS). The submunitions should be stable in the pitch, yaw, and roll modes. Experimental investigations were conducted in the USAFA 2' x 3' Subsonic Wind Tunnel

to determine the static stability and gliding characteristics of proposed high wing MASS configurations. One part of the investigation centered on the location of wing dihedral for optimum roll stability as well as maximum lift-to-drag ratio (L/D). Once this was determined the remainder of the effort centered on improving L/D with different boattail (afterbody) shapes as well as varying the tail configurations. All configurations were statically stable in pitch, yaw, and roll. The results of the above investigations were presented to the sponsoring organization in a briefing given by Cadet Woodman at Eglin AFB during March 1976.

3. Rolling Moment Induced by a Rotating Wing

Principal Investigator: Lt Col William A. Edgington, Department of Aeronautics

Associate Investigator: Cadet Carl W. Nuzzo, Class of 1976

Sponsored by the Air Force Armament Laboratory, Eglin AFB, Florida

A theoretical method for determining the rolling moment that is induced by a flat plate wing rotating 90° from a stored position along the body axis to the normal flight position. Rolling moment increments from both the angular velocity and the asymmetric position are investigated. Experimental data for the same conditions has been obtained in the USAFA 2' x 3' Subsonic Wind Tunnel for evaluation of the theory.

4. Wind Tunnel Tests of a 0.2 Scale Maneuvering Air to Surface Submunition (MASS)

Principal Investigator: Lt Col William A. Edgington, Department of Aeronautics

Sponsored by the Air Force Armament Laboratory, Eglin AFB, Florida

Wind tunnel tests were conducted on 0.2 scale Maneuvering Air to Surface Submunition (MASS) at Mach numbers of 0.31, 0.77, 0.91 and 0.97. The same model was tested in tunnel 1T at the Arnold Engineering Development Center and comparisons were made between the resulting coefficients. Results of the comparison indicate that the data from both wind tunnels are in close agreement. Additional tests were conducted at the USAFA to investigate the static stability of this configuration. Unstable modes were detected in yaw and roll.

5. Flow Field Behind Aerodynamic Fences

Principal Investigator: Maj Richard F. Felton, Department of Aeronautics

Associate Investigators: Cadet Charles L. Lindsay, Class of 1976; Cadet David N. Hatfield, Class of 1976

Sponsored by the Air Force Weapons Laboratory, Kirtland AFB, New Mexico

The Airborne Laser Laboratory is a specially configured NKC-135 aircraft being developed by the Air Force Weapons Lab. A laser is mounted in the fuselage of the aircraft and the laser beam exits the aircraft through a turret on top of the fuselage. Acoustic vibration required the use of an aerodynamic fence (perforated plate, screen) around the circumference of the turret opening. As propagation of the laser beam is a strong function of the density variation, the flow field created by the aerodynamic fence may cause attenuation problems. Experiments are being conducted in the Academy's trisonic wind tunnel to investigate the flow field created by perforated plates. Preliminary results have been used by the Air Force Flight Dynamics Lab in

preparation for larger scale tests. Present work is concerned with the flow field inside a cavity surrounded by an aerodynamic fence.

Publications

"Flow Field Visualization Behind Perforated Spoilers," DFAN TM 76-1, Jan 1976.

6. Roll Reversal in Canard-Configured Missiles

Principal Investigator: Capt Michael L. Smith, Department of Aeronautics

The armed forces are interested in designing a missile which utilizes canards as the primary movable control surfaces. They would be located forward, near the guidance and control system, thus allowing the missile to be constructed in a modular manner thereby increasing the flexibility of each missile.

Wind tunnel tests previously conducted by the Department of Aeronautics and others indicate that roll control using canards suffers a reversal phenomenon at high angles of attack due to interaction of body- and canard-generated vortices with the tail fins. Further experimental activities are being carried out by DFAN to explain the phenomenon. Currently, flow separation is being investigated about a missile model without fins or canards. The present method uses oil flow visualization. Experiments planned for this summer will use pressure taps on the body surface to define the flow separation points as a function of angle of attack and data from both sets of experiments will be correlated. Similar experiments will be conducted with canards and fins in place.

7. The Flow Dynamics of Unsteady Separated Regions

Principal Investigators: Maj James D. Lang, Department of Aeronautics; Capt Michael S. Francis, Frank J. Seiler Research Laboratory (AFSC)

Associate Investigator: Capt John P. Retelle, Jr., Air Force Institute of Technology, University of Colorado

Sponsored by the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

A combined analytical and experimental investigation is underway to determine the nature and details of the flow physics in an unsteady separated region above a lifting airfoil. Wind tunnel experiments employing a wing with an oscillating fence type spoiler are being used to verify the theoretical results and provide an understanding of the basic physical mechanisms. This knowledge will provide the basis for the generation of improved mathematical models which describe elements of the flow field and aid in the prediction of loading. Extension of the analysis to other related problems such as dynamic stall, is being investigated.

Publications

"Flow Characteristics of the USAF 2 ft x 3 ft Subsonic Wind Tunnel," Frank J. Seiler Research Laboratory Technical Memo-7905-1, October 1975.

"The Measurement of Spatial Vorticity Distributions Using Hot-Wire Anemometry Techniques," Frank J. Seiler Technical Report-76-0007, April 1976.

"The Interaction of an Oscillating Control Surface with an Unsteady Separated Region," (To be published in the Journal of Aircraft.)

8. An Undergraduate Propulsion Sequence

Principal Investigator: Prof Gordon C. Oates, Department of Aeronautics

Associate Investigators: Col Daniel H. Daley, Major John M. Fabian, Capts Howard M. Brilliant and Carl H. Steiling, Jr., Department of Aeronautics

Sponsored by the USAF Academy

The purpose of this work is to develop a comprehensive set of notes which fully portray an undergraduate two-course sequence in propulsion. During this period, the first course in the sequence was completed. Notes for the second course, covering more advanced material, are currently in rough form and will be completed by the end of the Fall Semester 1976.

Publications

"Notes on Rockets and Airbreathing Engines," DFAN TN 76-1, May 1976.

9. Boundary Layers in Axially Symmetric Nozzle Flows

Principal Investigator: Major John M. Fabian, Department of Aeronautics

Associate Investigator: Prof Gordon C. Oates, Department of Aeronautics

Sponsored by the USAF Academy

The problem of describing the boundary layer existing inside a conical surface due to the presence of a swirling flow through the cone was considered. Approximate solutions based upon the Karman Pohlhausen method were obtained for both laminar and turbulent cases. The results appear valid for any degree of swirl in the flow.

Publications

"The Boundary Layer Inside a Conical Surface Due to a Swirling Flow with Throughflow," (Accepted for publication in the Journal of Applied Mechanics).

10. Jet Engine Particle Separators

Principal Investigator: Major John M. Fabian, Department of Aeronautics

Associate Investigator: Prof Gordon C. Oates, Department of Aeronautics

Sponsored by the USAF Academy.

The behavior of small particles in various swirling flow fields representative of the flows in particle separators was considered. The physics of the interactions was investigated, and calculational methods were developed for describing the particle trajectories. The analysis was applied to a conical separator and to a helicopter engine separator design already in use. The results closely match the measured performance of the separator, indicating that the analysis should be of use for design purposes.

Publications

"Analysis of Flows within Particle Separators," (Submitted to the Journal of Fluids Engineering).

B. Department of Astronautics and Computer Science

1. The Data Administrator's Handbook

Principal Investigators: Major Anthony J. Winkler, Major Donald G. Pursley and Major John A. Zingg, Department of Astronautics and Computer Science; Mr. Jack Catalano (ESD/MCS), and Major Robert J. Tufts (AFDSC/GLD)

This report defines the role of the Data Administrator throughout the life cycle of a data management system. This role encompasses the functions of data base design, data base creation, data base integrity, data base efficiency, and data base administration. The report describes the problems that the Data Administrator may encounter, and the tools which are available to help solve those problems. It does not present solutions, because the solutions are dependent on the particular application involved, and the environment within which the Data

Administrator must perform his functions.

2. The Effects of Response Time on User Performance and Satisfaction in a CAI Environment

Principal Investigators: Lt Col George H. Walther, Captain James Legg, Department of Astronautics and Computer Science

Sponsored by Advanced Research Projects Agency (ARPA) of the Department of Defense

When users of a computer-assisted instruction (CAI) system do not have quasi-immediate response time, does the slower system response have any adverse effects on the user's performance or his satisfaction indices? To answer this question, a study was designed using PLATO IV's CAI system. Three plasma display terminals were connected remotely to that system at the University of Illinois at Champaign-Urbana via long-distance telephone circuits. Approximately 175 cadets were involved as subjects, half of them playing three Startrek games against the computer, the other half taking three French lessons as an adjunct to an academic course in French at the USAF Academy. Four levels of response time, ranging from quasi-immediate to fifteen seconds, were tested. One-half of the subjects also received "advisory messages" informing them what their response time was and suggesting that it was a function of the number of users on the system, telling them the exact number at that moment. Standard psychometric measures were used to assess each user's state anxiety, hostility, and attitude toward the computer at the end of the three sessions. A four-way Analysis of Variance program was written to analyze the results, and that analysis is still in progress.

3. Development of a 4-Way Analysis of Variance System

Principal Investigators: Captain James R. Legg, Department of Astronautics and Computer Science, and C2C Grady Booch

Sponsored by DOD/ARPA

A computer program was developed to accomplish up to a 4-way Analysis of Variance with the unequal-N data option. The program is interactive with the user and provides variable user-oriented output products. The system was designed to handle general problems with unequal sample sizes and will be made a library package on the B6700. The development of this system came primarily as a requirement to analyze the data from the PLATO IV system response time project; however, the program was designed and has evolved to handle any 4-way or smaller Analysis of Variance problems and all sub-analysis tables are printed when applicable.

4. ALGOL Procedures for Detection of Deadlocks among Parallel Processes

Principal Investigator: Captain Alan Gilkes, Department of Astronautics and Computer Science

The investigator has developed a set of ALGOL procedures which is functionally similar to Burroughs 6700 ALGOL intrinsic procedures such as: PROCURE, LIBERATE, WAIT, And CAUSE. These procedures facilitate communication between several computational processes (programs) which are executing simultaneously and are sharing the same data resources. However, in addition to the typical communication functions, these procedures detect, report and correct situations in which a process which is attempting to wait for a resource will cause a deadlock by so waiting.

These procedures directly support the teaching of multiprocessing in Comp Sci 483, and the development of computer programs which use multiprocessing.

The investigator's current activity is further testing and documentation of these procedures.

5. Visual Representation of Network Symmetry

Principal Investigators: Major Lawrence E. Druffel, Department of Astronautics and Computer Science, and ClC R. L. Brozovic

When working with graphs and networks, it is useful to visually display the symmetry of the graph. Symmetry is mathematically defined by the automorphism structure of the graph which in turn is summarized by the autree (tree representation of all automorphisms). However, visual symmetry is not precisely defined. The purpose of this effort is to investigate ways of interpreting the autree to visually display the symmetry. This research is in the preliminary stages.

6. Configurable Microprocessor Array

Principal Investigators: Major Lawrence E. Druffel, Department of Astronautics and Computer Science, and Captain Alan Klayton, RADC

Sponsored by Rome Air Development Center (RADC)

The highly competitive nature oi computer development prevents industry from discussing future systems with the academic and government communities. Because of long procurement cycles for large systems, DoD must often plan for future systems with insufficient knowledge of

future systems. Therefore, this study explores the concept of a Configurable Microprocessor Array which would permit emulation and performance evaluation of a given computer architecture. The project is in the preliminary investigation stage.

7. Artificial Intelligence Research

Principal Investigator: Capt R. H. Toews, Department of Astronautics and Computer Science

This research project is a continuation of individual research in Artificial Intelligence done by the principal investigator for several years. Its specific goal is to merge present day computer technology with information gathered on animate neurological processes to produce a methodology of building computer systems which exhibit high-level intelligence.

Most of this academic year was spent studying the B6700 to determine how its capabilities can be applied to the emulation of an "intelligent" machine. In addition, a high-level design has resulted in the following criteria. First, the machine will be goal-oriented rather than task-oriented. Second, the machine will constantly strive to form a logical model of the external world. Third, man-machine communications will be in ordinary English language syntax. Finally, the machine's information structures will be designed for multi-processing by any number of processors.

The design is still in progress, however the first model is expected to be running on the B6700 by spring 1977.

Publications

"A Backtracking Algorithm for Testing Vertex-Induced Subgraphs," published in the Proceedings of the 13th Annual Allerton Conference on Circuit & System Theory, Oct 1975.

C. Department of Chemistry and Biological Sciences

1. Chemiluminescent Gas Phase Reactions

Principal Investigator: Captain William E. McDermott, Department of Chemistry and Biological Sciences

Associate Investigators: Captain Richard E. Lotz and Captain Myron DeLong, Department of Chemistry and Biological Sciences, Captain David M. Thomas, Department of Physics, Cadets David Jareo and Douglas Loverro, Class of 1976

Sponsored by the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

Work during this reporting period has been directed in three general areas. These are: chemical production of singlet oxygen, measurement of singlet oxygen concentrations via electron paramagnetic resonance, and calibration of a phase sensitive photometric detection system.

Chemical generation of the first excited state of molecular oxygen is achieved via the heterogeneous reaction between gaseous Cl_2 and basic H_2O_2. A wall coated reactor was designed which allows steady production of singlet oxygen for a period of several minutes. This generator has produced yields of singlet delta oxygen in excess of 11%. This is the highest reported chemical yield.

The measurements of excited oxygen are being made utilizing the Electron Paramagnetic Resonance Spectrometer in the Department of Physics. This instrument has been calibrated to yield absolute concentrations of excited oxygen to within 3%. The flowing afterglow of

a microwave discharge in oxygen is also being investigated to verify the kinetic model of the proposed oxygen-iodine transfer laser.

A phase sensitive photometric system has been set up and calibrated in the spectral range from 360 - 1100 nm. This apparatus will be used to identify possible chemical laser candidates in metal/oxidant ternary flames.

Publications

McDermott, William E. and John T. Viola, "Efficient Chemical Production of Singlet Delta Oxygen", FJSRL (NC) Technical Memorandum TM 76-5, January, 1976.

2. Energetic Plasticizer and Binder Synthesis Via Organic Triflate Intermediates

Principal Investigators: Captain Scott A. Shackelford, Frank J. Seiler Research Laboratory (AFSC), and Captain Walter B. Avila, Department of Chemistry and Biological Sciences

Associate Investigator: Cadet Gregory L. Vitalis, Class of 1976

Sponsored by Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

New/improved energetic plasticizer or binder materials for potential plastic-bonded munitions or for solid fuel propellant applications are desired to increase the energy output in these volume/weight limited systems. Polynitroaliphatic compounds offer excellent properties as energetic plasticizer and/or binder materials; however, the direct synthesis of certain polynitroaliphatic chemical structures is exceptionally limited. Certain trifluoromethanesufonate (triflate) compounds can potentially form intermediate compounds possessing the desired chemical structure which cannot be synthesized by direct

polynitroaliphatic chemical methods. Generally, the triflate group ($-OSO_2CF_3$) is easily displaced by polynitroaliphatic groups to form the desired polynitroaliphatic derivative.

Work during this period focused upon a convenient synthesis of vicinal-1,2-polynitroaklyl materials from vicinal-1,2-ditriflate intermediate compounds. The stereochemistry of such chemical transformations was also considered.

Reaction between an organic epoxide and triflic anhydride was successfully demonstrated to produce a vicinal-1,2-ditriflate intermediate in reasonably good yield. While ethylene oxide produced 1,2-ethanediditriflate when reacted with triflic anhydride in methylene chloride, better results were obtained using diethyl ether as a solvent. The 1,2-ethaneditriflate conversion to the vicinal polynitroalkyl derivative has been a problem to date. Stereochemical investigations have just been initiated.

Research is continuing with other epoxide compounds to determine whether the conversion of vicinal 1,2-ditriflate intermediates is uniquely difficult only in the 1,2-ethaneditriflate system, or whether the vicinal 1,2-ditriflate structure itself is inherently stable toward polynitroalkyl derivatization. The stereochemistry of epoxide conversion to the 1,2-ditriflate intermediates will also be addressed using the rigid, cyclic epoxide, cyclohexene oxide.

3. Pelletized Thermal Batteries

Principal Investigators: Lieutenant Colonel Lowell A. King, Captain John K. Erbacher, and First Lieutenant Charles L. Hussey, Frank J. Seiler Research Laboratory (AFSC), and Lieutenant Colonel David W. Seegmiller, Department of Chemistry and Biological Sciences

Sponsored by the Frank J. Seiler Laboratory, Air Force Systems Command (AFSC)

Studies are being made on single cell pelletized thermal batteries utilizing electrolytes of molten aluminum chloride-sodium chloride mixtures. Anodes were made of aluminum, lithium, or aluminum-lithium alloys. Studies on aluminum and aluminum-lithium alloys have been essentially completed. A variety of cathodes have been investigated; two especially promising cathode systems for pellet cells, copper chloride and molybdenum pentachloride, are presently being examined. Work on the $CuCl_2$ system is essentially complete and a final paper in preparation. A joint study with R.A. Osteryoung at Colorado State University on $MoCl_5$ behavior in $AlCl_3$/NaCl melts is now in progress.

Publications

Hussey, C.L., J. K. Erbacher, L. A. King, "Progress Report on High Energy Density Pelletized Aluminum Chloride Thermal Battery Research", FJSRL (NC) TM-75-4, August, 1975.

Brabson, G. D., J. K. Erbacher, L. A. King, D. W. Seegmiller, "Exploratory Aluminum-Chloride Thermally Activated Battery: Single Cell Experiments", SRL-TR-76-0002, January, 1976.

Hussey, C. L., J. K. Erbacher, L. A. King, "High Energy Density Pelletized Aluminum Chloride Thermal Batteries", SRL-TR-76-0003, January, 1976.

King, L. A., G. D. Brabson, J. K. Erbacher, D. W. Seegmiller, A. A. Fanning, Jr., J. T. Viola, "Aluminum-Chloride Thermal Battery", Invention Disclosure; in final draft; to be submitted for patent applications.

4. Electrode and Electrolyte Physical and Electrochemical Measurements

Principal Investigators: Lieutenant Colonel Lowell A. King, First Lieutenants Charles L. Hussey and Ronald A. Carpio,

Frank J. Seiler Research Laboratory (AFSC), and Lieutenant Colonel David W. Seegmiller and Major Armand A. Fannin, Jr., Department of Chemistry and Biological Sciences

Sponsored by the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

Primary efforts during this period have been directed to the following areas: (1) physical property measurements on aluminum chloride, sodium chloride/aluminum chloride, and potassium chloride/aluminum chloride systems, (2) aluminum anode studies, and (3) mathematical reduction of physical property data. Specific accomplishments in each of these areas are given below beginning with physical property measurements. Additional data have been taken to complete the $AlCl_3$/NaCl/KCl ternary phase diagram. These measurements are aimed at providing selected low temperature (down to 100°C) electrolytes. Continuing studies of the anomaly in the triple point region of pure $AlCl_3$ are directed toward collecting sufficient data to define the behavior and determine the physical phenomena involved. Present studies involve comparison of samples with different thermal histories.

Reduction of physical property data using minimum distance fitting is continuing. This fitting process has been used for P-V-T relationships for saturated and unsaturated aluminum chloride vapor and to define the $AlCl_3$ triple point. Characterization of the $AlCl_3$/KCl/NaCl phase diagram will be completed using this technique.

Galvanostatic pulse studies of aluminum electrodes as a function of melt acidity are being conducted to give information on the actual processes occurring at the electrode.

Publications

Fannin, A. A., Jr., L. A. King, "Minimum Distance Least Squares Surface Fitting", SRL-TR-75-0020, December, 1975.

Viola, J. T., D. W. Seegmiller, A. A. Fannin, Jr., L. A. King, "Vapor Pressure of Aluminum Chloride Systems. I. Saturated Vapor Pressure of Solid and Liquid Aluminum Chloride", submitted for publication in J. Chem. Eng. Data.

Viola, J. T., A. A. Fanning, Jr., L. A. King, D. W. Seegmiller, "Vapor Pressure of Aluminum Chloride Systems. II. Pressure of Unsaturated Aluminum Chloride Gas", submitted for publication in J. Chem. Eng. Data

5. Aluminum Matrix-Trialuminum Nickelide Separation

Principal Investigators: First Lieutenant Charles L. Hussey, Frank J. Seiler Research Laboratory (AFSC) and Captain J. C. Nardi, Department of Chemistry and Biological Sciences, and Captain J. R. Clifford, Department of Physics.

Sponsored by the Frank J. Seiler Laboratory, Air Force Systems Command (AFSC), Air Force Cambridge Research Laboratories (AFSC) and Rome Air Development Center (AFSC).

The electrolytic separation of aluminum from a matrix of aluminum containing trialuminum nickelide (Al_3Ni) fibers has been successfully demonstrated in both high temperature and room temperature aluminum chloride ($AlCl_3$) containing melts. Equimolar NaCl-$AlCl_3$ at 175°C and 1:2 ethylpyridinium bromide-aluminum chloride at 25°C have been employed. The latter is recommended for industrial scale applications because of its ease of preparation and maintenance.

Studies are in progress to examine the relationship between current density and electrolytic attack on the Al_3Ni fibers using coulometry and electron microscopy. Problems arising from impurities both in the 1:2 ethylpyridinium bromide-aluminum chloride melt and in the aluminum matrix itself are being investigated.

6. Detonation Property Prediction and Modeling

Principal Investigator: 1st Lt. R. Martin Guidry, Department of Chemistry and Biological Sciences.

Sponsored by the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC).

Work during this reporting period has focused in three general areas: (1) The Becker-Kistiakowsky-Wilson (BKW) Equation of State; (2) numerical calculations of explosive behavior and (3) mathematical treatment of shock initiation phenomena. A summary of the work performed in the last two areas is presented under DFP and DFMS.

The BKW Equation is an empirical equation of state historically used to predict detonation pressure and velocity at the Chapman-Jouget (CJ) point. Incorporated into the equation are four empirical parameters (α, β, κ, Θ) and a set of specie covolumes. The purpose of this investigation was to reparameterize the BKW Equation of State such that one set of parameters would be adequate for all explosives and such that product composition data would be adequately predicted. A series of six explosives for which experimental detonation pressures, velocities and product composition data are known were used.

A successful parameterization of the BKW Equation of State was accomplished. One set of parameters was found to adequately fit both high and low solid carbon explosives as well as ideal and non-ideal explosives. Furthermore, not only were detonation product composition data adequately predicted, but detonation velocities and pressures were calculated. These calculations generally fit within 5% or better of experimentally measured data.

Publications

A presentation of the above work coupled with work from Lawrence Livermore Laboratory at Livermore, CA, will be presented at The Sixth Symposium (International) on Detonation on 24-27 August 1976 in San Diego, CA.

7. Simultaneous Monitoring of Climate and Air Pollutants at USAFA

Principal Investigators: Major Samuel P. Finch II, Captains John C. Nardi and William G. Thorpe, and C1C Robert Bivins; Department of Chemistry and Biological Sciences.

Data are being provided by civil and military agencies to evaluate the effects of weather on the pollution in the USAFA/Colorado Springs area. Pollution readings for CO, NO, NO_2, and O_3 are provided by the Colorado Springs and El Paso County combined Health Departments. Local weather data are provided by the Weather Detachment at the Air Force Academy air field, Peterson Air Force Base, and Fort Carson's Butts Air Field. These data are recorded hourly, and stored on computer tape.

8. Lead as an Indicator of Environmental Quality in Airport Environs

Principal Investigators: Major Charles E. Thalken, Lieutenant Colonel Lawrence R. Klinestiver, and Captains Michael J. Moran and Alvin L. Young, Department of Chemistry and Biological Sciences.

Associate Investigator: Cadet William D. Metzler, Class of 1976.

Sponsored by Frank J. Seiler Research Laboratory (AFSC).

This is a continuing project to obtain data on the concentration of lead in soils, vegetation, and animals found associated with the Air Installation Compatibility Use Zone (AICUS) of Peterson Field, Colorado Springs, Colorado. During FY 76, a Model 306 Perkin-Elmer Atomic Absorption Spectrophotometer was modified with a HGA-2100 Graphite

Furnace and a Deuterium Arc Power Supply in order to determine lead at the microgram/gram (μg/g) detection level. Soil and vegetation samples were collected from a control site on the Air Force Academy and from land adjacent to the Academy air strip. Soils from the control area had levels of lead from 2.18-2.64 μg/g, while those from near the airstrip had lead levels of 3.11-6.93 μg/g.

9. Lipids and Lipoproteins in USAF Academy Cadets

Principal Investigators: Lieutenant Colonel Eugene L. Arnold and Captain Gerlad L. K. Bargren, Department of Chemistry and Biological Sciences.

Sponsored by the Aerospace Medical Division/RDOP (AFSC).

This research was begun in 1972 as a cooperative effort between USAFA and the USAF School of Aerospace Medicine, Brooks AFB, Texas. The goals of the study were to assess factors associated with coronary heart disease in a randomly-selected group of 250 cadets from the entering Class of 1976. Nutritional patterns, blood chemistries, and physical characteristics were measured three times annually for a period of four years. While 234 cadets volunteered for the study, complete data were collected on only 130 members of this group. Loss of subjects was due primarily to Academy attrition. At the completion of 12 of 13 measurement periods, several significant findings have been made.

As a group, average cholesterol levels in these subjects have decreased over the past four years. This is in vivid contrast with a similar study conducted with the USMA Class of 1956, where cholesterol levels increased markedly in these subjects during a similar four year period and continued to increase after graduation. With the positive

correlation between elevated serum cholesterol and coronary disease, this finding was indeed encouraging. A positive correlation was also observed between periods of stress (academics, hell week, and Basic Cadet Training) and average cholesterol and uric acid levels. This finding may be useful in diagnosing emotional stress when the patient (subject) is not aware that he is under severe stress conditions. A third general finding was that there was an overall average weight increase in the subjects of this study. While this may not be unexpected, determinations of body fat revealed there was an unexpected decrease in this parameter. Apparently, this weight increase was due to an increase in muscle tissue rather than in fatty deposits. Overall, the data from this study tend to lend support to the current diet and physical conditioning programs at USAFA. Other findings will undoubtedly be forthcoming after all the data have been evaluated.

10. Determination of Parameters for a Model of Environmental Quality for USAF Installations

Principal Investigators: Captain Lawrence J. Biever and Alvin L. Young, and Major Manuel A. Thomas, Department of Chemistry and Biological Sciences.

Sponsored by Frank J. Seiler Research Laboratory (AFSC).

The major effort on this project this year has been to determine what effects non-potable sewage effluent have on ecosystems (e.g., parade fields and golf course) where it is used for irrigation. Data collected so far indicate that inclusions in the water are causing a unfavorable shift in species composition of grasses and are causing damage to tree species. The non-potable irrigation water includes high concentrations of phosphate, nitrate, chlorine, salt, and many heavy

metals, Soil analysis indicated progressive changes in soil chemical composition that may result in degradation of soil quality. Continuation of the program is being proposed to further delineate cause and effect relationships and to provide corrective measures.

11. An Evaluation of Current Capabilities in Genetics and Molecular Biology

Principal Investigators: Captain Lawrence J. Biever, Captain Alvin L. Young, Lieutenant Colonel Eugene L. Arnold, and Major William C. Wilson, Department of Chemistry and Biological Sciences.

Sponsored by the Defense Intelligence Agency.

This study has been initiated to determine the state-of-the-art of current biological technology. An evaluation of the results of the application of current biological research to agriculture, industry, medicine, and the military has been made. The study included an evaluation of the international political, economic, social, and military impact of technological developments in biology.

Data collected from current literature and contacts with researchers has been evaluated by DFCBS personnel. An interim report has been submitted. The final report will be submitted in June, 1976. A follow-on project has been proposed by the sponsor.

12. Disposal of Herbicide Orange by Soil Incorporation and Biodegradation

Principal Investigators: Captain Alvin L. Young, and Lieutenant Colonel Eugene L. Arnold, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

In August 1972, a site for soil incorporation of 2,4-D and 2,4,5-T herbicides was selected on the Air Force Logistics Command Test Range Complex, Hill Air Force Base, Utah. The site was considered

remote and the land of low-use potential. It was characterized by sandy loam soil with a pH of 8.0 and an organic carbon content of 0.95 percent. The herbicide formulation contained equal amounts of the n-butyl esters of 2,4-D and 2,4,5-T and was applied by simulating subsoil injection at rates as high as 4,000 lbs ai/A. The replicated plots were periodically sampled and the concentration of ester and acid forms of the herbicides was determined by gas-liquid chromatography. Levels of the toxic contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were also measured in certain selected samples. Degradation of both ester and acid form of each herbicide was initially rapid (1st year) but tended to taper off in succeeding years. Strict exponential decay kinetics were not followed. Application rate had only minimal effect on the rate or pattern of degradation. The rate of disappearance of 2,4-D was slightly higher than that for 2,4,5-T. In those samples in which it was measured, significant degradation of TCDD was also noted. Soil penetration of the herbicides as either acid or ester forms was negligible.

Publications

Arnold, E. L., A. L. Young, and A. M. Wachinski. 1976. Three years of field studies on the soil persistence and movement of 2,4-D, 2,4,5-T and TCDD. Presentation to the Weed Science Society of America, 3 February 1976, Denver, Colorado. Abstract No. 206.

Arnold, E. L. and A. L. Young. 1976. A rapid gas chromatographic method for the determination of phenoxy herbicide residues from soil disposal plots. Journal of Agriculture and Food Chemistry. In Press.

13. Ecological Studies on a Herbicide-Equipment Test Area (TA C-52A), Eglin AFB Reservation, Florida

Principal Investigators: Captain Alvin L. Young, and Majors Charles E. Thalken and Lorris G. Cockerham, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

During this past year species diversities and food chain studies were conducted in two aquatic ecosystems draining the unique one-square mile military test area (Test Area C-52A, Eglin AFB, FL) that received 160,948 lbs 2,4,5-T and 169,292 lbs 2,4-D herbicide during the period 1962-1970. Significant levels (10-710 parts per trillion, ppt) 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were found within the top six inches of the test area soil. Erosion of soil occurred into a pond on the test area and into a stream immediately adjacent to the area. TCDD levels of 10-35 ppt were found in silt of the aquatic systems, but only at the point where eroded soil entered the water. Species diversity studies of the stream were conducted in 1969, 1970, 1973 and 1974. Insect larvae, snails, diving beetles, crayfish, tadpoles, and major fish species from both aquatic systems were analyzed for TCDD. Species diversity studies indicated no significant change in the composition of ichthyofauna between these dates or a control stream. Concentrations of TCDD (12 ppt) were found in only two species of fish from the stream, Notropis hypselopterus, Gunther (sailfin shiner), and Gambusia affinis, Baird an Girard (mosquitofish). Samples of skin, muscle, gonads, and gut were obtained from Lepomis punctatus, Valenciennes (spotted sunfish), from the test grid pond. Levels of TCDD in those body parts were 4,4,18 and 85 ppt, respectively. Gross pathological observations of the sunfish revealed no significant lesions or abnormalities.

Publications

Young, A. L., C. E. Thalken, and W. E. Ward. 1975. Studies of the ecological impact of repetitive aerial applications of herbicides on the ecosystem of Test Area C-52A, Eglin AFB, Florida. AFATL-TR-75-142, Air Force Armament Laboratory, Eglin AFB, Florida.

Young, A. L., P. J. Lehn, and M. F. Mettee. 1976. Absence of TCDD toxicity in an aquatic ecosystem. Presentation of the Weed Science Society of America, 3 February 1976, Denver, Colorado. Abstract No. 107.

14. Radiochemical Bioassay of TCDD Uptake in Plant Material

Principal Investigators: Captains James M. Cupello, and Alvin L. Young, Department of Chemistry and Biological Sciences.

Sponsored by Frank J. Seiler Research Laboratory (AFSC), and Air Force Logistics Command/DS.

The Environmental Protection Agency currently limits the commercial use of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) herbicide due to the lack of environmental data on the teratogenic (birth-deforming) contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) found in many 2,4,5-T formulations. The consequence of such a use limitation directly affects the fate of a large USAF surplus inventory of Herbicide Orange (a2,4,5-T formulation).

In a study to determine potential plant uptake of TCDD, a 2,000 pounds per acre equivalent application of Herbicide Orange, containing 14 parts per million (ppm) C-14 labelled TCDD, was placed 4" beneath the soil surface in specially constructed growth boxes, containing 100 plants of Sorghum, Sorghum vulgare, per box. The plants were grown under controlled environmental conditions for a period of nine weeks, at which time they were harvested and assayed for TCDD uptake. Analysis of the plant tissue (exclusive of root systems) prior to hexane extraction, and

after hexane extraction for four hours in a Soxhlet extraction apparatus, indicated the presence of an amount of C-14 activity that was equivalent to 430 parts per trillion (ppt) of TCDD in the plant material. This represents the maximum amount of TCDD that could be present in the plant material, but could also represent (1) the preferential plant uptake of a minor impurity in the TCDD formulation that was applied to the soil; (2) a metabolic breakdown product that was formed in the plant material after TCDD incorporation; or (3) the preferential uptake of a soil decomposition or soil microbial degradation product of the original TCDD placed in the soil.

15. Ultrastructural Studies of Liver Tissue from TCDD-Exposed Beach Mice (Peromyscus polionotus)

Principal Investigators: Major Lorris G. Cockerham and Captain Alvin L. Young, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

In support of research on the biological effects of animals exposed to TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), ultrastructural studies were initiated on beach mice, Peromyscus polionotus, collected from a herbicide-equipment testing range (Test Area C-52 A, Eglin AFB, Florida). Liver tissue from 30 mice (from the test and a control area) were examined with an electron microscope for possible ultrastructural changes in mitochondria and smooth and rough endoplasmic reticulum. Similar data were collected from 22 mice brought from the field into the laboratory and exposed to 30 days of external dusting with alumina gel (with or without 2.5 ppb TCDD).

Five representative electron micrographs were made from the liver tissue of each animal and the data were obtained from each micrograph

using a technique known as "point counting". With this method, a transparent grid of intersecting lines was placed at random over the micrographs and all the line intersections which were over the required cell structures were counted. The total area of the cytoplasm was then measured in the same manner. An analysis of variance was conducted to determine whether there was a statistically significant difference between populations of cells, i.e., percentage mitochondria and smooth and rough endoplasmic reticulum, removed from experimental and control animals. Analysis of data indicated no statistical differences between field control and field treatment animals, although differences were noted between field and laboratory animals.

16. Ultrastructural Evaluation of Tissues Removed from Animals Exposed to TCDD

Principal Investigator: Major Glenn M. Buchanan, Department of Chemistry and Biological Sciences

Sponsored by the Frank J. Seiler Research Laboratory (AFSC)

A long-term study of the possible biological hazards of pelage exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) has been initiated on the beachmouse, Peromyscus polionotus. Animals were divided into three experimental groups: untreated controls, a "treated" control group dusted with diatomaceous earth, and a "treated" group dusted with diatomaceous earth containing 2.5 parts per billion TCDD. The animals were dusted three times per week; the TCDD concentration simulating an exposure that was twice that expected from normal rangeland application rates of 0.1 parts per million TCDD contaminated 2,4,5-T herbicide. The effect of TCDD on animal weight, blood components, and

cellular ultrastructure (adrenal cortex, testes, liver and kidney) will be investigated following completion of the study. Animal weight data collected over a nine-week period indicated no effect due to TCDD applications, relative to controls.

D. Department of Civil Engineering, Engineering Mechanics, and Materials

1. Backing Strength of Masonry Shear Walls

Principal Investigator: Captain Richard H. Jolley, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by the USAF Academy

Increased interest in using masonry for load-bearing structural systems has necessitated review of existing code design criteria and establishing improved design techniques. The objectives of this project are to (1) formulate a failure criteria for walls subjected to "in plane" loads and (2) establish a deflection prediction criteria for walls subjected to "in plane" loads.

The final report is complete and available to any agency or interested individual. Contact USAF Academy, DFCEM.

2. Validation of the Soil Stabilization Index System with Manual Development

Principal Investigators: Captains John J. Allen, and Dallas Little, and Technical Sergeant Glenn K. Kaneyuki, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by the Air Force Civil Engineering Center and the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

The project scope as detailed in Annual Research Progress Report No. 10 was extended to include required values of residual strength for

stabilized layers in airfield pavements. The three-dimentional finite element program was utilized for a wide range of pavement geometries and material properties. Design curves were prepared for residual strength after first freeze-thaw season.

The technical report was revised to include a chapter on strength requirements. Also included were design steps for utilizing the total design process for stabilized layers.

At the request of the Air Staff, work was begun on another section of the draft design manual. This section will outline the necessary steps for design of lime-cement-flyash mixes.

3. Polymer Tetherline Evaluation for Baloon Technology

Principal Investigator: Captain Donald L. Hausam, Department of Civil Engineering, Engineering Mechanics and Materials

Associate Investigator: Captain William J. McClelland, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by Air Force Geophysics Laboratories, Air Force Systems Command (AFSC)

Two cables made of Kevlar 29 were flight tested to 8000 feet at White Sands Missile Range, New Mexico, in November 1975. Both lines were rated at 7000 pounds minimum break strength. Post flight inspection and testing revealed that neither line suffered strength degradation due to the flights, but the Cortland line showed evidence of internal self-abrasion and the phillystran line had indications of manufacturing defects. Ground tests at White Sands in February 1976 on redesigned Cortland and Phillystran lines showed that these defects had been eliminated. Strength-to-weight comparisons of the two lines indicated

that the Cortland product was most favorable for the high altitude flight. Laboratory tests have shown that strength degradation of Kevlar 29 when exposed to ultraviolet rays is significant but controllable. Unprotected samples exposed to direct sunlight suffered 21 percent strength loss over a one year period, most of the loss taking place in the first three months. Protected samples (jacketed) lost no strength.

4. Solar Energy

Directors: Colonel Wallace E. Fluhr, Department of Civil Engineering, Engineering Mechanics and Materials; and Colonel Donald R. Reaves, Air Force Academy Deputy Chief of Staff for Civil Engineering

Principal Investigator: Major Marshall W. Nay, Jr., Department of Civil Engineering, Engineering Mechanics and Materials

Associate Investigators: Captains Jon M. Davis and Anthony Eden, Department of Civil Engineering, Engineering Mechanics and Materials; Major Richard N. Miller and Captain Roy L. Schmiesing, Department of Electrical Engineering; and First Lieutentnt William A. Tolbert, Air Force Academy Base Civil Engineers

Sponsored by the Air Force Systems Command (AFSC)

The project, Solar Heating Retrofit of Military Family Housing, has progressed to the point where significant performance data is being acquired. The Solar Test House construction, and instrumentation and control system installation was completed in November 1975. Work efforts have focused on optimizing the major controlling system variables. An additional two years of test and evaluation are planned.

5. Statics and Dynamics of Cables

Principal Investigator: Captain J. J. Russell, Department of Civil Engineering, Engineering Mechanics and Materials

Cables are used in a variety of ways, varying from actual structural uses such as cable trusses and nets for roof support to airborne uses such as target towing and antennae. This work has concentrated on using the finite element technique to study airborne or other applications in which the cable is subjected to aerodynamic loads. Theoretical and computer work to predict the equilibrium and stability of a cable towed by an aircraft in a circular path was completed.

Another area investigated was the equilibrium and stability of cables subjected to a steady state wind condition (or towed from an aircraft in a straight flight path) and the nonlinear forced response of each system.

Publication

The above article was published in conference proceedings and AIAA Journal

Presentation

Paper entitled "Equilibrium and Stability of a Circularly Towed Cable subject to Aerodynamic Drag" was presented at 17th Annual Structures, Structural Dynamics, and Materials Conference 4-7 May 1976.

6. Sublimation of Basal Faces of Zinc Oxide Single Crystals Under Ultraviolet Illumination

Principal Investigator: Major D. A. Carey, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by the US Office of Naval Research through the Ohio State University Research Foundation

Free evaporation experiments of zinc oxide single crystals were conducted in the 950 - 1050^{o} C temperature range at 10^{-6} torr.

Evaporation rates of the zinc (0001) and oxygen (000T) faces were measured using a vacuum microbalance and changes in these rates were detected during illumination with ultra-violet light. Studies of scanning electron photomicrographs of surface morphology both with and without illumination were correlated with a proposed mechanism of evaporation. With no illumination (dark), the evaporation rate of the zinc surface was 2-3 times that of the oxygen face at the same temperature. While illuminated, the rate of evaporation rate of the oxygen face increased, while that of zinc decreased. This behavior cannot be explained by a charge-transfer controlled process previously proposed for other noncentrosymmetric II-VI compounds, such as CdS.

7. Finite Element Analysis of Single Span Cables

Principal Investigator: Major W. M. Henghold, Department of Civil Engineering, Engineering Mechanics and Materials

The analysis of cable structures has been of interest for a number of years. The structures are generally elastic in nature but are highly nonlinear in their geometric sense. This effort concerns the finite element method as applied to cable structures. During this reporting period a family of nonlinear finite elements was developed. The class of elements developed retains all geometric nonlinearities and allows for any elastic deformation. A computer program was written which determines equilibrium shapes and natural frequencies for single span cables with arbitrary static loading including the effects of concentrated masses. Work is now in progress for the problems of system stability when subjected to steady wind and harmonic forcing.

Publications on Presentations

"Equilibrium and Natural Frequencies of Cable Structures (A Nonlinear Finite Element Approach)" by W. M. Henghold and J. J. Russell. Presented at the Second National Symposium on Computerized Structural Analysis and Design held at George Washington University on 28-31 March. The same paper has been selected for publication in Computers and Structures.

8. Lateral Dynamics Optimization of a Conventional Railcar

Principal Investigator: Major Joseph J. Cox, Jr., Department of Civil Engineering, Engineering Mechanics and Materials

PhD Dissertation, Arizona State University, Te-pe, Arizone, December 1975

The attempt to develop a railway vehicle that can operate in the 100 to 300 mph speed regime is seriously hampered by the problems of ride comfort, guidance on both tangent and curved track, adequate adhesion for traction, and the "hunting" phenomena. "Hunting," a sustained lateral oscillation that occurs above a certain critical forward velocity, caused large dynamic loads between the wheels and track and contributes to passenger discomfort. This research presents results of an effort to solve those problems by utilizing optimization procedures and both a three and fifteen degree-of-freedom models to design a high speed railway vehicle.

The reported results demonstrate that the primary suspension and the wheel conicity have the most profound influence on maximizing the critical speed. The optimum solution is also sensitive to values of the creep coefficients when the wheels are worn.

E. Department of Electrical Engineering

1. Troposcatter Communications Simulator

Principal Investigators: Captains Ed Pearsall, George Peterson, and Michael O'Brien, ClC Scott Von Tonningen

Sponsored by Air Force Communications Service

The objective is to develop a device which will simulate the statistical properties of a troposcatter communications system. The design incorporates a microprocessor to generate a digital signal with troposcatter statistical properties. Further design will result in converting the digital signal to analog and using the analog signal to vary the strength of a troposcatter signal.

2. Micro-Computer Solutions to the Time Difference of Arrival Problem

Principal Investigators: Major Warren H. Glenn, Captains Charles R. Wells, III and Richard A. Kowaleski, Department of Electrical Engineering

Sponsored by the Air Force Technical Applications Center/Headquarters Command

The goal of this project was to evaluate the feasibility of and requirements for utilization of a micro-computer to determine a geographical position based on the difference of arrival times of three signals. The principal effort consisted of developing a suitable algorithm, computer simulation to verify the algorithm, and evaluating the possible trade off between speed, accuracy, and micro-computer size.

The possibility of incorporating more than three signals is being investigated.

3. Study of Composite Materials in an Electromagnetic Environment

Principal Investigators: Lieutenant Colonel Oscar D. Graham, Major Jerry D. McCannon, Captain John E. Erickson, Department of Electrical Engineering

Sponsored by Rome Air Development Center Post-Doctoral Program, Air Force Systems Command

The goal of this research is to understand the behavior of a composite material when exposed to an electromagnetic environment. The composite material to be used for the study is graphite epoxy. A model will be developed for graphite epoxy in the form of a computer program. This program will be capable of providing field strengths for an antenna mounted over a graphite epoxy ground plane as well as expected terminal characteristics of the antenna itself. Experimental measurements will be made and the results correlated to the predictions of the computer model.

4. USAFA Solar Energy Program

Directors: Colonel Wallace E. Fluhr, Department of Civil Engineering, Engineering Mechanics and Materials; and Colonel Donald R. Reaves, Air Force Academy Deputy Chief of STaff for Civil Engineering

Principal Investigator: Major Marshall W. Ney, Jr., Department of Civil Engineering, Engineering Mechanics and Materials

Associate Investigators: Major Richard W. Miller and Captain Roy L. Schmiesing, Department of Electrical Engineering, Captains Jon M. Davis and Anthony Eden, Department of Civil Engineering, Engineering Mechanics and Materials; and First Lieutenant William A. Tolbert, Air Force Academy Base Civil Engineers

Additional Investigators: Captains Willie J. Honea, Roger R. Wells, Arthur R. Miller, Ronald A. De Yoe, and Richard A. Kowaleski; and C2C Michael L. Baumgartner, Department of Electrical Engineering

Sponsored by the Air Force Systems Command (AFSC)

The project, Solar Heating Retrofit of Military Family Housing, has progressed to the point where significant performance data is being acquired. The Solar Test House construction, and instrumentation and

control system installation was completed in November 1975. The follow-on test and evaluation phase began in December 1975. DFEE work efforts since then have focused on improving the instrumentation and control system and on data analysis.

5. Space Test Program Experiment Prioritization

Principal Investigator: Captain Raymond J. Leopold, Department of Electrical Engineering

Associate Investigator: Captain Steven K. Dingman, Department of Electrical Engineering

Sponsor: Director of Space, Headquarters USAF

The space test program (STP) involves the launch of DoD sponsored experiments with the Director of Space, USAF, as the executive agent for the DoD. Space test program experiments are secondary payloads that do not have sufficient priority for a dedicated launch. In the past there has been no formal rationale for the method of establishing the order of launch for these STP experiments. This investigation is providing the Director of Space with explicit criteria, procedures, and recommendations concerning STP priorities.

Presentations:

Presentations

Briefed to Staff and Scientists of Naval Research Laboratory, Washington, D.C., 10 July 1975.

Briefed to Staff and Scientists of the Cambridge Research Laboratory, Hanscom AFB, Massachusetts, 22 July 1975.

Briefed to Staff and Scientists of the Air Force Wright Aeronautical Laboratory, Wright-Patterson AFB, Ohio, 23 July 1975.

Briefed to Staff and Scientists of the Space and Missile Systems Organization, Los Angeles AFS, California, 24 July 1975.

Briefed to Director of Space at Headquarters USAF, Washington, D.C., 7 October 1975.

Presented to the Space Shuttle Utilization Conference, Space and Missile Systems Organization, Los Angeles AFS, California, 23 October 1975.

Formal presentation for the Director of Space and Senior DoD Staff, Headquarters USAF, 2 February 1976.

6. Digital Communications Performance Monitop

Principal Investigators: Captains Roy L. Schmiesing and Larry R. Kizer, Department of Electrical Engineering

Associate Investigators: Captain Charles E. Pearsall and C2C David Dimiduk, Department of Electrical Engineering

Sponsored by the Rome Air Development Center Post-Doctoral Program and AFCS

The goal of this project is to design a prototype performance monitor for digital communication system performance. An instrument that computes two new performance criteria: Recursive BER and Recursive EFS has been designed, constructed and delivered to the customer.

Publications

Captains Roy L. Schmiesing and Larry R. Kizer, "A Recursive Bit Error Rate Tester and Digital Performance Monitoring System", USAFA, 1975.

7. A Microprocessor Based Controller for an Isolation Pad

Co-Principal Investigators: Lieutenant Colonel David R. Carroll and Captain Arthur R. Miller, Department of Electrical Engineering

Sponsored by the Frank J. Seiler Research Laboratory

This study is in two parts. The first is software development, and the second is system hardware and interface design. Software development has proceeded on a National Imp-16 microprocessor. An evaluation of digital data processing on 16 bit versus 8 bit machines is being carried out.

8. Effects of Weightlessness on the Cardiovascular System

Principal Investigator: Lieutenant Colonel Richard J. Gowen

Sponsored by NASA

This research is a continuing program in support of NASA studies of the effects of the weightlessness of space upon the cardiovascular system. Activities during this period were directed toward the completion of the analysis of the Skylab Mission data and the development of a new generation of instrumentation using microprocessors. This microprocess instrumentation is commonly termed "smart instrumentation" and will incorporate the analysis algorithms essential for determining the data from space experiments. The design of a smart instrument to control the lower body negative pressure chamber has received the principal emphasis during this report period.

9. Management Model of the Military Health Care Systems

Principal Investigators: Lieutenant Colonel Richard J. Gowen and Captain Michael S. Anselmi

Sponsored by the Office of the Asst Secretary of Defense (OASD)

This project supported the OASD(M&RA) in the development of management options and recommendations for the Military Health Care Task Force. Economic and manpower models of the 133 military hospitals in the CONUS were developed and the results studied. This project led to summer research opportunities for cadets and faculty members, in addition to providing consultation to several offices in the DoD.

F. Department of Mathematical Sciences

1. Efficient Branch-and-Bound Algorithms for Permutation Problems

Principal Investigator: Capt John D. Maybee, Department of Mathematical Sciences

A methodology is presented for the development of efficient branch-and-bound algorithms for the solution of permutation type problems. The methodology utilizes computer CPO time as the measure of efficiency and it encompasses the stages of design, experimentation, and refinement. To exemplify the methodology, a new improved algorithm is developed for solving the quadratic assignment problem.

2. Distributed Parameter Control

Principal Investigator: Major D. C. Washburn, Department of Mathematical Sciences

Continuing theoretical investigation of control problems involving systems whose state is described by Partial Differential Equations. In particular, I have concentrated on the investigation of time optimal problems where the control is exercised thru the boundary of the spatial domain. These efforts resulted in the presentation of an invited paper entitled, "A Semigroup Approach to Boundary Control", at the UCLA Systems Theory Workshop.

3. An Encke Method Applied to Element Equations

Principal Investigator: Lt Col Haynes R. Bryan, Department of Mathematical Sciences

A study to determine the advantages of applying the classical Encke method of orbit prediction to element equations rather than cartesian state equations, with the analytic solution accounting for

first-order perturbation effects rather than only two-body motion. This element-Encke method is applied to elements of an oscillator, then to the Delaunay-similar orbital elements developed by Schifele.

For certain conditions, the results show a potential gain of 3-4 significant digits accuracy or a saving of 35% in computational time for unchanged accuracy.

4. Seismic Network Capability Model

Principal Investigator: Major Jay D. Sherman, Department of Mathematical Sciences

Associate Investigators: Captains Brian E. Esterby and Robert W. Langley, and Major Jerome A. Michel, Department of Mathematical Sciences

A mathematical model is being developed to determine the value of a network of seismic stations. This model incorporates the detection, location, identification and evaluation features of a seismic network that is designed to monitor underground weapons testing. It will be used to determine the comparative value of different networks of stations.

5. Detonation Property-Predictions and Modeling

Principal Investigator: Lieutenant Colonel James E. Wade, Department of Mathematical Sciences

This effort is part of work unit 7903-0404 of F. J. Seiler Research Laboratory. This is a basic research project to look at various aspects of explosive processes. Assistance from DFMS will consist of evaluating the conservation equations in order to obtain better agreement between analytically determined explosive quantities and their measured values. The normal shock Hugoniot relations do not yield the correct values for

measured pressures. This effort will be primarily directed towards determining if the admission of a non-normal shock discontinuity will yield field quantities which better agree with measured quantities.

C. Department of Physics

1. Portable Solar Collector for Sea Survival

Principal Investigator: Lieutenant Colonel W. R. Robertson

Unsponsored

The investigation of a portable solar collector for sea survival is being conducted. The system utilizes a portable paraboloidal collector which focuses the solar radiation on a small vessel which contains sea water. The salt water is heated to boiling with the vapor being sent through condensing coils to a collection point. The condensor and collection vessel are submerged in the ocean water. Components have been constructed to the point where thermal transfer efficiency to the salt water source cup can be determined, from which point, further modification and completion of remaining systems can be accomplished, if warranted.

2. Transverse Electric Atmospheric Laser

Principal Investigators: Lieutenant Colonel W. R. Robertson and Major John J. Armstrong

Associate Investigator: Cadet Joseph L. Byerly, Class of '76

Sponsored by the Department of Physics

A transverse electric atmospheric (TEA) laser was designed, constructed and tested. The discharge enclosure consisted of lucite and brass. The cathode consisted of straight pins and the anode consisted

of a five-eighths inch outside diameter copper tube. The pulsed discharge extended over the 115 centimeter length of the enclosure. With a pin-tube spacing of 2.8 centimeters, a discharge of 40 kilovolts, and a pressure of 40 torr, the laser was successfully operated with an approximate 50 Kilowatt output. The pulse width was estimated at 300 nanoseconds.

3. Unstable Resonator Mirror Misalignment

Principal Investigators: Major John J. Armstrong and Major Harald O. Dogliani, Department of Physics

Sponsored by the Air Force Weapons Laboratory, Kirtland AFB, New Mexico and the Frank J. Seiler Research Laboratory, USAF Academy, Colorado.

Negative branch unstable resonators have the advantage over positive branch unstable resonators of not being as susceptible to mirror misalignment effects. Specifically, as a negative branch resonator mirror is misaligned, the angle at which lasing ceases is significantly larger. The theoretical cease lasing angle is derived using ray optics. The experimental cease- lasing angle is found to lie between this theoretical angle and the "best case" angle.

Publication

Unstable Resonator Mirror Misalignment Measurements, USAFA-TR-75-6, SRL-TR-75-0016.

4. Spontaneous Emission Using Vector-Spherical Harmonics

Principal Investigator: Major Harald O. Dogliani, Department of Physics

Unsponsored

A formalism utilizing vector-spherical harmonic, second quantized photons to describe spontaneous emission for an atom to all multiple

order has been investigated. Preliminary investigation in the transverse magnetic mode suggests that for specific initial and final atomic states, the spontaneous emission lifetime involves a finite number of integrals.

5. Single Particle Green's Functions

Principal Investigator: Major Harald O. Dogliani, Department of Physics

Unsponsored

Single-particle Green's functions have been numerically obtained for tin using a central field approximation. The Green's functions can be evaluated for energies above and below mc^2. Although the radial portions of the Green's function diverge at either the origin or at large radii, typical matrix element integrals have been shown to converge numerically.

6. Liquid Metal Equation of State

Principal Investigator: Major Harald O. Dogliani

Associate Investigator: Cadet Mark E. Rogers, Class of 76

Unsponsored

An investigation of theoretical descriptions of liquid metal equations of state (LEOS) has been initiated. The primary problem encountered has been to adequately describe the melting temperature as a function of density. The LEOS scales to the melting temperature. A computer program version of the LEOS has been written obtaining the energy of liquid aluminum and lead scaled to their melting temperatures. The addition of pressure calculations and an analysis of the model's predictive capabilities remain.

7. Lamb Shift in Hydrogen

Principal Investigator: Major Harald O. Dogliani, Department of Physics

Unsponsored

An expansion of outgoing photons in terms of second quantified, vector spherical harmonics is being applied to the Lamb shift in hydrogen. This technique coupled with the use of Dirac single particle propagators avoids the intractable expansion normally encountered.

8. Deformable Mirror Control System Parameters

Principal Investigator: Captain Robert Asher, FJSRL

Associate Investigators: Major Winston K. Pendleton, Captain John D. German and Captain Charles Coolidge, Department of Physics

Sponsored by the Air Force Weapons Laboratory, Kirtland AFB, New Mexico

The purpose of this ongoing research project is to determine the control parameters for a deformable mirror control system designed to maximize the intensity of a laser focused on an object. The past year was spent designing and building a single-element model of an adaptive optics system and using the output of this system to test and improve a digital filter program.

9. Analysis of Electronic Component Damage Due to EMP

Principal Investigator: Captain Robert B. Bell, Department of Physics

Sponsored by the Air Force Weapons Laboratory, Kirtland AFB, New Mexico

Operational improvement and increased survivability of electronic components in several Air Force systems currently under development

including AWACS, B-1, EC 135, and Advanced Airborne Command Post is required. The subject of this study is resistors which are often used as current limiting devices in electronic circuits. Scanning Electron Microscope (SEM) Analysis of resistor damage due to Electromagnetic Pulses (EMP) has been performed to gather information on damage levels and associated damage models. Specifically, carbon composition, carbon film, metal film, and metal oxide type resistors were examined to determine the damage mechanism as a function of EMP pulsewidth. Evidence was found to support the theory that arcing (a voltage effect) occurs for microsecond to millisecond pulses rather than thermal failure (a power effect).

10. Diagnostic Technique for the AFWL SHIVA X-ray Simulator

Principal Investigator: Captain Robert A. Nuttelman, Department of Physics

Sponsored by the Air Force Weapons Laboratory, Kirtland AFB, New Mexico

This work involved the optimal design of a generalized pinhole scintillator, image intensifier camera model offering simultaneous energy, spatial, and time resolution of soft x-rays. This type of diagnostic system is particularly suited to analysis of x-rays from intense plasma discharge sources. The usual diffraction limited, optimum pinhole design for spatial resolution is not used since sufficient x-ray intensities are not often available from laboratory plasmas to take advantage of optimum pinhole resolution. Instead, the conditions for obtaining optimum spatial resolution for the intensity limited case for given time and energy resolution requirements are derived.

11. Visual Perception: Nature and Cause of the Horizontal-Vertical Bias in the Human Visual System

Principal Investigator: Captain Alexander M. Sadowski, Department of Physics

Associate Researchers: Second Lieutenant David D. Dyche (Class of '75) and Cadet J. Michael Reames (Class of '76)

Sponsored by the Department of Physics, United States Air Force Academy, Colorado

Continued studies in the retinal processing of geometrical images have indicated that the fovea centralis, the elliptically shaped, densely packed array of photopic receptors in the retina, is the key to the horizontal-vertical illusion. The theorized role of the fovea centralis in the dynamical process of the retinal analysis of geometric images was computer simulated. The computer results compare most favorably with empirical data obtained during the last year. The results from our investigation does support Kunnapas' theory that the perceived human visual field is elliptical. This allows for a physical explanation rather than a purely psychological explanation of many optical illusions and even confirms Ptolemy's explanation of the horizon moon illusion. In addition, we can demonstrate that although the use of the fovea centralis in the processing of geometrical images does result in certain processing errors, the use of such an elliptical scanner has significant advantages over that of a circular scanner.

Presentations

A. M. Sadowski, D. D. Dyche, and J. M. Reames, "The Fovea Centralis, the Key to the Retinal Processing of Geometrical Images," presented at the 47th Annual Meeting of the Colorado-Wyoming Academy of Science at the University of Colorado, Boulder, on 23 April 1976.

12. Numerical Calculation of Explosive Behavior

Principal Investigator: Captain Richard E. Swanson, Department of Physics

Sponsored by the Frank J. Seiler Research Laboratory, USAF Academy, Colorado

I performed a series of calculations using the explosive properties computer code (BKW) in an effort to determine the appropriate detonation product specie covolumes to use with the Becker-Kistiakowsky-Wilson equation of state. Results of the calculations were compared with experimental pressure -volume shock loci (hugoniot) curves for H_2O, CO, and N_2. The choice of covolumes for those species was confirmed. I also compared the detonation properties and product compositions calculated using new BKW parameters with data and calculations performed using BKW parameters established in 1963 by Charles L. Mader of the Los Alamos Scientific Laboratory. This is a continuing effort.

13. Aircraft Engine Oil Analysis by Neutron Activation

Principal Investigator: Captain Virgil H. Webb, Department of Physics

Sponsored by Frank J. Seiler Research Laboratory, USAF Academy, Colorado.

The feasibility of employing ^{252}Cf as a neutron source for trace analysis of aircraft engine oil samples by neutron activation techniques has been investigated. The study included an analysis of detecting by neutron activation metals commonly found in aircraft engine oils due to the wear of the oil-wetted parts as well as the construction of a neutron radiational facility designed to contain up to 1 milligram of

^{252}Cf. Preliminary results indicate that engine oil analysis by neutron activation is feasible.

Presentations:

Captain Virgil H. Webb and Second Lieutenant William S. Kurey, "A ^{252}Cf Neutron Radiational Facility", presented at the 47th Annual Meeting of the Colorado-Wyoming Academy of Science, at the University of Colorado, Boulder, on 23 April 1976.

II. GENERAL RESEARCH IN THE HUMANITIES AND SOCIAL SCIENCES

A. Department of Astronautics and Computer Science

1. Computerized Scheduling of CCQ for the Cadet Wing

Principal Investigators: Lieutenant Colonel George H. Walther, Department of Astronautics and Computer Science; Captain Robert Eggleston, Department of Behavioral Science and Leadership; C1C Garrison H. Flemings and C2C Robert Simmons

Sponsored by CW

This cadet-initiated project took cognizance of the fact that manually prepared schedules for third classmen serving as Cadets in Charge of Quarters (CCQ) throughout the Cadet Wing were often inadvertently inequitable with respect to the kind of shift a cadet served repetitively, and to the number of times one cadet serves as CCQ in comparison with another. Two sets of computer programs were written: (1) interactive data collection from cadet representatives from each Cadet Group, which rendered cadets eligible or ineligible for certain types of CCQ shifts, reflected in the data base the fact that two cadets had exchanged assigned tours during the previous cycle, and set the minimum number of days between times any single cadet would have to serve as CCQ. Considerable data validation takes place during this data entry phase, and unreasonable inputs are rejected and the computer asks for clarification. (2) The main scheduling program, a data base manager, attempts to derive equitable schedules for a two-week period for a single squadron based on 13 scheduling variables. The program prints a schedule in the form of a "Subject-To" letter bearing the signature block of that squadron's First Sergeant.

To assess cadet attitude toward the computerized system in comparison with the manual system, an attitude survey was administered to squadrons, one-half of which were under the mechanized system. The survey was given twice, three months apart. A semantic differential was constructed to assess attitude, and in the same surveys, a paired-comparison measure was employed to determine the relative importance of each of 13 different scheduling factors.

Results of the attitudinal assessment are currently being analyzed.

2. A Layman's Interface to the AID-4 Statistical Computer Program

Principal Investigators: Lieutenant Colonel George H. Walther, Department of Astronautics and Computer Science; C1C Marc M. Moore and C2C Jeff Brown.

AID-4 is a large-scale statistical analysis program, capable of producing a graph structure which depicts binary splits of the predictor variables in a large data sample. Using one-way analysis of variance and mean splitting techniques, the program sequentially answers the question, "What is the best single predictor of a given criterion variable?," and then proceeds to split data points surrounding that predictor into hi-low categories. The hi category is then split following the same procedure, and then the low category in the same manner. The binary splitting continues until statistical significant is lost, or until all predictor variables have been split. One can actually read the computer-generated graphical tree and make a statement such as, "The person most likely to

attrit from the USAF Academy is one who . . . ." and the name the attributes occurring in the top box of the splits.

The program came to the Academy from the University of Texas at Austin. The FORTRAN source code was incompatible with the FORTRAN compiler on the Academy's B6700 computer and much translation has to be done. Then the program's output printing was garbled due to incompatibility of word size onthe two computer systems.

Once the program was working, a layman's interface was designed and programmed. It allows the nontechnical scientist to set up the parameters for his AID-4 run by responding to computer-generated questions at an on-line terminal. The program transparently generates the complicated parameter cards required by the statistical program.

3. Phase Testing for a First Course in Computer Science

Principal Investigator: Captain Kenneth Krause, Department of Astronautics and Computer Science

To support the minimum paced self-instruction system used in Computer Science 200, a computerized testing scheme was developed to test the level of learning of each cadet. Using hash-coding and random number generating techniques on a compressed question data base, computer software was developed to produce a large number of unique tests for any cadet or any number of cadets. The answers were also scrambled. The tests were self-administered; i.e., printed on the computer and graded by the computer with no instructor interaction.

4. Minimum Paced Self-Instruction in a Two-pass Course

Principal Investigators: Major Lawrence E. Druffel, Major Vance A. Mall, Captain Robert N. Hawley, Captain Lawrence G. Jones, Captain Kenneth L. Krause, and Captain Marion A. Pumfrey, Department of Astronautics and Computer Science

There have recently been many experiments with techniques which permit a student to learn at his own pace. Although many of these self-paced systems have been successful, others have been disastrous. Perhaps the largest single cause of the failures has been the tendency to completely ignore the psychological need of many students to attend a lecture. Our experiment is being conducted in Computer Science 200 with a two-pass minimum paced system. All the important concepts are condensed into the first seven lectures with very little supporting detail. Students who demonstrate an understanding of these concepts may work at their own pace in a special section with a lab instructor to help them. The other students continue to attend normal lectures aimed at the C student, which establishes the minimum pace for the course.

5. The Computer Science Core Course Grade Score Data Base; Generating, Updating and Analyzing

Principal Investigators: Captain Wesley L. Cooper and Captain James Legg, Department of Astronautics and Computer Science

With an increasing number of students enrolled in the Computer Science core course, a method of freeing instructors' time from manual score recording and accumulation was investigated. Machine grading of exams was also implemented. A series of programs to generate an initial data base and enable grade score updates was written and used operationally. Sophisticated report generator programs and statistical

analysis programs were also written. Significant savings of instructor time was realized, with improved accuracy of scores reporting. Additionally, many valuable statistical analyses were available for use by the Course Director and the Deputy Head. These were virtually impossible to attain previously.

6. The Front-end Processing Programs of the Basic Cadet Training Tracking Program and BCT Standing System

Principal Investigators: Captain Wesley L. Cooper and Captain James R. Legg, Department of Astronautics and Computer Science

Extensive time needed to evaluate a basic cadet's progress and performance during BCT prompted a request from offices of the Commandant of Cadets to investigate a computerized method of providing timely attendance and evaluation of each basic cadet's progress through each of the 30 BCT events. A study resulted in the planning, design, and implementation of programs to provide the information. The study also addressed problem areas, solutions, and recommended improvements based on operational experience. Statistical analysis programs use the final output summary tape of these processing programs to generate and provide several different analysis and report formats, including a BCT order of merit.

7. Analysis of the Military Order of Merit (MOM) System

Principal Investigators: Major W. J. Lucas, AOC CWDS-15, Major P. W. Loper, AOC CWDS-29, Major V. L. Kapinos, AOC CWDS-05, and Captain James R. Legg, Department of Astronautics and Computer Science

Sponsored by CW.

The purpose of this study was to accomplish a complete analysis of the MOM and propose changes to make the system better and more responsive to the needs of the Air Force Academy. The project resulted in changes to the cadet performance report and the relative percentages assigned to the various components of the MOM. The quartile system will be replaced with a "word picture" approach based on standard deviation above and below the mean of the standard composite. The performance report changes include several basic modifications to the Cadet Wing organization and rank structure. The implementation of the new performance report closely parallels the OER in the Air Force.

8. Statistical Analysis of the Military Order of Merit (MOM)

Principal Investigator: Captain James R. Legg, Department of Astronautics and Computer Science

Sponsored by CWD and RRE.

The purpose of this study was to design a system to analyze the components of the MOM by Wing, Group, Class and Squadron. The methodology applied at the time the project began involved the running of 160 separate statistical mini-programs using a library statistical package. A program was developed in ALGOL which runs on the B6700 which provides a detailed analysis of MOM which satisfies the basic purpose of the project. This project resulted in a cost savings to the Air Force of over $2,000 over a three-year period.

9. ELSIE Data Reduction

Principal Investigators: Captain R. H. Toews, Department of Astronautics and Computer Science, Major D. Wilkins, Department of Foreign Languages, and C4C Barnard

The Edmonds Learning Style Identification Exercise (ELSIE) is a 50-question word/mental-process association test designed to determine the mental processes by which people learn. This test was administered twice to 750 USAF Academy students of basic and intermediate foreign languages, and the raw data was transferred to punched cards.

Three computer programs were developed to reduce the data. The first program used an ELSIE-developed algorithm to sort each student's responses into "bands" or categories. It then combined this information with terminal-entered files containing cadet control number and grades to produce output of learning style band averages for each foreign language section. The second program computed various means, variations and correlations to determine if there was any relationship between a student's test results and his course grade. The third program evaluated responses on both test administrations to determine the test's consistence.

The required information has been assimilated for evaluation.

Publications

"An Attempt to Establish and Maintain Standards in a Large Course," published by IEEE Transactions on Education, Nov 1975.

B. Department of Behavioral Sciences and Leadership

1. The Validity of Various Measures in Predicting Pilot Training Performance

Principal Investigators: Major Jefferson M. Koonce and Major Eugene H. Galluscio, Department of Behavioral Sciences and Leadership

Sponsored by Frank J. Seiler Research Laboratory (AFSC)

In the first phase, one hundred and twenty-two cadet subjects performed a two-axis compensatory tracking task with and without a digit cancelling side task for four seven minute trials. Measures of pitch,

roll, latency in responding to the side task, and the performance detriment resulting from the side task were correlated to performance in the T-41 aircraft. Typical learning curves were attained and initial correlation coefficients of tracking performance to T-41 performance criteria are in progress.

Phase II consisted of thirty-six subjects who received five, one hour training sessions in a Singer-Link GAT-1 flight simulator. Each session was pre-recorded and presented via video film strips synchronized with instructions on cassette tapes. The performance measures included flight parameters as well as responses to a digit cancelling side task. Digitizing and reduction of data are in progress. The primary purpose of Phase II is to validate the results of a recent project by HRL/PE contracted to Dr. George Long, McDonnell-Douglas Corporation. The data will be correlated to T-41 performance scores and retained to determine their relationship to subsequent T-37 and T-38 performance at Undergraduate Pilot Training.

Presentation

Use of two-axis tracking task in predicting pilot success
U.S. Air Force Academy, Colorado: Proceedings of the 5th Psychology in the Air Force Symposium, April 1976.

2. Level of Alertness and the Perceptual Processing of Visually Displayed Information during Simulated Flying Missions

Principal Investigators: Major Eugene H. Galluscio, Jock C. H. Schwank and Jefferson M. Koonce; and Captains John M. Bermudez, Thomas M. Longridge and Thomas M. McCloy.

Sponsored by AMRL/HEA WPAFB, OH

The purpose of this study was to determine a research protocol which will examine the psychological and physical stressors which degrade visual information processing. The resultant proposal included the need for developing a technology which will allow precise machine measurement and scoring of eye movements and eye position. It was also proposed that visual information processing of signals presented to the visual periphery be investigated. A further line of research was proposed that would attempt to scale the level of stress imposed by different auditory and visual stressors which vary on dimensions of meaningfulness as specified by relevancy to the task. Simulated flying missions were proposed to study patterns of visual search under different stress levels to determine how scanning, attention, and information processing are affected by realistic distractors.

3. Behavioral and Physiological Correlates of Varying Noise Environments

Principal Investigators: Lieutenant Colonel Lawrence F. Sharp and Captains John F. Swiney and Mickey R. Dansby, Department of Behavioral Sciences and Leadership

Sponsored by the United States Environmental Protection Agency

This research is in two phases. Phase I, accomplished during FY 75, investigated the effects of moderate levels of noise on heart rate, muscle tension, and error rate on a skilled psychomotor tracking task. Results from Phase I indicated that moderate noise does influence behavior, but physiological results were inconclusive. In Phase II, conducted during FY 76, more sensitive physiological indices were compared, including

urinary catecholamines, plasma catecholamines, plasma cortico-steriods, and common metabolities. Analysis of the Phase II data is currently underway. The general question to be answered is whether moderate noise levels induce both physiological and psychological stress in a fashion similar to high noise levels.

Publication

"Behavioral and Physiological Correlates of Varying Noise Environments: Annotated Bibliography" U.S. Environmental Protection Agency Technical Report, In press.

Presentation

"Effects of Moderate Noise Levels, Anxiety and Task Difficulty on Behavioral and Physiological Response Indicants" presented to American Psychological Association, 5 August, 1975; also to Psychology in the Air Force Symposium, 9 April, 1976.

4. The Use of Biofeedback Techniques in Stress Management Training

Principal Investigators: Captain Robert G. Eggleston and Captain Kermit C. Parker, Department of Behavioral Sciences and Leadership

Sponsored by Frank J. Seiler Research Laboratory (AFSC)

A nine lesson stress management program was designed in which the results showed that high anxious academically deficient cadets learned to control their tension (stress) level after stress management training. These cadets realized a significantly greater increase in GPA than low anxious cadets receiving the same training. Further, they out performed high anxious cadets who received training in study habits development. Research is underway to refine the stress management program and to modify it for audio tape presentation

Presentation

"Stress Management Training as Related to Scholastic Performance" presented to the Psychology in the Air Force Symposium, USAFA, April 1976.

C. Department of Economics, Geography and Management

1. Observable Public Good Preferences

Principal Investigators: Doctor David F. Bradford, Deputy Assistant Secretary for Tax Policy (Tax Analysis), Department of the Treasury and Princeton University, and Major Gregory G. Hildebrandt, Department of Economics, Geography and Management

The circumstances under which it is possible to use the market or aggregate demand function generated from individual utility maximization to obtain consumers' preferences for certain classes of public goods such as highways and education are analyzed. The restrictions on the preferences of all consumers which are sufficient to use the aggregate demand function are (i) there exists a price vector such that the level of public good provision is valueless and (ii) the marginal rate of substitution of price for the level of public good provision is independent of income.

Publications

"Observable Public Good Preferences," Princeton University Econometric Research Program Research Memorandum No. 193, December 1975, and USAFA-TR-76-5, March 1976.

Presentations

"Observable Public Good Preferences," presented at the University of Colorado, the Harvard-MIT Joint Theory Seminar in Economics, Yale University, Princeton University, and the University of Chicago, during March and April, 1976.

2. Centralized Planning

Principal Investigator: Major Gregory G. Hildebrandt, Department of Economics, Geography and Management

The use of three central planning control tools during the plan implementation phase of the central planning process are discussed. The control tools are price signals, prescribed quantities, and performance incentives. It is proven that the optimal performance incentive function achieves allocative efficiency when used to control the production of a single good, whereas price or quantity signals necessarily entail a dead-weight loss. When the distribution of social income between the central planning organization and the producer matters, then it is possible for the center to construct a performance incentive function which achieves allocative efficiency and the distributional objectives simultaneously. The actual use of performance incentives by central planning organizations of the United States and the Soviet Union is also discussed.

Publication

"Essays on the Use of Control Signals in Centralized Planning," April, 1976. A dissertation presented to the faculty of Princeton University in candidacy for the degree of Doctor of Philosophy.

3. Hahn, Inc.

Principal Investigators: Major Robert L. Taylor, Department of Economics, Geography and Management, and James M. Utterback, Harvard University

A two-part case study of Hahn, Incorporated of Evansville, Indiana, centers on the marketing and organizational concerns of a firm from its inception in 1948 to the present. This comprehensive presentation includes marketing, production, financial, personnel, and legal

aspects of the firm as it progresses from a young company to a mature corporation. A computer simulation is included to permit students to make alternative decisions in essentially the same environment faced by Lloyd Hahn to test strategies and policies different from the actual decisions that were made.

Publication

Published in Dalrymple, Douglas J. and Leonard J. Parsons, Marketing Management, New York: Wiley, 1976, pp. 619-631.

4. Performance Appraisal: A View From Using Organizations

Principal Investigators: Major Robert L. Taylor, Department of Economics, Geography and Management, and Robert A. Zawacki, University of Colorado, Colorado Springs

This research reports the findings from a survey of 50 industrial performance appraisal systems. Contrary to our hypothesis, few firms have turned to the collaborative approach even though it may be theoretically the more attractive performance appraisal alternative. Managers are generally satisfied with their performance appraisal systems and there is no relationship between the size of the organization and the type of system used. The study raises questions regarding the application and understanding of performance appraisal theory by organizations and the data presented are but a first step in identifying the substance and trends of performance appraisal systems.

Publication

Published in Personnel Journal, June 1976.

5. The Technological Gatekeeper--A Boundary Role Communicator

Principal Investigator: Major Robert L. Taylor, Department of Economics, Geography and Management

A sociometric study identifies a two-step flow process of scientific and technical information among 184 engineers at a large in-house military research and development laboratory. Individuals serving in mediating roles are identified as "gatekeepers." The study provides evidence that age, level of education, technical experience, tenure in the laboratory and work group, and composition of the work group (military or civilian) are all associated with the gatekeeper phenomenon. Gatekeepers tend to be older, have a higher level of education, have more technical experience, have been at the laboratory longer, and are predominatly civilians. The analysis of spatial relationships demonstrates that the probability of communication declines as the distance between communicators is increased. Gatekeeper effectiveness does not appear to be diminished because of location or distance from colleagues. There is no identifiable "profile" of the gatekeeper.

Presentation

Presented at the Western Academy of Management meetings, Santa Barbara, April 1976.

6. Capturing Judgment Policies in Performance Ratings

Principal Investigators: Major Robert L. Taylor, Department of Economics, Geography and Management, and William D. Wilsted, University of Colorado

Cadets at the Air Force Academy are rated by their peers twice yearly on the basis of ten performance factors: duty performance, initiative, judgment, human relations, expression, moral standards, personal appearance, acceptance of authority, cooperation, and leadership. Although individual rater policies are highly consistent, there are

significant differences in rating policy between cadet squadrons. Performance factor emphases vary between classes but do not reflect different training objectives. There is no significant difference between a linear and a nonlinear model in explaining variances in overall ratings with only two performance factors needed to predict overall ratings. Specific recommendations for eliminating policy differences are described.

Publication

Published in Industrial Relations, May 1976

Presentation

Presented at the 35th Annual Meeting, Academy of Management, New Orleans, August 1975.

7. The Technological Gatekeeper

Principal Investigator: Major Robert L. Taylor, Department of Economics, Geography and Management

The present study identifies a two-step flow process of communication mediated by technological gatekeepers for scientific and technical fields characterized by dynamic information flows. Peer identification and a supervisory recognition validate the gatekeeper phenomenon. The external communication needs of military in-house researchers are mitigated greatly by the infusion of technical information into the laboratory. Gatekeepers are differentiated by the topic and not the media monitored. Finally, the gatekeeper phenomenon is implicitly recognized, even though the development may be spontaneous and is a natural response to an information need.

Publication

Published in R&D Management, Vol. 5, No. 3, June 1975, pp. 239-243.

8. Tertiary Sedimentation into the Denver Basin, Colorado: A Model for Alluvial Plain Deposition

Principal Investigator: Captain David G. Morse, Department of Economics, Geography and Management

This is an attempt to reconstruct the depositional environments of the Dawson and Castle Rock formations in the High Plains of Colorado between Denver and Colorado Springs. These are a series of alluvial or stream sediments deposited in an easterly to southeasterly direction from the Rocky Mountains shortly after the mountains began to uplift in the early Tertiary Period. They were deposited as alluvial fans near the mountains and then deposited by sediment chocked, braided streams further east. Easterly current directions were determined from hundreds of foreset dip directions measured at over fifty field locations in Douglas, El Paso and Elbert counties. Complete geologic columns at each field location were prepared to examine lithologic variation in time and space. Selected samples were taken so that all lithologies and sequences of beds can be studied in detail during the next year.

9. Reconstruction After an Earthquake Disaster

Principal Investigator: Captain William A. Mitchell, Department of Economics, Geography and Management

This research is based on a study of Turkish villages that were damaged by an earthquake. Emphasis is on how the government and villages responded to the disaster. Many problems in human adjustment surfaced during the analysis. Dissatisfactions presented by the villagers are described and suggestions for future restoration efforts are afforded.

Publication

"Reconstruction After Disaster: The Gediz Earthquake of 1970," Geographical Review, forthcoming.

Presentation

"Rural Reconstruction After an Earthquake," presented as a DFEGM Brown Bag Seminar, 22 April 1976, USAFA.

10. Kutahya Province, Turkey

Principal Investigator: Captain William A. Mitchell, Department of Economics, Geography and Management

Associate Investigator: Major Edward A. Glowatski, Department of Economics, Geography and Management

This research involved an analysis of the human and natural resources in one of Turkey's 67 provinces. Emphasis is on the role of agriculture, industry, and the Turkish village. This study is based on four months of intensive field research by Captain Mitchell in 1970 and 1973.

Publication

"A Geography of Kutahya Province, Turkey," USAFA-TR-76-4, January 1976.

11. Disaster and Change

Principal Investigator: Captain William A. Mitchell, Department of Economics, Geography and Management

Associate Investigator: Captain C. Taylor Barnes, Department of Economics, Geography and Management

This research is an analysis of socio-economic change in Turkish villages after a natural disaster. Seventeen variables are isolated and examined for 47 villages. A detailed village analysis is provided.

Publication

"Disaster and Change in Rural Turkey," Middle East Journal, forthcoming.

12. Inflation Models of Selected NATO Countries

Principal Investigator: Major John S. Brush, Department of Economics, Geography and Management

Sponsor: Internal request by Systems Command and Air Staff

In an effort to determine both absolute and relative future inflation rates for NATO countries--particularly those involved in the F-16 program, the analytical tools developed in USAFA-TR-75-6 were applied to the economies of Belgium, the Netherlands, Denmark, Norway, and Germany.

13. Fighter-Maker Base Selection Project

Principal Investigator: Major William J. Weida, Department of Economics, Geography and Management

Associate Investigators: Captain Michael W. Gaffney and Major Felix M. Fabian, Jr., Department of Economics, Geography, and Management

Sponsored by Military Personnel Center (MPC)

This research investigated the least-cost criteria which should be considered in the base selection for the fighter-maker program. The study showed that almost all the variables washed out of the problem and the only important consideration was distance to the firing range. A model based on this variable was developed to give cost options for all aircraft in the T-38 to F-5E categories.

14. An Algorithm for a Pattern Sensitive Data Storage System (PSDSS) (PhD dissertation)

Principal Investigator: Major William J. Weida, Department of Economics, Geography and Management

An algorithm was developed which allowed the storage and recall of binary information which was structured in a relational data matrix format. The original data matrix was compressed significantly during entry into storage, and the algorithm allowed data to be recalled from this compressed matrix by Boolean query, thus eliminating normal search procedures. This method was successful in overcoming the mutually exclusive descriptor state restrictions normally associated with taxonomic information retrieval systems.

15. Federal Energy Administration Mapping Project

Principal Investigators: Major Charles J. Smith and TSgt John R. Wagner, Department of Economics, Geography and Management; 25 cadets enrolled in Geography 340

Sponsored by Federal Energy Administration, Region 7.

Cadets enrolled in Geography 340, Cartography, produced 24 maps in response to a request by the Regional Administrator of FEA Region 7. Each cadet was responsible for the preparation of a separate map using data in various forms. The completed maps showed: the location of all power plants and transmission lines in the region, the location of all Federal installations, and all pipelines.

16. Analysis of Hospital Overhead Costs

Principal Investigator: Lieutenant Colonel F. Theodore Helmer, Department of Economics, Geography and Management

A cost analysis within any hospital reveals three types of costs: fixed, variable, and semi-variable. Fixed costs may be defined as costs which remain unchanged over any relevant range of activity, such as depreciation, housekeeping, repairs and maintenance, utilities, communications, general and administrative expenses, research, fringe benefits,

taxes, etc. Each of these costs is affected separately by inflation, and each must be estimated for budgeting and for prospective reimbursement systems. This research concerns the investigation of these costs and their level of incurrence in an attempt to explain their magnitudes and relationships with easily predictable variables. The methodology should help reveal the nature of these fixed, or overhead, costs and explain what drives the level of their incurrence.

D. Department of English and Fine Arts

1. Edward, Lord Herbert of Cherbury: A Preliminary Checklist

Principal Investigator: Lieutenant Colonel Jack M. Shuttleworth, Department of English and Fine Arts

Sponsored by the Department of English and Fine Arts and individual.

The checklist provides the first modern bibliographic listing of the works of Edward, Lord Herbert of Cherbury (1583-1648). It covers all his works in Latin and English, philosophy, history, autobiography, and poetry, together with critical comments on those works.

Publication

Edward, Lord Herbert of Cherbury: A Preliminary Checklist, accepted for publication in the Bulletin of Bibliography in 1976.

2. The Donne-Herbert Family Relationship

Principal Investigator: Lieutenant Colonel Jack M. Shuttleworth, Department of English and Fine Arts

Sponsored by the Department of English and Fine Arts and individual

The relationship between John Donne and the family of Mrs. Magdelene Herbert, her sons George and Edward, has never been adequately explored. Usually dismissed with inexplicit statements of friendship or

influence, these literary and personal relationships significantly affected Donne as both preacher and poet. His importance has previously been established; this study will detail the nature and importance of the various Herberts in his life.

3. Radiographic Reproduction of Early American Watermarks

Principal Investigators: Lieutenant Colonel Jack M. Shuttleworth Department of English and Fine Arts; Captain Virgil Webb, Department of Physics; Cadet First Class Russell Latenser

Sponsored by the Frank J. Seiler Research Laboratory, the Department of English and Fine Arts, the Department of Physics, and the individuals.

No catalogue of watermarked American papers now exists. Such a catalogue listing dates of production, places, and kinds of uses would provide a research source for historical and literary scholars in the search for proper dating of manuscripts and the identification of forgery. The first step to such a catalogue is to reproduce the watermarks without damage to the original, often fragile paper. A process using beta-radiography with Ca45 promises to provide such reporduction. This study is experimental to determine exposure times and means of reproduction.

4. The Air Force Academy and Total Environmental Education

Principal Investigators: Lieutenant Colonel Joseph F. Tuso, Department of English and Fine Arts and Major Rolf A. Trautsch, Directorate of Counseling and Scheduling

Sponsored by the Department of English and Fine Arts and the Directorate of Counseling and Scheduling

The U. S. Air Force Academy exists to provide the Air Force with the best possible officers. The Academy provides a total environmental

education which closely mirrors the life cadets will live as officers. Cadets are placed in various controlled athletic, academic, professional, and extracurricular learning situations designed to help them attain those traits vital to future Air Force leaders. Ongoing evaluations indicate that the Air Force Academy is producing highly effective officers, yet the Academy continues to evaluate and tailor its programs, innovate teaching techniques, and alter subject matter in accordance with the latest developments in education and in anticipation of future Air Force needs.

Publication

The Air Force Academy and Total Environmental Education. To appear in Education Journal (Spring, 1976)

5. The Teaching of Old English Literature in Translation

Principal Investigator: Lieutenant Colonel Joseph F. Tuso, Department of English and Fine Arts

Sponsored by the Department of English and Fine Arts and individual

With the dropping or diminishing of the Old English requirement in many M.A. and/or PhD programs in recent years, there is an increasing need for the teaching of Old English in translation to be as carefully conceived and executed as possible. Teaching OE in modern versions is legitimate for many reasons; a number of undergraduate programs already include this approach to our subject, and graduate courses may become necessary, as well. Although there are a number of fine modern English versions of many OE works, a good deal more work needs to be done in this area.

6. A Descriptive Bibliography of Robert Penn Warren, 1917-72

Principal Investigator: Major James A. Grimshaw, Jr., Department of English and Fine Arts

Sponsored by the Department of English and Fine Arts and individual

A complete descriptive bibliography of the works of Robert Penn Warren; includes secondary material about his works.

Publication

Robert Penn Warren: A Descriptive Bibliography, 1917-72. Charlottesville: University Press of Virginia. To appear in 1976.

7. A Bicentennial Edition of Thomas Godfrey's "The Prince of Parthia, A Tragedy" (1765)

Principal Investigator: Captain William E. McCarron, Department of English and Fine Arts

Sponsored by the Dean of Faculty Secretariat, the Department of English and Fine Arts, and individual

This study provides a critical introduction to an edition of America's first printed tragedy, Thomas Godfrey's The Prince of Parthia, A Tragedy (1765). Several critics have mentioned Godfrey's debts to Shakespeare in writing his play; no one has examined at length Godfrey's specific borrowings from Shakespeare. Hence, the critical introduction evaluates Godfrey's use of Shakespeare in constructing the Plot, Characters, and Language of The Prince of Parthia. In addition, the critical introduction traces Godfrey's use of certain Elizabethan themes,

ideas, and situations. The remainder of the Report contains a text of the play itself, plus appendices on textual matters and a Godfrey bibliography.

Publication

A Bicentennial Edition of Thomas Godfrey's "The Prince of Parthia, A Tragedy" (1765). United States Air Force Academy Technical Report 76-3. May 1976.

8. Writing and the Composition Teacher

Principal Investigators: Captain William E. McCarron and Captain Edward P. Bailey, Department of English and Fine Arts

Sponsored by the Department of English and Fine Arts and individuals.

An article suggesting five practical ways the teacher of writing can improve his teaching and student writing

Publication

"On Remaining Proficient as a Composition Teacher: Five Practical Tips." Statement [The Journal of the Colorado Language Arts Society], February 1976, pp. 7-10.

E. Department of Foreign Languages

1. FRANCE - Land and People: A Handbook

Principal Investigator: Captain Donald C. Scott, Department of Foreign Languages - sponsored by the USAF Academy

This 167-page handbook provides the basic French language student with an introductory insight into the culture and civilization of France. It has been incorporated into the curriculum of the Defense Language Institute's French courses.

2. GERMANY - Land and People: A Handbook

Principal Investigator: Colonel William Geffen, Department of Foreign Languages - sponsored by the USAF Academy.

This two volume, 388-page handbook provides the basic German language student with an introductory insight into the culture and civilization of Germany. It has been incorporated into the curriculum of the Defense Language Institute's German courses.

3. Criterion-Referenced Foreign Language Testing

Principal Investigator: Colonel William Geffen, Department of Foreign Languages - sponsored by the USAF Academy.

The research deals with the development of criterion-referenced foreign language tests. Test models (for use in basic college level foreign language courses) measure achievement (proficiency) of language learning based on integrative language skills (listening/reading comprehension and spoken language production) rather than discrete point items (grammar control). Research uses performance data of cadets on the USAFA Foreign Language Placement Test, administered annually to the incoming class, and the end-of-course examination, taken by cadets upon completion of the core language requirement. Test models designed so far, in addition to the Placement Validation Examination, include Graded Reviews, final and end-of-course examinations. On-going research attempts to validate both content and construct validity of tests and to develop an entire battery of criterion referenced tests. Final research product is a Reference Book on Froeign Language testing.

Presentations

"A Comprehensive Placement Test, A Model for Criterion-Referenced Performance Testing." Presented to the 27th Annual Conference of the Pacific Northwest Council on Foreign Languages, Seattle, Washington, 24 April 76.

"Foreign Language Placement Procedures and Testing for Entering Freshmen at the U.S. Air Force Academy." Presented to the 1976 Spring Meeting of the Colorado-Wyoming Chapter, American Association of French Teachers, University of Colorado, Boulder, Colorado, 1 May 76.

Publications

"A Comprehensive Placement Test. A Model for Criterion-Referenced Performance Testing." 1976 Proceedings Pacific Northwest Council on Foreign Languages, June 76.

"Erfahrungen mit dem Gebrauch des Modells Zertifikat Deutsch als Fremdsprache als Einstufungs und Abschlussprufung in Universitatsanfangskursen fur Deutsch als Fremsprache." (Results of the use of the Certification German as a Model for Placement and Final Examinations in Elementary German Courses at the University Level) To be published (Oct 76) in Zielsprache Deutsch.

F. Department of History

1. A History of the United States Air Force

Principal Investigator: Colonel Alfred F. Hurley, Department of History

Sponsored by the USAF Academy and the John S. Guggenheim Foundation

Research on the development of the Air Force as an institution with emphasis on its origins from 1890 to 1947. Makes use of primary sources among records of the Air Force and its ancestors, Air Force Archives at Maxwell AFB, National Archives in Washington, D.C., and papers of such founders as Foulois, Pershing, Spaatz, and Arnold. Results to be published in a book by Macmillan Company for its series on Wars and Military Institutions of the United States.

2. General Hoyt S. Vandenberg, Sr.

Principal Investigator: Colonel Alfred F. Hurley, Department of History

Sponsored by the American Council of Learned Societies

The first scholarly article on the life and career of General Vandenberg. Accepted for publication in the next volume of the Dictionary of American Biography.

3. USAFA Oral History Program

Principal Investigator: Captain Robert S. Bartanowicz, Department of History

Sponsored by the USAF Academy

The Oral History Program conducted several taped interviews which were typed into manuscripts. The manuscripts will serve as "original source" historical documents and will be deposited in the Special Collections Division of the USAF Academy Library; Butler Library, Columbia University; and the USAF Historical Research Division, Maxwell AFB, Alabama.

The interviews covered a total of twenty hours and were all related to aviation, Air Force, US Air Force Academy, or military history. Among the interviews conducted were: Lieutenant James R. Allen on his part in the planning and execution of the Son Tay mission; Miss Jacqueline Cochran on her personal aviation achievements, her role in the formation of the World War II Womens' Air Force Service Pilots (WASPS) program, and her post-war activities as a registered congressional lobbyist working for an independent Air Force; Mr. Oliver C. LeBoutillier on his experiences as a World War I fighter pilot which

included his eyewitness account of the air action leading to the death of the famed "Red Baron," Baron Manfred von Richthofen; Colonel Frank E. Merritt, USAF (Retired), on the development of the USAF Academy intercollegiate athletic program; General Theodore R. Milton, USAF (Retired), on his involvement as one of the planners and participants in the 1948 Berlin Airlift and on his recollections of the 1961 Taylor-Rostow mission to Southeast Asia.

4. The Harmon Memorial Lectures in Military History

Principal Investigator: Captain Charles W. Specht, Department of History

Sponsored by the USAF Academy and the Association of Graduates

The first seventeen annual lectures in the Harmon Memorial Lecture Series have been published separately. Plans call for publication in the future of a volume containing all lectures presented to the date of publication.

5. The Military and Society: The Proceedings of the 1972 History Symposium

Principal Investigator: Lieutenant Colonel David MacIsaac, Department of History

Sponsored by the USAF Academy and the Association of Graduates

Editing a series of papers presented at the 1972 Military History Symposium by prominent military and civilian historians. The proceedings of this symposia were published by the Government Printing Office in 1975.

6. The Military History of the American Revolution: The Proceedings of the 1974 History Symposium

Principal Investigator: Major Stanley J. Underdal, Department of History

Sponsored by the USAF Academy and the Association of Graduates

Editing the papers presented at the 1974 Military History Symposium by noted military and civilian historians. The proceedings were published by the Government Printing Office in the spring of 1976.

7. The Marquess Wellesley in Irish and British Politics: 1781-1842

Principal Investigator: FSO-5 Edward Brynn, Department of History

Wellesley is known to history as the eldest brother of the Duke of Wellington, a remarkably unjust diminution of his importance over a period of sixty years. As a friend of William Pitt and William Grenville, he established Arthur in the army and as viceroy in India secured British ascendancy there. He was foreign secretary from 1809 to 1812, and twice viceroy in Ireland. He fashioned a family political interest which secured Arthur his position as head of British forces in the Iberian peninsula and promoted the fortunes of other members of the family. This research and writing is attached to a PhD in Irish history at Trinity College, Dublin.

One publication has already resulted from this research: "Wellesley and Ceylon: A Plan for Imperial Consolidation" in the Modern Ceylon Studies, Summer, 1975.

8. Air Force Images of Research and Development and Their Reflections in Organizational Structure and Management Policies

Principal Investigator: Major Donald R. Baucom, Department of History

Sponsored by the USAF Academy

This is a study of the development of Air Force R&D Policy between 1945 and 1953. It explores the roles of such men as Generals Hap Arnold, James H. Doolittle, Hoyt S. Vandenberg, and Donald L. Putt, as well as those of Drs. Theodore von Karman and Louis Ridenour, in the establishment of an Air Force research and development program. Dissertation completed February, 1976. Research continues.

9. The Development of Aircraft and Doctrine in the Royal Flying Corps, 1912-1914

Principal Investigator: Major Thomas A. Keaney, Department of History

Sponsored by the USAF Academy

Analysis of the peacetime development of the air weapon in Great Britain from the time of the formation of the R.F.C. until the outbreak of the First World War. Dissertation completed October, 1975. Research continues.

10. Blacks in the Army Air Forces During World War II: The Problem of Race Relations

Principal Investigator: Major Alan M. Osur, Department of History

Sponsored by the USAF Academy and the Office of the Chief of Air Force History

There is no question that during World War II the Army Air Forces achieved some success in the area of race relations, such as expanding the role of Blacks. However, the AAF failed to develop a comprehensive policy that was effective in dealing with all the problems that were inevitable with the absorption of large numbers of black soldiers. Four themes are apparent during the war: segregation was

the official policy, but it did not achieve "separate but equal" as facilities and opportunities for Blacks were inferior to those for whites; protest was necessary to effect change; leadership determined the degree of racial harmony attained; and out of the war emerged ambiguous ideas about the future employment of Blacks.

11. U.S. Army Aviation 1963-Present

Principal Investigator: Major David H. Price, Department of History

Explores the maturation of the Army's airmobility concept during and after the Vietnam War. Results of research to be published in U.S. Army Aviation Digest, in four monthly installments, beginning in June, 1976.

12. Biographical Study of Sergei Mikhailovich Soloviev, 1820-1879

Principal Investigator: Major Carl W. Reddel, Department of History

Sponsored by the International Research and Exchanges Board (IREX)

Investigation of the major events and circumstances of the personal and professional life of Russia's greatest nineteenth century historian.

13. Introduction to the "Zapiski" of S. M. Soloviev

Principal Investigator: Major Carl W. Reddel, Department of History

Sponsored by Oriental Publishers

Provides historical background and bibliographical information.

14. S. M. Soloviev's Role in Russian Historiography

Principal Investigator: Major Carl W. Reddel, Department of History

Sponsored by the USAF Academy

Examines impact of Soloviev's ideas and publications on Russian and Soviet historians.

15. Publication History of S. M. Soloviev's "Istoriia Rossii c drevneishikh vremën"

Principal Investigator: Major Carl W. Reddel, Department of History

Sponsored by the USAF Academy

Investigation of extraordinary publishing record of Soloviev's "History," which was reprinted in the 1960's in the Soviet Union and is now appearing in English translation for the first time.

16. The Creation of the GHQ Air Force

Principal Investigator: Major John F. Shiner, Department of History

Sponsored by the USAF Academy

Explores the interplay between the Army General Staff and air-power advocates in the Air Corps from the late 1920's through 1935. This interplay resulted in the creation of the GHQ Air Force. Dissertation completed September, 1975. Research continues.

17. The Divergence of Policy and Power: The American Military and Postwar Foreign Policy (1945-47)

Principal Investigator: Major John F. Shiner, Department of History

Sponsored by the USAF Academy

Explores the growing divergence of U.S. foreign policy and available military power in the 1945-47 period. Major focus is on military force structure and employment potential.

18. The Army and Its Air Corps

Principal Investigator: Major James P. Tate, Department of History

Sponsored by the USAF Academy

A history of the Army Air Corps and its relations with the Army General Staff in the 1920's and 1930's. Dissertation completed October, 1975.

19. U.S. Army Air Corps: 1926-1941

Principal Investigator: Major James P. Tate, Department of History

Sponsored by the USAF Academy

Explores interservice rivalry between the Air Corps and the Navy in the period between the World Wars. Also explores the impact of the Great Depression upon the Air Corps and the efforts to develop modern air forces.

20. Nevada's Figh ing Irishman: Senator Pat McCarran of Nevada

Principal Investigator: Major Stanley J. Underdal, Department of History

Sponsored by the USAF Academy

Biographical study of the influential senator, emphasizing his role during the McCarthy period and his championship of civil and military aviation.

21. On the Road Toward Termination: The Pyramid Lake Paiutes and the Indian Attorney Controversy

Principal Investigator: Major Stanley J. Underdal, Department of History.

Sponsored by AFIT

Examines the roots of the most recent movement to terminate Indian tribal status and force Indians to assimilate into mainstream American society.

22. American Military Missions to Korea: 1882-1896

Principal Investigator: Captain Donald M. Bishop, Department of History

Sponsored by the USAF Academy

An analysis of the role of American military and naval officers in the period which followed the opening of Korea by Commodore Shufeldt in 1882. The investigation emphasizes the modernization impact of the American missions on the social order of the late Yi dynasty and the failure of the Korean armed forces to reform.

The first phase of this research has been published; see the investigator's "Navy Blue in Old Korea: The Asiatic Squadron and the American Legation, 1882-1897," Journal of Social Sciences and Humanities (Bulletin of the Korean Research Center) No. 42 (December, 1975), 49-63.

23. Studies in English on Modern Korean History, 1876-1910: A Critical Bibliographic Survey of Primary and Secondary Sources

Principal Investigator: Professor Young I. Lew, Department of History, University of Houston

Associate Investigator: Captain Donald M. Bishop, Department of History

The 150 most significant primary and secondary historical sources relating to late Yi dynasty Korea in the English language were selected. Each source was annotated. The completed bibliography was submitted to Professor Han-Kyo Kim, the General Editor of the Korean Studies Guide Project, for publication in 1976.

24. Stalag Luft III: An American Experience in a World War II German Prisoner of War Camp

Principal Investigator: Captain Arthur A. Durand, Department of History

Sponsored by AFIT

Describes and analyzes the conditions encountered by the captured American fliers housed in Stalag Luft III and notes the actions taken by the prisoners in terms of internal organization; the fostering of good relations among their own ranks, the structuring of recreational, athletic, educational, and religious programs; and the fostering of covert intelligence and escape activities. Dissertaion completed April, 1976. So far, one publication has resulted from the research: Delmer T. Spivey and Arthur A. Durand, "Secret Mission to Berlin," Air Force Magazine (September, 1975), 115-120.

25. Black Spies in America's Wars

Principal Investigator: Captain George H. Wayne, Department of History

Sponsored by the USAF Academy

Investigation of the presence and contributions of Black spies in America's major wars from the American Revolution to Vietnam.

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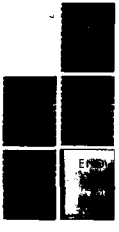

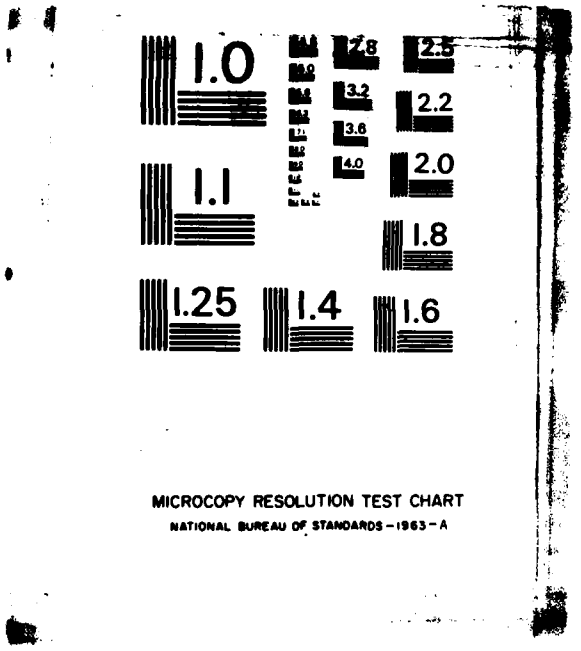

26. Negro Migration to Colorado: 1870-1930

Principal Investigator: Captain George H. Wayne, Department of History

Sponsored by the USAF Academy

Explores the increase in Black population in Colorado after the Civil War. Investigates the attitudes and views of both the Black migrants and the White population during the period. Also explores Black efforts to build towns in Colorado. The town of Deerfield, Colorado, located in Weld county, is presented as a case study. One publication has already resulted from this research; it appears in the January 1976 edition of The Journal of the West.

G. Department of Law

1. Due Process Requirements in Cadet Disenrollment Proceedings

Principal Investigator: Captain Phillip A. Johnson, Department of Law

Sponsored by the USAF Academy

Legal research and opinion concerning procedural requirements for the disenrollment of cadets based upon the due process clause of the Fifth Amendment to the United States Constitution and federal court decisions interpreting that provision.

Publication

"Due Process Requirements in the Suspension or Dismissal of Students from Public Educational Institutions," Capital University Law Review, Winter 1976.

2. Teaching by a USAF Academy Faculty Member During the Summer at a Civilian Educational Institution

Principal Investigator: Captain Phillip A. Johnson, Department of Law

Sponsored by the USAF Academy

Legal research and opinion on the propriety of a member of the USAF Academy teaching at a civilian educational institution during the summer, with a discussion of duty status, receipt of a salary from the institution, and reimbursement for expenses.

3. Legitimated Interposition and International Law

Investigator: Captain Burrus M. Carnahan

Relates the theory of "legitimated interposition," which has been identified as a characteristic of the American legal system, to the international legal order. This provides new insights into both legitimated interposition and the nature of international law.

Publication

Air Force Law Review, Winter, 1975.

4. Legality of Orders

Principal Investigator: Captain Burrus M. Carnahan

Sponsored by the USAF Academy

Legal research into the extent of command authority in American military law, setting forth the tests adopted by military courts to determine the lawfulness of orders, and identifying those situations which have most frequently given rise to disputes. Also discusses the "presumption" that all orders are lawful and the defense of superior orders. This material will be published in the Law 400 text for the Fall of 1976.

H. Department of Political Science and Philosophy

1. A Comparison of Military Elite Role Perceptions in Indonesia and the Philippines

Principal Investigator: Captain Harold W. Maynard, Department of Political Science and Philosophy

This study drew upon military doctrine and military journal literature to create a typology of military elite role perceptions in Southeast Asia. These included all of the following roles: revolutionary, pledged norm, stewardship-leadership, civil-military, external defense, internal security, national development and self-maintenance. Seventy-eight in depth elite interviews were conducted to discover elite background characteristics, professional values, threat perceptions, and elite cleavages. Officers were found to think in terms of dichotomous sets, and the civil-military paradigm was rejected as a useful apriori model.

Publication

Published as a doctoral dissertation.

2. Israel and the PLO: Persistence or Transformation

Principal Investigator: Major Bard E. O'Neill, Department of Political Science and Philosophy

This research analyzes recent developments within the Palestine Liberation Organization and their political implications against the backdrop of the October 1973 War. A number of considerations are outlined which need to be addressed in any negotiations between Israel

and the PLO.

Publication

Published in the Strategic Review, Spring 1976.

3. Insurgent Strategies: An evaluation of Four Approaches

Principal Investigator: Major Bard E. O'Neill, Department of Political Science and Philosophy

After defining insurgency, this article differentiates among the various types of insurgent movements. Four basic insurgent strategies--Leninist, Maoist, Cuban and Urban--are then examined in terms of their relative emphasis on six variables: government response, environment, organization, unity, popular support, and external support.

Publication

To be published in American Defense Policy, 4th edition, forthcoming.

4. Petroleum Security: the Role of the Military Instrument of Statecraft

Principal Investigator: Major Bard E. O'Neill, Department of Political Science and Philosophy

This analyzes the variables affecting the decision to employ military force in two scenarios: Soviet interference with the flow of oil and attempts by radical insurgents to overthrow the regimes in friendly oil producing states.

Publication

This research is currently undergoing security review.

5. Revolutionary Warfare in Oman: A Strategic Appraisal

Principal Investigators: Major Bard E. O'Neill, Department of Political Science and Philosophy, and William Brundage, Cadet at the USAF Academy.

This project focuses on the revolutionary insurgency in Oman which is conducted by the Popular Front for the Liberation of Oman. Discussed here are the origins of the insurgency and the current situation is analyzed in terms of six factors that have an impace on the outcome of insurgencies.

Publication

This research is currently undergoing security review.

6. An Analysis of Possible Policy Changes in Terms of Selected Defense Policy Issues

Principal Investigator: Captain Chris L. Jefferies, Department of Political Science and Philosophy

In anticipation of a broad military strategy review being considered by the Office of the Joint Chiefs of Staff, this study has three objectives: to discern and analyze changes in emphasis from the Nixon Doctrine, to compare the articulated national policy positions with JCS positions where differences may appear, to attempt to define the threads of a force doctrine, if one is emerging.

Publication

Prepared for Strategy Division, Plans and Policy Directorate, OJCS, August 1975. Classified Secret.

7. Decision-making in the Organizational-Bureaucratic Context

Principal Investigator: Captain Chris L. Jefferies, Department of Political Science and Philosophy

This article is an effort to explain organizational and bureaucratic phenomena in decision-making based upon Graham Allison's three

models: the rational actor, the organizational process and the bureaucratic politics. With Allison as a departure point, it then develops a simplified conceptual model of the phenomena to use in analyzing the impact of organizations and bureaucracy on decision-making.

Publication

To be published in American Defense Policy, 4th edition, forthcoming.

8. Final Report: Colloquium on NATO's Southern Flank

Principal Investigators: Captain Chris L. Jefferies and Captain Vic Hackley, Department of Political Science and Philosophy

This is a summary and final report of the findings and conclusions of a series of five colloquiums sponsored by the Air Staff Doctrine, Concepts and Objectives. The colloquium is concerned with the nature of Political changes occurring in three regions of NATO's southern flank: Spain and Portugal, Italy and Yugoslavia, and Greece and Turkey. Political changes here are analyzed in terms of the effect they may have on NATO strategies and operations. Participants included representatives from the Air Staff, Department of State, Rand Corporation, Central Intelligence Agency, Stanford Research Institute, Defense Intelligence Agency, Air Force Academy and BSM Corporation.

Publication

Prepared for Air Staff/AFXOD

9. Japan: The 1975 Debate Over Ratification of the NPT

Principal Investigator: Lieutenant Colonel John E. Endicott, Department of Political Science and Philosophy

This study traced the debate which surrounded the 1975 drive to ratify the Non-proliferation Treaty in Japan, closely examined the

decision-making process and relationship between the Liberal Democratic Party and the Japanese Government, and provided information on why Japan did not ratify the treaty in 1975, though European states were doing so.

Publication

To be published in Asian Survey, October 1976.

10. The Ethics of Leadership

Principal Investigator: Colonel Malham M. Wakin, Department of Political Science and Philosophy

This study investigates the relationship between ethical norms and the requirements of military leadership. Prominent military values such as honor and obedience are identified and analyzed with the aim of suggesting normative benchmarks for the profession. Here it is proposed that one should think less in terms of moral absolutes or ethical relativism than in terms of universal obligations which may conflict when applied to particular situations.

Publication

To be published in the American Behavioral Scientist and in American Defense Policy, 4th edition, forthcoming.

11. Security Implications of Normalization of Relations Between the United States and Cuba

Principal Investigator: Captain Vicente Collazo-Davila, Department of Political Science and Philosophy

This study focused on the military ramifications of normalizing political relations with the government of Cuba. Army, Navy, Air Force, State Department and Central Intelligence Agency sources were consulted

in order to identify the tactical and strategic implications to the U.S. base at Guantanamo and U.S. installations in the Panama Canal Zone. The study concluded that political factors were far more important than military considerations in deciding whether to normalize relations with Cuba.

Publication

Prepared as a secret report for J-5, JCS.

12. Chinese Military Power and Foreign Policy: The Case of the Paracel Islands

Principal Investigator: Captain William R. Heaton, Department of Political Science and Philosophy

The paper examines the use of military force in Chinese foreign policy by comparing China's intervention in the Paracels with other military actions.

Publication

Unpublished, but it was presented at the Western Social Science Association Conference in Denver, 2 May 1975.

13. The Minorities and the Military in China

Principal Investigator: Captain William R. Heaton, Department of Political Science and Philosophy

This research illustrates five areas in which the Peoples Liberation Army has been instrumental in integrating Chinese minorities into the political system and examines the role of minorities within the Army.

Publication

Planned for publication in either Problems of Communism or Military in Society.

14. Inner Mongolia: The Haos and Huais of Chinese Policy Toward the Mongols

Principal Investigator: Captain William R. Heaton, Department of Political Science and Philosophy

This research examined the status of the Mongol minority in contemporary China utilizing the vehicle of two Mongol spokespersons, the first supportive of communist policy and the second in opposition. The paper concluded that an evaluation of communist policy is contingent on the values of the evaluator.

Publication

Presented at the Toronto conference of the International Studies Association, 27 February 1976, and planned for publication in the Journal of Mongolian Studies.

15. Thailand: A Case Study in Counterinsurgency

Principal Investigator: Captain William R. Heaton, Department of Political Science and Philosophy

This study uses five variables to examine the Thai government's response to the insurgency in various parts of Thailand. It concludes that the government's program has not been successful in containing the insurgency, though the insurgency does not yet constitute a major threat to the stability of the Thai policy.

Publication

To be published in American Defense Policy, 4th edition, forthcoming.

16. The Political Element in Military Expertise

Principal Investigator: Major Michael A. Freney, Department of Political Science and Philosophy

The extent and depth of political knowledge required by military professionals has been a matter of considerable debate. There has been

faulty information, however, regarding the political element of military expertise. This research focuses on the senior American, British and Canadian military professional schools dealing with politico-military subjects. Curricula, methodology, student body, faculty composition, and other variables are examined longitudinally over a twenty year base. Similarities and differences are described and analyzed. Findings include the fact that a considerable body of politico-military expertise has existed in the military professions of the three countries without adverse consequences for civilian control of the military.

Publication

Published as a doctoral dissertation.

III. RESEARCH AND ANALYSIS OF SPACE AND WEAPONS SYSTEMS

A. Department of Astronautics and Computer Science

1. Air-to-Air Fire Control Research

a. Laboratory Test of the ASCOT Electro-Optical Tracker Aided by a Digital Estimator

Principal Investigators: Lieutenant Colonel Edward J. Bauman and Major Anthony L. Leatham, Department of Astronautics and Computer Science

A Digital six state estimator was developed to aid the Bendix ASCOT (Adaptive Scan Optical Tracker) in the presence of background clutter. Laboratory tests were conducted at the U.S. Air Force Academy Guidance and Control Laboratory to determine the basic accuracy of the ASCOT in a laboratory environment. During the tests the ASCOT tracker was successfully aided through various kinds of background clutter by two different methods. The first method was to aid the ASCOT in the presence of background clutter using an independent sensor. In the laboratory, this "independent sensor" signal consisted of the true target position corrupted by radar-type noise. The second method was to drive the ASCOT with the digital estimator during the presence of background clutter.

The ASCOT tracker demonstrated remarkably low noise characteristics. The ASCOT noise levels in the laboratory on azimuth and elevation signals were on the order of .25 milliradians or less. The tests substantiated the concept of improving the ASCOT tracker for employment as a sensor in a director type gunsight.

Presentations

"Ascot Tracker Tests for a Director Gunsight Application," presented by Anthony L. Leatham to the Air Force Avionics Laboratory Comparative Gunsight Program Review, Kirtland AFB, NM, 15-17 July 1975.

"Proposed Flight Test Program for the ASCOT/Director Gunsight," presented by Edward J. Bauman and Anthony L. Leatham to the commanders of the Air Force Avionics Laboratory and Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, 30 September 1975.

"On Understanding the Director Gunsight," presented by Anthony L. Leatham to the Air Force Avionics Laboratory Air-to-Air Fire Control Review, US Air Force Academy, CO. 13-15 January 1976. This presentation was rated by the Executive Committee to be the best analytical presentation given at the conference.

Publication

"Laboratory Test of the ASCOT Electro-Optical Tracker Aided by a Digital Estimator," USAFA-TR-76-7, April 1976, by Anthony L. Leatham, Edward J. Bauman, Ronald P. Fuchs, and Charles E. Fosha.

b. Development of a Director Gunsight for Flight Test

Principal Investigators: Lieutenant Colonel Edward J. Bauman, Major Anthony L. Leatham, and Major John W. Moore, Department of Aeronautics and Computer Science

This research effort will result in development of the fire control algorithms, integration of the ASCOT electro-optical sensor and the ROLM 1664 mini-computer to obtain an improved air-to-air tracker, and laboratory tests to determine the performance of the algorithms, sensor, and computer combination. Flight test of the resulting gunsight system is proposed for the summer of 1977 at Tyndall AFB, Florida. The work is sponsored by the Air Force Avionics and Flight Dynamics Laboratories. Participating contractor is the Bendix Aerospace Division.

c. Director Gunsight for an Advanced Fighter

Principal Investigator: C1C Murray E. Daniels, Class of 1976

Associate Investigator: Major Anthony L. Leatham, Department of Astronautics and Computer Science

This effort includes the development of the director gunsight equations, investigation of the effect of certain small angle assumptions on the accuracy of the sight, and a sensitivity analysis of the gunsight to errors in input variables.

d. Scoring Algorithm for Advanced Fighter Gunsights

Principal Investigator: C1C Richard B. Mintz, Class of 1976

Associate Investigators: Major Anthony L. Leatham and Captain Harold L. Daniel, Department of Astronautics and Computer Science

This research effort is to develop a digital computer algorithm which will (1) simulate the steady state tracking of an airborne target with a lead-computing optical gunsight, (2) simulate the firing of bullets, and (3) determine the closest approach of the bullets to the target. This analytical tool is required to evaluate advanced gunsights without a sophisticated man-in-the-loop simulation.

e. Digital Simulation of One-on-One Air-to-Air Combat

Principal Investigator: Captain David A. Willett, Department of Astronautics and Computer Science

A digital simulation of the one-on-one air-to-air combat dynamics of fighter aircraft is being developed for employment in the Department of Astronautics and Computer Science aerospace simulator. The end result will be the ability for a man to "fly" this simulator against a computer graphics target aircraft with both the target and the simulator responding according to the dynamics in the digital simulation. This simulation, when complete, will support both cadet instruction and faculty research.

f. F-16 Gunsight Evaluation

Principal Investigator: Major Anthony L. Leatham, Department of Astronautics and Computer Science

Associate Investigators: Captains Harold L. Daniel and William H. Hohwiesner, Department of Astronautics and Computer Science

This research effort was to investigate the accuracy of the two gunsights proposed by the prime contractor for the F-16 fighter aircraft. Digital simulations of both the proposed lead computing sight and the historic tracer sight were constructed, and each gunsight was evaluated in several maneuvers and compared against accurate standards. The results of the effort were given to the requesting agency, the Aeronautical System Division, Wright-Patterson AFB, Ohio, who in turn directed the contractor to make major changes to correct deficiencies in the gunsight algorithms.

g. Gunsight Heads-Up Display for the Aerospace Simulator

Principal Investigator: C1C Harry Dutchyshyn, Class of 1976

Associate Investigators: Captain Robert J. Kirkpatrick and Major Anthony L. Leatham, Department of Astronautics and Computer Science

The purpose of this project is to develop the computer software which will generate a heads-up display on the GT-40 graphics display system. The display is an advanced fighter gunsight system from the F-4E Austere Heads-Up Display program. The gunsight will be responsive to control inputs from the cockpit of the simulator. The display will be used for both cadet instruction in aerospace simulation and faculty research in advanced air-to-air fire control concepts.

h. Air-to-Air Combat Simulation Support to Tactical Air Command

Principal Investigators: Lieutenant Colonel Edward J. Bauman, Department of Astronautics and Computer Science; Major Robert A. Rappold and Captain Roy R. Kilgore, Department of Mathematics; Major James D. Lang and Major Robert G. Lorenz, Department of Aeronautics

Associate Investigator: Captain David A. Willett, Department of Astronautics and Computer Science

This research is a joint effort between the Departments of Astronautics and Computer Science, Aeronautics, and Mathematics in support of the Tactical Air Command's air-to-air combat simulator at Luke AFB, Arizona. The work is sponsored by the Tactical Air Warfare Center, Eglin AFB, Florida. The objective of the work is to program the dynamic characteristics of the MIG-21 aircraft on the simulator's digital computer. Major Rappold and Captain Kilgore completed schooling on the simulator at Luke AFB in March. The project completion date is scheduled for August 1976 with an anticipated savings to the government of approximately $40,000.

2. Principles of Airborne Fire Control Text

Principal Investigator: Captain William H. Hohwiesner, Department of Astronautics and Computer Science

Associate Investigator: Major Anthony L. Leatham, Department of Aeronautics and Computer Science

Captain Hohwiesner consolidated and summarized current airborne fire control theory and technology into a text for the ASTRO 450 course, "Principles of Airborne Fire Control." This text fills a void in the discipline of fire control engineering since there is no single text or

manual which encompasses the breadth of knowledge required. The text serves as a book for the ASTRO 450 course and also as a widely distributed reference in the fire control engineering community. Major Leatham served as technical advisor, contributing ideas, editing, and clarifying the test material.

Publication

"Principles of Airborne Fire Control," Department of Astronautics and Computer Science, December 1975, by Captain William H. Hohwiesner.

3. Independent Stability and Control Analysis for the Navigation Demonstration Satellite-1 of the Global Positioning System - (GPS) - NAVSTAR

Principal Investigators: Major Thomas J. Eller and Captains Craig A. Baer, Mark A. Dobbels, Ronald P. Fuchs, and George T. Kroncke, Department of Astronautics and Computer Science

Sponsored by GPS Joint Program Office (SAMSO/YE)

The Department of Astronautics and Computer Science is supporting the Global Positioning System program by performing portions of an independent stability and control analysis. Honeywell Systems and Research, Inc., and USAFA/DFACS are jointly verifying the design of the attitude and velocity control system for the NDS-1 satellite which is being manufactured by Rockwell International for SAMSO.

Using the digital simulation program provided by Honeywell, Major Eller and Captains Baer, Dobbels and Fuchs verified nominal performance of the attitude control system in response to various commanded inputs; during eclipse periods; under the influence of solar and magnetic torques; and during earth reacquisition and orbit adjustment maneuvers.

Captain Baer is responsible for the verification of mass properties which is one of the tasks of the overall analysis of the stability and control system of GPS. Its goal is to insure that the mass properties of the fabrication GPS satellite are known and, moreover, that the stability and control system are adequate for the satellite. Specific tasks include computer software verification, calculation of mass properties given component data, and monitoring of mass properties tests/ measurements.

4. The Time Rate Changes due to Relativistic Effects on the Global Positioning System

Principal Investigator: C1C Karl D. Larson, Class of 1976

Associate Investigators: Major John May, Department of Physics, Major Thomas J. Eller, Department of Astronautics and Computer Science

This study examined the significant relativistic effects on the Global Positioning System (GPS). Dilation of the time output from the satellite clock occurs because the speed of the satellite is different from the speed of the master control station on earth. The change in this effect was examined for various time intervals along the GPS satellite orbit for several orbital eccentricities. It was determined that the time dilation effect could be properly evaluated through the use of special relativity theory. This study supported the conclusion that the relativistic correction to GPS satellite time must include the orbital eccentricity.

Publication

USAFA Technical Report in preparation.

5. GPS Satellite Selection Criteria

Principal Investigator: Major Kenneth D. Kopke, Department of Astronautics and Computer Science

In the nominal 3 x 8, 63° inclination constellation, a user may see up to eleven satellites; only four satellites are required to determine user position. Major K. D. Kopke is developing simple algorithms that determine which four satellites will provide for best user accuracy assuming errors are present in the pseudo-range measurements and the user clock.

6. GPS Deployment Using the Space Shuttle

Principal Investigator: C1C Randal L. Richey, Class of 1976

Associate Investigator: Major Richard C. Walsh, Department of Astronautics and Computer Science

Initially, each of the GPS satellites will be deployed using the Atlas-F, two perigee kick motors (PKMs), and an orbit insertion system motor (OIS). The Air Froce has plans to use the Space Shuttle and interim upper stage (IUS) to deploy eight GPS vehicles at once. This study shows that it is possible to deploy eight GPS vehicles sequentially from the Space Shuttle using existing PKM/OIS hardware, thus eliminating the need for the IUS.

B. Department of Mathematical Sciences

1. Strategic C^3 Study Group

Sponsored by the Air Force Weapons Lab (AFSC)

Principal Investigator: Major William T. Hodson, III, Department of Mathematical Sciences

Associate Investigator: Captain James Barry, Department of Mathematical Sciences

The aim of the Strategic C^3 Study Group is to assist AFWL in feasibility studies for nuclear-survivable communications systems to be developed as alternatives to existing systems which are either impossible to assess for survivability, for which the assessments already undertaken are insufficiently reliable and/or for which the cost to "harden" would be prohibitive. Particular attention has been given to network studies for a proposed rocket relay system, a system of ground based UHF repeaters and a network of UHF repeaters mounted on commercial aircraft. Reports on these projects are forthcoming. In addition to these studies, the group has provided critiques for contractor outputs as well as general consulting.

2. Effect of transition on Aerodynamic Coefficients of Hypersonic Reentry Vehicles

Sponsored by Naval Surface Weapons Center (NSWC), White Oak, MD

Principal Investigator: Captain Joseph B. Williams, Jr., Department of Mathematical Sciences

The research is presently in the modeling and analysis stage. A model is being constructed to represent transition fronts on conical bodies. Once I determine that this model is accurate, the transition region will be coupled with the laminar region and aerodynamic forces will be integrated over the body surface. The results will be used to model center of pressure movement on the vehicle.

IV. MANPOWER, PROCUREMENT, AND LOGISTICS STUDIES

A. Department of Astronautics and Computer Science

1. Automation of the Cadet Status Records

Principal Investigator: Captain James R. Legg, Department of Astronautics and Computer Science

Sponsored by CW

This project involves automation of the Cadet Status Record which is currently maintained manually. The project involves the analysis of existing data systems and determining the feasibility of implementing this goal. Several data elements have been created and/or extended. Phase I of this project was approved by CW. This phase is currently in the process of being converted from research to an Air Force Academy production system with implementation scheduled for July 1976. This has been a very successful development effort and the potential cost savings to the Air Force could approximate $30,000-100,000 per year.

2. Cadet Time Analysis System

Principal Investigator: Captain James R. Legg, Department of Astronautics and Computer Science

Sponsored by RRE (Mr. Porter)

This study resulted in development of a system to facilitate the analysis of cadet time survey data and greatly speed up the process of providing an analysis of the data. The system (methodology) in being had a significant time lag and no general way to provide sophisticated analysis or to remove erroneous time survey transactions. The program developed provides a by-squadron, group, wing, class analysis and also

generates a file of good transactions which can be merged with other data. This data can then be analyzed using available statistical packages and may lead to more significant results than previously available. This program is being used to analyze time surveys up to two years old in order to gather more significant results from those surveys. The approximate savings to the Air Force over the next three years exceeds $17,000.

3. Analysis of the Military Order of Merit (MOM) System

Principal Investigators: Major W. J. Lucas, AOC CWDS-15, Major P. W. Loper, AOC CWDS-29, Major V. L. Kapinos, AOC CWDS-05, and Captain James R. Legg, Department of Astronautics and Computer Science

Sponsored by CW

The purpose of this study was to accomplish a complete analysis of the MOM and propose changes to make the system better and more responsive to the needs of the Air Force Academy. This project resulted in changes to the cadet performance report and the relative percentages assigned to the various components of the MOM. The quartile system will be replaced with a "word picture" approach based on standard deviation above and below the mean of the standard composite. The performance report changes include several basic modifications to the Cadet Wing organization and rank structure. The implementation of the new performance report closely parallels the OER in the Air Force.

B. Department of Economics, Geography and Management

1. Variable Obsolescence Rates

Principal Investigator: Captain Michael S. Anselmi, Department of Economics, Geography and Management

Sponsored by USAF Procurement Research Office

This project is an attempt to determine if obsolescence rates for EOQ items can be calculated and utilized in the AFLC EOQ requirements computation system. Currently, AFLC uses a constant obsolescence rate for all 450,000 EOQ items; this constant rate does not take into consideration the peculiarity of some items--some have no obsolescence, while others obsolesce rapidly.

Data was collected from AFLC data systems during FY 75; these data gave us the dollar value of items disposed of by AFLC over that year. At the end of FY 75, the current inventory position of these items was obtained from the EOQ master file, and we are in the process of calculating a rate of disposal for each item. By categorizing the rates by Federal Supply Class (FSC) and weapon system, we hope to be able to incorporate an obsolescence rate that more nearly indicates the true rate for each item. Projected completion date for this project is December 1976.

2. Procurement Productivity Indices

Principal Investigator: Captain Michael S. Anselmi, Department of Economics, Geography and Management

Sponsored by USAF Procurement Research Office

Productivity indices are to be calculated by FY 75 using the programs developed by Lieutenant Colonel Larry M. Austin, Major Donald G. Pursley, Captain Ralph H. Freeman, Lieutenant Wade D. Knight and Lieutenant Marc A. Wooten--see USAFA-TR-74-9. Project completion date for this project is June 1976.

3. General Recruit Quality and Its Relationship with Air Force Technical Training

Principal Investigator: Major Kenneth H. Fleming, Department of Economics, Geography and Management

The research is an attempt to develop a cost minimization model which will generate shadow prices for quality and training trade-offs. The model incorporates inequality constraints to approximate existing Air Force minimum entry level specifications and seeks to answer the question as to whether there is a most efficient method of awarding bonuses. Attention is also focused on the determinants of human productivity.

4. A Conceptual Model for Evaluating Contractor Management During Source Selection

Principal Investigators: Lieutenant Colonel F. Theodore Helmer and Major Robert L. Taylor, Department of Economics, Geography and Management

This report provides the reader with a conceptual model for evaluating a contractor's management potential during source selection. The model is not a definitive outline of what must be done; rather, a discussion of a number of the variables that ought to be reviewed. The reader can then include only those variables most relevant to the task at hand. The model, then, should be viewed as a thought triggering device for source selection panels to define and structure contractor management evaluation during the source selection process. The evaluation of contractor management is divided into three major functional areas: planning, organizing, and controlling. A checklist of variables under each topic is included in the report, with examples of a numerical scoring

system, a color-coded evaluation system, and a descriptive adjective evaluation system. This report should be invaluable to organizations entering into source selection.

Publication

Published as USAFA-TR-76-6, March 1976.

5. Proceedings of the Fourth Annual Department of Defense Procurement Research Symposium

Editor: Major Robert L. Taylor, Department of Economics, Geography and Management

Sponsored by Director of Procurement Policy, HQ USAF, and USAF Business Research Management Center

The 33 papers presented at the Fourth Annual DoD Procurement Research Symposium are published in this volume. Papers are divided into nine topic areas: quantitative approaches, procurement management prior to award, buying for inventory, pricing and estimating, foreign military business, program management, current issues in procurement, information systems, and current procurement research programs.

Award

Presented the 1976 Faculty Service Award by the National University Extension Association Division of Conferences and Institutes, St. Louis, April 1976.

6. USAF Procurement Quality

Principal Investigator: Captain Michael W. Gaffney, Department of Economics, Geography and Management

Associate Investigators: Cadets Facenda, Flynn, Topolski, and Willis, Class of 1975

Sponsored by Director of Procurement Policy, HQ USAF

The study was designed to use opinion research to define and rank order factors which influence the quality of procurement actions in

the $100,000 to $1,000,000 price range. Two questionnaires were mailed to procurement managers in the field. The results indicate that communication among all parties to a procurement action is most essential to insure quality. Also several environmental factors (e.g., case workload) were identified as well as some important educational and experience qualifications for members of the procurement team. These results now must be validated through an analysis of actual procurement actions.

7. Improvement of Aeronautical Systems Division Inflation Forecasting Indices

Principal Investigator: Major John S. Brush, Department of Economics, Geography and Management

Associate Investigator: Mr. John Dorsett, Air Force Management Analysis, HQ USAF

Sponsored by ASD, Systems Command

Applied analytical tools of time series analysis to the problem of improving the accuracy of forecasts for inflation rates of six measures peculiar to weapon system acquisition. Suggested improvements are now being implemented by Systems Command.

Award

Defense Economic Analysis Council Award for Modeling, 1975.

8. R&D Cost Expenditure Pattern Analysis

Principal Investigator: Major William J. Weida, Department of Economics, Geography and Management

A general curve for monetary expenditures during the R&D phase is being developed. This is a Pearl-Reed type curve and it is hypothesized that a rather narrow band encompassing this curve form can be shown to

apply to the general R&D process in all weapons systems acquisitions. Research work on this curve has been completed for the A-10, B-1, AWACS, Maverick, and Minuteman programs with a general confirmation of this hypothesis.

C. Department of Mathematical Sciences

1. Manpower Modeling in Support of CAREERS

Principal Investigator: Captain Robert W. Langley, Department of Mathematical Sciences

Sponsored by MPC/DPMDA

Continuing support of the optimization algorithm for careers job finder. Current tasks include development at a data management routine to allow the algorithm to function in a reduced amount of core consistent with the MPC computer limitations. Additionally, investigation of several starting routines and costing routines is being conducted in an effort to improve solution time. It is anticipated that a worldwide line test will be made in the near future.

2. F-16 Logistical Support Studies

Principal Investigator: Major Charles R. Mitchell, Department of Mathematical Science

This is a research/consulting effort which uses statistical and operations research techniques to aid decision making during the latter phases of acquisition and the early phases of operations on the F-16 aircraft. Current emphasis is on incentive award fee plans and reliability improvement warranties. Future emphasis will be in designing data collections and analysis systems related to reliability/maintainability assessment.

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This is the fifth published Annual Research Progress Report; the editions previous to 1972 were published as Semi-Annual Progress Reports. Further information desired on any project may be obtained by writing to the department listed for the principal investigator, USAF Academy, Colorado 80840.

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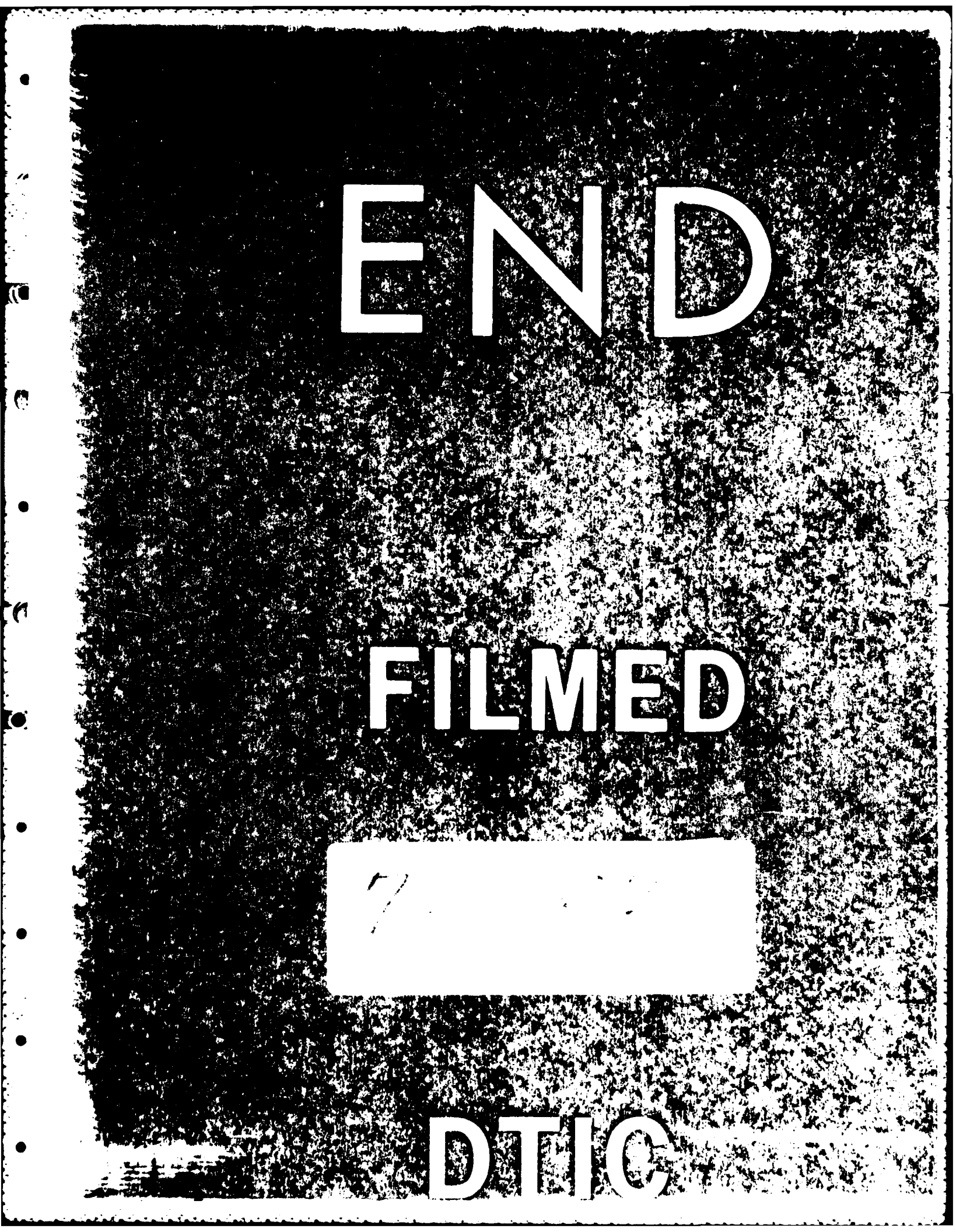
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