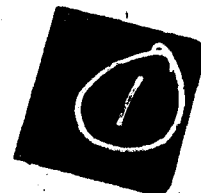


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UNITED STATES AIR FORCE

RESEARCH REPORT

1991

RESEARCH REPORT

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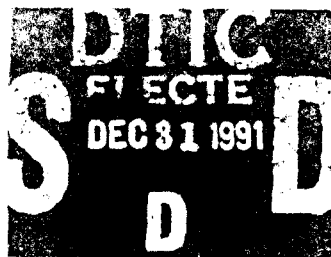
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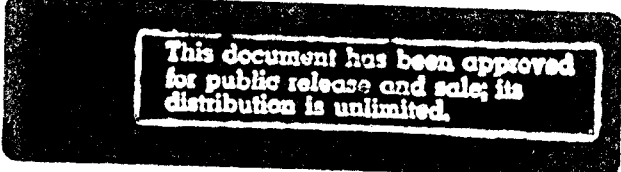
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UNITED STATES AIR FORCE
SUMMER FACULTY RESEARCH PROGRAM
1990
PROGRAM MANAGEMENT REPORT
UNIVERSAL ENERGY SYSTEMS, INC.

Program Director, UES
Rodney C. Darrah

Program Manager, AFOSR
Lt. Col. Claude Cavender

Program Administrator, UES
Susan K. Espy

Submitted to
Air Force Office of Scientific Research
Bolling Air Force Base
Washington, DC
December 1990



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I. INTRODUCTION

Universal Energy Systems, Inc. (UES) was awarded the United States Air Force Summer Faculty Research Program on August 15, 1984. The contract is funded under the Air Force Systems Command by the Air Force Office of Scientific Research.

The program has been in existence since 1978 and has been conducted by several different contractors. The success of the program is evident from its history of expansion since 1978.

The Summer Faculty Research Program (SFRP) provides opportunities for research in the physical sciences, engineering, and life sciences. The program has been effective in providing basic research opportunities to the faculty of universities, colleges, and technical institutions throughout the United States.

The program is available to faculty members in all academic grades: instructor, assistant professor, professor, department chairman, and research facility directors. It has proven especially beneficial to young faculty members who are starting their academic research programs and to senior faculty members who have spent time in university administration and are desirous of returning to scholarly research programs.

Beginning with the 1982 program, research opportunities were provided for graduate students. The 1982 pilot student program was highly successful and has expanded from its initial involvement with 17 graduate students to its current level of 121 graduate students in the 1990 program. Initially the graduate students were selected along with their professors to participate in the program. Starting with the 1985 program, the graduate students were selected on their own merits. The students were assigned to be supervised by either a professor on the SFRP or an engineer/scientist at the participating Air Force Laboratory. The following table shows the growth of this program.

Year	Number of graduate students
1982	17
1983	53
1984	84
1985	92
1986	100
1987	101
1988	107
1989	102
1990	121

Table 1 Growth of GSRP

The 1990 GSRP report is published as four separate documents under the 1990 Summer Faculty Research Program and are entitled, Graduate Student Summer Support Program Management Report and Technical Reports, Volume I, II and III, October 1990.

Follow-on research opportunities have been developed for a large percentage of the participants in the SFRP. In 1979-1983 period this was accomplished through an AFOSR Minigrant Program.

On 1 September 1983, AFOSR replaced the Minigrant Program with a new Research Initiation Program (RIP). The RIP provides follow-on research awards to home institutions of SFRP participants. Awards were made to approximately 50 researchers in 1983. The awards were for a maximum of \$12,000 and a duration of one year or less. Substantial cost sharing by the schools contributes significantly to the value of the RIP.

For the 1985 program, the amount of the RIP was increased to a maximum of \$20,000. The growth of the RIP is shown in Table 2.

Year	Number of SFRP Fellows	Number of RIP Applicants	Number of RIP Awards
1983	101	No Data	50
1984	152	No Data	80
1985	154	120	82
1986	158	141	97
1987	159	124	83
1988	153	126	92
1989	168	134	96
1990	165	N/A	(Approx. 75)

Table 2 Growth of the RIP

Funding and cost sharing for the RIP is shown in Table 3.

Year	Number of RIP's	AFOSR Funding	Cost Sharing
1985	82	\$1,551,091.00	\$782,812.00
1986	97	\$1,932,164.00	\$754,857.00
1987	83	\$1,646,379.00	\$721,398.00
1988	92	\$1,826,152.00	\$967,713.00
1989	96	\$1,900,187.00	\$1,100,081.00

Table 3 RIP Funding and Cost Sharing

Under the SFRP a High School Apprenticeship Program was conducted. This program is described in Section VI of this report.

II. RECRUITING AND SELECTION

The program is conducted on a nationally advertised and competitive selection basis. Advertising for the 1990 program was conducted via direct mail to all accredited schools. The mailing was sent to the department chairman at the schools. The departments included biology, genetics, ecology, entomology, chemistry, computer science, graphics, mathematics, physics, aeronautical engineering, ceramic engineering, chemical engineering, materials science, mechanical engineering, electrical engineering, metallurgy, nuclear science, and psychology. The brochures were also mailed to all of the participants in the 1985, 1986, 1987, 1988 and 1989 programs. Brochures were mailed to the Presidents of Historically Black Colleges. The brochures were sent to all participating USAF laboratories/centers; distribution was made through AFROTC units on university campuses; information was supplied to all who made requests. Overall, more than 17,000 brochures were distributed throughout the country.

Application deadline was February 1, 1990. There were over four (4) applications received for each position available on the 1990 Summer Faculty Research Program. The selection panels met in February. The announcements of selections were mailed on March 1, 1990. In total, 200 offers of position were made for the Summer Faculty Research Program, with 165 professors accepting appointments. Table 4 shows the growth in the number of faculty and graduate students participating in the program.

Year	Number of SFRP Participants	Number of GSRP Participants
1979	70	0
1980	87	0
1981	87	0
1982	91	17
1983	101	53
1984	152	84
1985	154	92
1986	158	100
1987	159	101
1988	153	107
1989	168	102
1990	165	121

Table 4 SFRP and GSRP Participation

III. PRE-SUMMER VISIT (Optional)

Each Summer Fellow was directed to contact the designated representative at the laboratory/center of assignment to discuss a pre-summer visit. The purpose of the pre-summer visit is basically threefold: 1) to meet with laboratory personnel, especially the Effort Focal Point

visit is basically threefold: 1) to meet with laboratory personnel, especially the Effort Focal Point with whom the Summer Fellow would be working most closely, and to become personally acquainted with the laboratory facilities; 2) to finalize and formalize objectives for the Summer Fellow's summer research period and report these to UES; 3) to make arrangements for lodging for the research period. The focus of this visit was on making sufficient preparations so that the ten week summer research effort would be effective.

IV. SITE VISITS

Visits listed below include those by UES and AFOSR personnel. The faculty, USAF research colleagues, and student participants are generally satisfied with the program. Criticisms were: a) too much paper work to administer program, b) housing difficult to find, c) delays experienced in receiving payment d) 10 weeks too short for research period.

June 19, 1990	Arnold Engineering Development Center Arnold Air Force Base, Tennessee
June 20, 1990	Armament Laboratory Eglin Air Force Base, Florida
June 21, 1990	Engineering and Services Center Tyndall Air Force Base, Florida
June 22, 1990	School of Aerospace Medicine HRL: Training Systems Division HRL: Manpower and Personnel Division Occupational and Environment Health Laboratory Brooks Air Force Base, Texas
June 26, 1990	Electronic Systems Division Geophysics Laboratory Hanscom Air Force Base, Massachusetts
June 27, 1990	Wright-Patterson Air Force Base Dayton, Ohio
June 29, 1990	Rome Air Development Center Griffiss Air Force Base, New York
July 10, 1990	Astronautics Laboratory Edwards Air Force Base, California
July 11, 1990	Weapons Laboratory Kirtland Air Force Base, New Mexico

July 12, 1990

Frank J. Seiler Research Laboratory
United States Air Force Academy, Colorado

Because of the proximity of UES to Wright-Patterson Air Force Base, several site visits were made to the following laboratories:

Aerospace Medical Research Laboratory
Aero Propulsion Laboratory
Avionics Laboratory
Electronic Technology Laboratory
Flight Dynamics Laboratory
Human Resources Laboratory
Materials Laboratory
Wright-Patterson Air Force Base, Ohio

We find that the objectives of the SFRP are being well served. SFRP Research Fellows indicate that they are performing independent research, and are not being used as "summer help". There are some misconceptions by research colleagues and summer fellows concerning the purpose of the program; one misconception is that the program is suitable for repeated research efforts by an individual. However, in this program we have found no abuse of the non-personal services requirements. As expected, enthusiasm is high for the possibilities of follow-on funding by AFOSR at the home university. Research fellows often conduct lectures and seminars at the Air Force locations.

As a record of the documentation supplied to the appointees, the UES Information and Appointment Packets are provided in Appendix I of this report.

V. HISTORICALLY BLACK COLLEGES/UNIVERSITIES (HBCU's) WORKSHOP

In support of the Summer Faculty Research Program, and as part of the UES EEO/Affirmative Action Program, UES sponsored an information booth at the NAFEO (National Association for Equal Opportunity in Higher Education) Conference. The conference was held on March 28 through April 1, 1990. UES provided information on the UES-AFOSR summer programs at this conference.

Data prior to 1985 is not available for this report. Table 5 lists the participation of the HBCU's in these programs.

Year	Number of HBCU SFRP Applicants	Number of HBCU GSRP Applicants	Number of HBCU RIP Applicants
1985	76	15	10
1986	70	20	16
1987	82	32	23
1988	53	23	8
1989	39	13	9
1990	43	17	N/A

Year	Number of HBCU on SFRP	Number of HBCU on GSRP	Number of HBCU on RIP
1985	23	11	7
1986	18	10	10
1987	18	10	7
1988	17	14	4
1989	15	4	4
1990	14	3	N/A

Table 5 HBCU Participation

VI. HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP)

As part of the Special Studies section of the Summer Faculty Research Program, UES initiated an Air Force High School Apprenticeship Program in 1986. The purpose of the program was to place highly qualified and highly motivated high school students in the Air Force Laboratories for orientation and training in science and engineering. UES provided the recruiting, selection, and management to start up the Air Force HSAP. Much of the program development was based on the successful Army High School Program and material prepared under the contract to the Department of the Army by the National Institute for Work and Learning. To accomplish this effort, UES followed the schedule presented in Table 1. There were 42 High School students participating in the 1986 program, 73 students in the 1987 program, 101 in the 1988 program, 103 in the 1989 program, and 132 students in the 1990 program.

TABLE 1
AIR FORCE HIGH SCHOOL
APPRENTICESHIP PROGRAM

Calendar of Activities

December	- o Identify schools and laboratories for participation - o Prepare informational material for schools and installations application forms for students and mentors, and covering letters. - o Disseminate information - o Recruit apprentices, mentors
January	o Send student applications to teachers
February	- o Applications with teacher recommendations - o Receive mentors' project descriptions and student requirements - o Make preliminary selection of students for referral to mentor
March	- o Make preliminary matching of students with mentors; send letters with several student applications to each mentor - o Mentors interview students, inform UES of choice
April	- o Send letters of placement to students, with acceptance forms to be signed by them and parents and returned to UES - o Place 2nd year apprentices - o Make final matches - o See that security clearances are started, where applicable - o (Mentors provide background reference material to chosen apprentices) - o Encourage enrichment activities: arrange for films, speakers, tours, etc.
May	- o Send letters to students and mentors re-opening session - o Send students Apprentice Handbook
June	o Arrange general orientation for students and mentors
July, August	- o Administer and monitor apprenticeships - o Check on enrichment activities - o Distribute evaluation forms to students and mentors
September	- o Analyze evaluations - o Prepare final report to Air Force

In the near future the United States may face shortages of scientists and engineers in such fields as physics, electronic engineering, computer science, and aeronautical engineering. High school students are currently not selecting to prepare for careers in these areas in numbers large enough to match the projected need in the United States.

The Air Force faces "a formidable challenge - the acquisition and retention of the technological competence needed to ensure a strong national security, both in-house and in the industrial and academic base which supports defense preparedness." The Director of the Office and Science of Technology Policy in the Executive Office of the President in 1979 responded to this need by requesting the federal agencies to incorporate in their contract research programs the mechanisms to stimulate career interests in science and technology in high school students showing promise in these areas. The Air Force High School Apprenticeship Program is an example of the response to this.

Under this program, UES placed the selected high school students in a wide variety of scientific and engineering fields at the participating Air Force Laboratories/centers. The students worked for an eight-week period during their summer vacations. UES provided all the support and administration to advertise the program, coordinate applications with the Air Force Laboratory mentors, made final selection of student-mentor matches for the summer, made payment to the students during their working period, and collected and coordinated the final reports from the students.

The Laboratories participating in the program, along with the number of high school students assigned to the laboratory is listed below.

<u>Laboratory</u>	<u>"90" Students</u>	<u>"89" Students</u>	<u>"88" Students</u>
Aero Propulsion Laboratory Dayton, Ohio	7	7	4
Armament Laboratory Fort Walton Beach, Florida	16	16	16
Arnold Engineering Development Center Tullahoma, Tennessee	6	0	0
Astronautics Laboratory Lancaster, California	12	10	14
Avionics Laboratory Dayton, Ohio	6	10	9
Electronic Technology Laboratory Dayton, Ohio	5	0	0
Engineering and Services Center Panama City, Florida	15	7	11
Flight Dynamics Laboratory Dayton, Ohio	9	12	12

	<u>"90"</u> <u>Students</u>	<u>"89"</u> <u>Students</u>	<u>"88"</u> <u>Students</u>
Geophysics Laboratory Boston, Massachusetts	7	8	9
Harry G. Armstrong Aerospace Medical Research Laboratory Dayton, Ohio	7	8	9
Materials Laboratory Dayton, Ohio	1	0	0
Occupational and Environment Health Laboratory San Antonio, Texas	3	3	1
Rome Air Development Center Rome, New York	15	15	11
School of Aerospace Medicine San Antonio, Texas	13	7	5
Weapons Laboratory Albuquerque, New Mexico	10	0	0

There were a total of 132 participants in the program selected from 516 High School student applicants. The final report on the High School Apprenticeship Program is published under a separate report entitled United States Air Force High School Apprenticeship Program 1990 Program Management Report.

APPENDIX I

This appendix presents the following documents which were distributed to appointees and other program participants.

- A. Information Brochure for Summer Fellows.
- B. Questionnaire for participants and a summary of their replies.
- C. Questionnaire for Air Force laboratory representative and a summary of their responses.
- D. Questionnaire for participants research colleagues and a summary of their replies.

APPENDIX 1.A

INFORMATION BROCHURE

for

SUMMER FELLOWS

on the

1990 USAF-UES SUMMER FACULTY RESEARCH PROGRAM

March 1990

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I. SUMMER FELLOW OBLIGATIONS

Universal Energy Systems, Inc. (UES) is required by contract to impose certain obligations on you in your status as a Summer Fellow. This section outlines those obligations, and you should read them thoroughly. You are required to sign and return the statement of understanding before the final processing of your appointment can be completed. The following is a list.

1. Pre-Summer Visit: A pre-summer visit to your research location is optional but has been of great value to previous participants in planning the summer research effort. Approval for such a trip may be granted upon approval of your budget by UES along with the concurrence of the Laboratory/Center representative. The purpose of this visit is to enable you to make your final plans for the summer research period if needed. Reimbursement is paid for allowable travel expenses incurred on a pre-summer trip as indicated in the Allowable Travel Expenses section (page 3) of this brochure. To be reimbursed, you must invoice for it as described in the Instructions for Invoicing for Compensation and Reimbursement section (page 5) of this brochure.
2. Research Goals and Objectives: A statement of research objectives must be provided to UES PRIOR TO the start of the summer research period. It should outline your goals and the approach you intend to follow in researching these goals. Neither travel expenses nor expense allowances will be reimbursed until after receipt of your statement of research objectives. The report should also clearly indicate the date of your first working day of the summer research period. In many cases, these will be finalized during the pre-summer visit.
3. Final Report: At the end of your summer research effort, you are required to submit to UES a completed, typewritten scientific report stating the objectives of the research effort, the approach taken, results, and recommendations. Information on the required report format will be sent to you with a "FINAL REPORT INFORMATION BULLETIN" and sample report illustrating a suggested format. The final report must first be approved by your Effort Focal Point and then transmitted so as to reach UES by Sunday, September 30, 1990. Payment of "Compensation" for the final two weeks of your ten-week research period cannot be made until UES has received and approved this report in the required format.
4. Program Evaluation Questionnaire: This critique form should be completed and returned to UES, along with your final report, by Sunday, September 30, 1990. The return of this form is a program requirement; it also must be received by UES before the final compensation payment can be made.

5. **U.S. Air Force - Summer Fellow Relationship:** The U.S. Air Force and UES understand and agree that the services to be delivered by Summer Fellows under this contract will be non-personal services and the parties recognize and agree that no employer-employee or master-servant relationships will exist between the U.S. Air Force and the Summer Fellows. Non-personal services are defined as work performed by an individual who is responsible for an end item, such as a report, free of supervision of the U.S. Air Force and free of an employer-employee relationship.

As a Summer Fellow, you will not:

- (a) Be placed in a position where you are appointed or employed by a Federal Officer or are under the supervision, direction, or evaluation of a Federal Officer, military or civilian.
- (b) Be placed in a staff or policy-making position.
- (c) Be placed in a position of command, supervision, administration, or control over Air Force military or civilian personnel or personnel of other contractors or become a part of the U.S. Air Force organization.

The services to be performed under the SFRP do not require UES or the Summer Fellow to exercise personal judgement and discretion on behalf of the U.S. Air Force; rather, the Summer Fellows will act and exercise personal judgement and discretion on their research programs on the SFRP conducted by UES.

The Air Force will have unrestricted use of and access to all data developed during the period of this appointment.

II. ALLOWABLE TRAVEL EXPENSES

If you live outside of the area (50 miles) where you will be assigned for the summer program, the SFRP provides potential funding for two trips between your home and your assigned research location. As soon as you have signed and returned your appointment letter along with the budget sheet, you will be authorized to receive reimbursement for travel expenses as described below.

As outlined in the Summer Fellow Obligations section in this brochure, you may make a pre-summer visit in addition to the trip to and from your assigned research location for your summer effort. You are expected to make your own arrangements for these trips, and after the trips you may invoice UES for reimbursement of allowable expenses in the format described in the Instructions for Invoicing for Compensation and Reimbursement section of this brochure. Closely coordinate your travel plans with your FOCAL POINT.

All travel reimbursements under Summer Fellow appointments are made according to current UES policy, and deviations from the approved budget are not authorized and will not be reimbursed. In light of these restrictions, you may choose either to travel by common carrier at coach rates or less, by driving your private auto, or by a combination of both. (Please note that funding for rental cars requires ADVANCED WRITTEN approval by UES and UES will not reimburse this expense unless the prior written approval is obtained.) With any of these choices you may claim reimbursement up to the amount for the most direct routing, taking into the account the desirability of routing on interstate highways if you drive your private auto.

Reimbursement for direct route travel by common carrier will be paid on your submission of an invoice to UES following the invoicing instructions referenced above. In the view of the convenience of having a car at the research location, UES strongly recommends that a private auto be used for travel when practical. Reimbursement when you drive your private auto is at the rate of 25¢ per mile within the above routing restrictions and will be paid on submission of a suitably prepared invoice. These reimbursements cannot be extended to cover travel by your family if they accompany you on either of these authorized trips.

During the pre-summer visit, you will be authorized to claim a per diem reimbursement at the rate of \$50.00 per day for a maximum of three days spent at your assigned research location outside of your area of residence. Instructions for claiming this per diem are also described in the Instructions for Invoicing for Compensation and Reimbursement section of this brochure.

During the ten week summer research period, you will be authorized to receive an expense allowance in lieu of a per diem payment at a rate of \$45 per day for a maximum of 70 days. To receive this allowance, you must invoice for it and be living (50 miles) outside your area of residence.

These items above are the only reimbursable travel allowances authorized under the SFRP appointment. Any additional travel expenses incurred during the appointment period will be your personal responsibility.

UES has arranged with a travel office in Dayton, Ohio, to have the Air Fare costs of your travel on the SFRP charged directly to UES. For you to take advantage of this you must call this travel service. The number in Dayton, Ohio, is 293-7444 or 1-800-628-6668. You must give the code SLI3 to have the tickets charged to UES. Please reference project 210 when ordering tickets.

III. INSTRUCTIONS FOR INVOICING FOR COMPENSATION AND REIMBURSEMENT

Attached is a copy of the Invoice Format that you are required to use to obtain compensation or reimbursement from UES. Note that all disbursements by UES for compensation, travel, and/or other expenses are subject to audit approval, so you must submit receipts substantiating charges invoiced.

In addition, you must prepare, sign, date and attach to each completed invoice a Brief Report of Effort

A. PREPARATION OF BRIEF REPORT OF EFFORT

Whenever you submit an Invoice for reimbursement to UES you must also include a brief report describing your activities for the invoice period. To meet this obligation, you must prepare, date, sign, and attach to your completed invoice a Brief Report of Effort describing the research accomplished on the appointment and explain any travel during the invoice period.

This report should describe innovative techniques and designs or discoveries which may be disclosed as patents. Rights to any inventions or discoveries shall reside with UES unless determined otherwise by the contracting agency.

The Brief report should never exceed one typewritten page and most often should be considerably shorter than one page.

B. PREPARATION OF INVOICE FORMAT

The financial items required on the Invoice Format are for COMPENSATION, TRAVEL, EXPENSE ALLOWANCE, AND PER DIEM.

Item (1) SOCIAL SECURITY/MAILING ADDRESS

Fill in your name, social security number, and address to which you wish to have your check mailed.

Item (2) COMPENSATION

- (a) Indicate the dates for which you are claiming compensation, and indicate the number of days you are claiming for compensation, this may include holidays, such as July 4.
- (b) Multiply this number by \$132.00 and enter the total dollar amount in the blank total charges for service. The accumulated total number of days you claim on this appointment may not exceed the number authorized in your appointment letter.

Item (3) TRAVEL

- (a) Under the heading Date indicate the date you departed on your trip and the date you arrived at your destination. If you are invoicing for a round trip, also list the date you departed on your trip and the date you arrived home.
- (b) Under the heading Dept/Arrival Time list the departure and arrival times for the corresponding days you listed under Date.
- (c) List your destination under the heading Destination.
- (d) Under the heading Mode, indicate your principal means of conveyance; i.e., commercial air, private auto, etc.
- (e) Under the heading Amount, itemized these expenditures for travel reimbursement. Continue them on a separate sheet if necessary.
- (f) Total these travel items and enter the dollar amount for travel in this invoice on the line to the right of Total Travel Expense.

Item (4) EXPENSE ALLOWANCE

This item on the invoice will be used to claim the \$45 per day expense allowance.

- (a) In the first blank to the right of EXPENSE ALLOWANCE enter the number of days for which you are claiming the expense allowance at your assigned research location.
- (b) Multiply this number by the daily allowance rate of \$45.00 and enter this total dollar amount in the blank at the far right.
- (c) Itemize the days for which you are claiming the Expense allowance reimbursement. It can include weekend days and holidays as well as regular work days. It does not apply to the pre-summer visit.

Item (5) PER DIEM

This item will be used to claim reimbursement only for Per diem charges on the optional pre-summer visit. This cannot exceed three days; only days spent at the actual research site are allowed.

- (a) In the first blank to the right of PER DIEM enter the number of days reimbursement being requested. This entry must correlate with an accompanying lodging receipt.

- (b) Multiply this number by the \$50.00 daily Per diem rate and enter the total dollar amount in the blank at the far right.

Item (6) **INSTRUCTIONS**

You may combine reimbursement requests for compensation, travel, and Per diem or expense allowance in the same invoice. The total for all items invoiced should be indicated on the blank labeled "Total Amount of Bill" in the lower right hand side of line 6.

- Item (7) If you have arranged your travel through the UES travel office as described on page 4, please indicate the cost of the tickets on this line.

IMPORTANT: Indicate in the space provide on each invoice the address to which you want the check mailed.

You must sign and date your invoice in the space provided as "Summer Fellow" before it is submitted; you **MUST** also have your Focal Point countersign the invoice before it is mailed to UES. Your Focal Point is an Air Force individual at your research location who will be identified prior to your effort start date. If you encounter problems, contact the UES office.

Invoices should be mailed to:

Universal Energy Systems, Inc.
SFRP Office
4401 Dayton-Xenia Road
Dayton, Ohio 45432

IV
BILL FOR SERVICE

1. _____
Name (First, Initial, Last) Social Security # _____

Address (Street, City, Zip)

SERVICE: SFRP Summer Fellow

SERVICE AUTHORIZED BY: Rodney C. Darrah RATE AUTHORIZED: \$132.00/day

This service is for: Project # 210 Government Contract No. F49620-88-C-0053

2. DATES OF SERVICE: _____ TOTAL DAYS OF SERVICE _____
TOTAL CHARGES FOR SERVICE: _____

ADDITIONAL ITEMIZED REIMBURSABLE EXPENSES:
(receipts required for airline tickets)

3. TRAVEL: DATE _____ DEPT/ARRIVAL TIME _____
DESTINATION MODE _____ AMOUNT _____

4. EXPENSE ALLOWANCE: (____ days at \$45.00/day) \$ _____

5. PER DIEM: (____ days at \$50.00/day) (Pre Summer Visit) \$ _____

6. TOTAL AMOUNT OF BILL: _____

7. AIR FARE TICKETS CHARGED DIRECTLY TO UES AMOUNT \$ _____
(Receipts Required for Airline Tickets)

Summer Fellow Signature - Date Telephone

Invoice Approval: _____
Effort Focal Point Signature

X _____ Brief Report of Effort
Type or Print Name Attached _____

Location: _____

Telephone: _____ Date: _____

Send bill to:
UNIVERSAL ENERGY SYSTEMS, INC.
ATTN: SFRP Office
4401 Dayton-Xenia Road
Dayton, Ohio 45432

In order for UES to provide quick turn around of your bills for service, we request your assistance in complying with the following schedule. The dates indicated are the dates your bills **MUST** be at UES. Please allow adequate mailing time for UES to receive your bills by the dates indicated for 1990

DATES BILLS MUST BE AT UES

April 6, 23
May 8, 23
June 7, 21
July 6, 23
August 8, 23
September 6, 21
October 8, 23
November 8, 22
December 6, 21

DATES CHECKS WILL BE MAILED

April 16, 30
May 15, 30
June 15, July 1
July 16, 30
August 15, 30
September 17, Oct. 1
October 15, 30
November 15, 30
December 17, 31

For bills received on or before these dates, UES will be able to process checks to you in the mail by the 15th and 30th. For bills received after these dates, the checks may not be processed until the next pay period, causing a two week delay in your receiving your check.

Your bill may be for any period of time. It does not have to start on a Monday or end on a Friday. Your bill may be for any period convenient for you to meet our billing dates listed above. Please note these are the dates the bill must be at UES. For example, a bill received on or before April 6 will be mailed out to you on April 17. A bill received on April 7 will not be mailed until the April 21 bills are processed on May 1.

1990-91 RESEARCH INITIATION PROGRAM

As a participant in the 1990 Summer Faculty Research Program (SFRP) you are eligible to submit a proposal for the AFOSR RIP Program, as discussed in the 1990 SFRP Program Brochure.

To compete for a RIP Program award SFRP participants must submit a complete proposal and proposed budget either during or promptly after their SFRP appointment period. Each proposal will be evaluated for technical excellence, with a special emphasis on relevance to continuation of the SFRP effort, as determined by the Air Force Laboratory/Center. The most effective proposals are those closely coordinated with the SFRP Effort Focal Point and which follow the SFRP effort with proposed research having strong prospects for later sustained funding by the Air Force Laboratory/Center.

The maximum award under the RIP Program is \$20,000 plus cost-sharing by your University/College.

The total funds available from AFOSR will limit the number of awards to approximately 75, or one-half of the 1990 SFRP participants. The final decision on funding a proposal is the responsibility of AFOSR.

The mechanics of applying for a RIP Program award are as follows:

- (1) Program proposals for \$20,000 plus cost-sharing must be submitted no later than November 1, 1990. Budgets must include, where applicable, Principal Investigator time, graduate assistant and support effort, equipment and expendable supplies, travel and per diem costs, conference fees, indirect costs, and computer charges. No special format is required, however cost sharing must be indicated on the budget if applicable.
- (2) Proposals are evaluated and a final award decision is recommended by AFOSR after consultation with the Laboratory/Center.
- (3) Subcontract awards will be negotiated with the employing institution, designating the individual as Principal Investigator, with the award period having a start date no earlier than October 1, 1990 and a completion date no later than December 31, 1991. The performance period of the research may not exceed one year. Employing institutions are encouraged to cost-share since this Program is designed specifically as a research initiation procedure.

1990-91 RESEARCH INITIATION PROGRAM

Page 2

In summary, a RIP Program proposal must be:

Technically excellent;
A continuation of SFRP work:
Received no later than November 1, 1990
Budgeted not to exceed \$20,000 plus cost-sharing
Less than one year duration.

Proposals for the RIP Program should be transmitted to UES as soon as possible. Some awards may be made prior to the submission deadline. The first RIP awards are planned to be in effect during the month of December 1990. All awards are expected to be in effect shortly after the final submission deadline of November 1, 1990, with final negotiation with your University completed by January 1, 1991.

Send completed proposals to:

RESEARCH INITIATION PROGRAM
Universal Energy Systems, Inc.
4401 Dayton-Xenia Road
Dayton, Ohio 45432

APPENDIX 1.B

PARTICIPANTS' QUESTIONNAIRE REPLY SUMMARY

**UES 1990 EVALUATION RESPONSE
QUESTIONNAIRE EVALUATION SUMMARY
(Participant)**

1.	<u>Assignment in field of competency and/or interest?</u>	Yes - 161
		No - 1
2.	<u>Reasonable choice of assignment?</u>	Yes - 155
		No - 7

If no, why?

Topic was selected by lab. (ATL)

Only one project of a legitimate research nature was being conducted by the group.
(SAM)

One summer fellow indicated no choice, but had discussed the problem earlier. (WL)

One indicated that there was no choice in the research topic. Another that the topic had to be mutually agreed upon. (WRDC/APL)

Suggestion for a better, more challenging approach to the topic was not acted on.
(WRDC/ML)

No Comment: (AAMRL, AEDC, AL, ESC, ESD, FJSRL, GL, HRL, OEHL, RADC, WHMC, WRDC/AL, WRDC/ETL, WRDC/FDL)

3. Work challenging? Yes - 158
No - 2

If no, why?

Did not involve generation of new data or results. (WRDC/FDL)

Could have been more challenging by mutual interaction. (WRDC/ML)

4. Would you classify your summer effort as research? Yes - 155
No - 7

Comments:

Three indicated that the work was developmental. (AEDC)

It was developing an experimental facility to be used for research. (AL)

Project involved the theoretical literature search, not experimental empirical research.
(GL)

Primarily literature review research and development of experiments. (HRL)

One commented the research effort was the first such for the parameters, another spent considerable time to understand Air Force problems and needs. A third indicated that it was not true scientific, experimental research, rather information gathering and compiling. (OEHL)

One commented that the work was of investigative nature. (RADC)

One indicated opportunity to investigate and draw conclusions. (WRDC/AL)

Did not require an advanced degree. (WRDC/FDL)

No Comment: (AAMRL, ATL, ESC, ESD, FJSRL, SAM, WHMC, WL, WRDC/APL, WRDC/ETL, WRDC/ML)

5. Were your relations with colleagues satisfactory? Yes - 157
No - 4

If no, why?

The people at the lab seemed to do more research management, rather than research. Research colleague did not contribute to research, but rather provided information about the problem of interest. (ATL)

One professor indicated that the colleagues were unfamiliar with the technical difficulties and one was particularly hostile towards engineers and have very little technical contribution to the research effort. (ESC)

One summer fellow commented that he/she was only source of technical expertise. (RADC)

Capabilities were not exploited - differing concepts of "research". (WRDC/FDL)

No Comment: (AAMRL, AEDC, AL, ESC, FJSRL, GL, HRL, OEHL, SAM, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/ML)

6. Suggestions for improvement of relationships.

Conduct a seminar series on a variety of topics. It would be an opportunity to meet other SFRP participants and to find out more about other labs on the base. (AAMRL)

It was suggested that laboratory colleague spend more time with professor. (AEDC)

Suggestions included supplying participants with technical information before the summer research begins and more communication and discussion and more visits to the lab. (AL)

Encourage labs to match summer faculty with people actually doing research, rather than people managing research contracts. (ATL)

Provide an organization chart and roles of position. One suggested that the colleague remain in his own area of expertise and competence and stay out of engineering. (ESC)

Limit TDY for Air Force colleagues. (FJSRL)

The project did not lend itself to a team effort, did not get to present a seminar. (GL)

Suggestions included having the colleagues spend more time in direct consultation and less time TDY and concerned with the confusion caused by the planned re-organization. (HRL)

One indicated being "left out", another a need to maintain stronger relationships. (RADC)

Two suggested longer pre-summer visits. Two also indicated problems with obtaining needed supplies/materials due to procurement delays. Two indicated a need for more interactions with Air Force colleagues such as regular weekly meetings. (SAM)

Suggestions included having better facilities, and direct means of continuing follow-ons. (WRDC/AL)

The colleague should be intimately involved in the research. (WRDC/APL)

Colleagues should be familiar with researchers' technical area; clear understanding that the project will not be just a 10 week assignment. (WRDC/FDL)

More interaction at a professional level, more flexibility. (WRDC/ML)

No Comment: (ESD, OEHL, WHMC, WL, WRDC/ETL)

7. Were you afforded adequate facilities? Yes - 153
No - 8

If no, why?

There was a computer shortage. A personal terminal was finally obtained from another branch. This shortage seems to be a temporary problem, otherwise, facilities were fine. (ATL)

While indicating that the facilities were excellent and support from the chemistry division was superb, one response indicated that the support from the immediate colleague was less than satisfactory. The colleague was reluctant to assist in the effort. (ESC)

The computer facilities were inadequate, equipment and software was dated. (FJSRL)

Secretarial support would have been helpful. (HRL)

Comments included not enough computers; no genuine imagery; no clearance. (RADC)

Since research laboratory was still in embryonic phase, little research was accomplished.
(SAM)

Due to facility expansion, a stable terminal with internet access was not provided.
(WRDC/AL)

Computing facilities not adequate. (WRDC/FDL)

No Comment: (AAMRL, AEDC, AL, ESD, GL, OEHL, WHMC, WL, WRDC/APL, WRDC/ETL, WRDC/ML)

8.	<u>Accomplishment in ten weeks?</u>	More than expected - 33
		Less than expected - 21
		About what expected - 107
9.	<u>Will you continue this or related research efforts?</u>	Yes - 153
		No - 9
10.	<u>Were you asked to present seminars?</u>	Yes - 100
		No - 62
11.	<u>Were you asked to participate in meetings?</u>	Yes - 98
		No - 64
12.	<u>Did you travel on behalf of the laboratory?</u>	Yes - 13
		No - 149
13.	<u>Did you participate in "special" meetings?</u>	Yes - 61
		No - 100

14. Please give other comments on extra activities.

One indicated attending a picnic, another attended an air show. (AAMRL)

One mentioned the Branch picnic. (ATL)

Mentioned were the farewell picnic, monthly picnic and military science conference, and commander installation ceremony/reception. ((ESC)

Wrote a paper on Simulation and will present the results in the Southeast Simulation Conference in Huntsville, Alabama. (ESD)

Picnic was enjoyable. (FJSRL)

Air Show, visited local university, frequent informal discussions group. (GL)

Visited the LAMP project. (HRL)

Tour of four labs was worthwhile; visited neighboring universities; brown-bag lunches; and social gatherings after hours. (SAM)

Attended military parade and graduation ceremonies, toured trainee facilities, watched training process for a day, was a participant observer in Wellness program that we assessed. (WHMC)

Comments included using the library and visiting with other scientists. (WL)

Two responses mentioned a tour of the laboratory and dinner at Officer's Club. (WRDC/FDL)

No Comment: (AEDC, AL, OEHL, RADC, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/ML)

15.		A (High) . . . D (Low)			
	<u>Technically challenging?</u>	A- 110	B-46	C- 6	D-0
	<u>Future research opportunity?</u>	A-119	B-35	C- 6	D-2
	<u>Professional association?</u>	A-123	B-31	C- 6	D-2
	<u>Enhancement of my academic qualifications?</u>	A- 83	B-62	C-12	D-1
	<u>Enhancement of my research qualifications?</u>	A-102	B-50	C-10	D-0
	<u>Overall value?</u>	A-127	B-33	C- 1	D-1

B. ADMINISTRATIVE ASPECTS

1. How did you first hear about this program?

Colleagues	- 51
Advertisement	- 6
Air Force	- 16
Direct Mail	- 86

2. Decisive aspect of application?
NOTE ON THIS QUESTION, APPLICANTS HAD MORE THAN ONE ANSWER

Area of possible future research funding	- 42
Good research opportunity	- 110
Opportunity to work with USAF	- 35
Location	- 14
Financial support	- 7
Chance of publishable result	- 0
Flexible research schedule	- 0

3. Did the program timetable cause you any problems?

Yes	- 21
No	- 141

4. Program information satisfactory?

Yes	- 139
No	- 23

5. Did you have problems in domestic aspects? Yes - 21
No - 139

If yes, explain.

One participant was unable to leave his family for the summer. He ended up commuting 150 miles a day. Another mentioned the difficulty in finding an apartment. (AEDC)

Finding suitable housing for so short a period is difficult and expensive. (AL)

Two indicated a promise of housing in the VOQ, but upon arrival, no space was available; another that the Base community was not very socially welcoming. (ESC)

One indicated that his/her family had other responsibilities and were not able to accompany for the summer. (FJSRL)

Very little help was given with regard to these aspects. The summer fellows met as a group only once. There was no interaction. Housing is expensive. (GL)

Not allowed to eat at the NCO mess; summer in Phoenix is a bit trying. (HRL)

Three indicated a problem with housing for the 10 weeks. (RADC)

Housing is difficult to find and very expensive for short-term. 12 weeks is better. (SAM)

Finding an apartment for just three months. (WRDC/APL)

Problems mentioned were short term housing and establishing social contacts. (WRDC/FDL)

No Comment: (AAMRL, ATL, ESD, OEHL, WHMC, WL, WRDC/AL, WRDC/ETL, WRDC/ML)

6. Stipend level? Generous - 6
Adequate - 117
Meager - 39
7. Travel reimbursement? Adequate - 129
Inadequate - 17
N/A - 16

NOTE. THAT NOT EVERYONE WENT ON A PRE-PROGRAM VISIT

8. Pre-program visit? Essential - 107
Convenient - 34
Not worth expense - 3
N/A - 18

9. Housing information?
- | | |
|-----------|------|
| VOQ | - 15 |
| Apartment | - 87 |
| Other | - 60 |
10. Mailing list suggestions?
 ASEE, Department heads. (AAMRL)
 ASME Magazine, AIAA magazine. (AEDC)
 Chemistry and Chemical Engineering News. (AL)
 IEEE Spectrum, SIAM, AIAA Journals. (ATL)
 Chemical and Engineering News, American Chemical Society. (ESC)
 IEEE Spectrum or AIAA Journals. (ESD)
 ASC (Chemistry and Engineering News). (FJSRL)
 AAAS, Bulletin of the American Meteorological Society (AMS), American Association of Physics Teachers, AIAA, Physics Today. (GL)
 National Psychomonics Society, Black Education University "Grants" offices. (HRL)
 Chronicle of Higher Education, Science. (OEHL)
 IEEE Spectrum, ACM (RADC)
 Science, Society for Industrial Microbiology, American Society of Engineering Educators. (SAM)
 American Psychological Association's Monitor, Chronicle of Higher Education. (WHMC)
 American Math Society, Society for Industrial and Applied Math. (WL)
 IEEE. (WRDC/AL)
 Physics Today. (WRDC/ETL)
 ASEE. (WRDC/FDL)
 No Comment: (WRDC/APL, WRDC/ML)
11. Addition of Graduate Student Program increased effectiveness of program?
NOTE THAT NOT EVERY FACULTY MEMBER HAD A GRADUATE STUDENT WORK WITH THEM. THEREFORE, THEY DID NOT ANSWER THIS QUESTION.
- | | |
|-----|-------|
| Yes | - 121 |
| No | - 7 |
12. Did a student work with you?
- | | |
|-----|-------|
| Yes | - 59 |
| No | - 103 |
13. Program administration overall rating?
- | | |
|-----------|------|
| Excellent | - 99 |
| Good | - 57 |
| Fair | - 6 |
| Poor | - 0 |
- 14a. Comments on the strong points of the program:
 Most responses indicated the research opportunities offered by the program. Also included in the comments were the facilities and equipment available for the research. Several indicated that the opportunity to initiate research interests. The follow on mini grant opportunity was mentioned by several. The research freedom was a factor. One mentioned the graduate student opportunities. (AAMRL)

The interaction with colleagues and peers was mentioned by six of the faculty. one mentioned that for faculty at small schools with limited research opportunities it provides an extremely valuable experience. The support and help of the host personnel as well as the teamwork was noted. The opportunity to manage research procedures and the computational facilities and equipment were seen as strong points. The opportunity for future funding was also mentioned. (AEDC)

Several mentioned the research opportunities offered. Two found the experience of being able to pursue the research for 10 weeks without the interruption on teaching or administration very rewarding. Two mentioned the establishment of links with the Air Force researchers. One mentioned the support for graduate students. (AL)

The opportunity to work at the research laboratory was mentioned by 8 of the summer fellows. A few mentioned the possibility for expanding research interests. The equipment and facilities were seen as strong points as was the exposure to the research interests of the Air Force. The graduate student opportunity was mentioned by one. (ATL)

Five mentioned the facilities and equipment available for the summer. Five also mentioned the opportunity for introduction to problems of Air Force interest. The cooperation of the Air Force and UES was also seen as a strong point. (ESC)

Interchanging ideas between industry and academic circle. (ESD)

Several mentioned the research facilities and the opportunity to interact with the Air Force Researchers. Also mentioned were the funding potentials, the opportunity to bring graduate students, and the interaction with other faculty members. (FJSRL)

Several mentioned the research follow on possibilities and the opportunity for exposure to research interests of the Air Force. Two mentioned the program was well organized and well conceived. Others mentioned the flexibility to start visit, opportunity to do research. (GL)

Seven of the respondents mentioned the chance to learn about the research being conducted by the Air Force and the opportunity to exchange ideas with the Air Force researchers. Five noted the chance for a follow on effort through the RIP and other Air Force programs. Several mentioned the opportunity to be exposed to Air Force concerns. Two noted the opportunity for the faculty to expand their interests. Others mentioned the opportunity to bring graduate students through the GSRP. Several mentioned the flexibility and research freedom offered under the program. Others noted the stipend, the turnaround time from application, opportunity to work without university distractions, and the opportunity to work in a different area of the country. (HRL)

Two mentioned the opportunity to work with Air Force researchers and use equipment and facilities. Also cited were the relative ease with which the budgets are set up and the dissemination of these funds; the dialogue which is developed between the college faculty and the service people in these labs; the salary; the flexibility in scheduling individual programs and the ability/knowledge of UES personnel in answering questions. (OEHL)

Nine of the summer fellows mentioned the opportunity to work with the Air Force researchers and become involved in the research interests of the Air Force. The research equipment available was seen as a strong point of the program. The follow on funding if the RIP was mentioned by several fellows. Also seen as strong points were the UES support, the opportunity to bring a graduate student under the GSRP, the UES/AFOSR luncheon, the opportunity to perform research away from the university, and the excellent matching of applicants with associated labs. (RADC)

Five summer fellows mentioned the research opportunities, facilities, equipment, etc. Establishing a project with potential future funding was mentioned by five fellows. Several mentioned the opportunity to work with Air Force researchers. Also noted were the UES program administration, rapid processing of applications, minimum of paperwork, work on practical problems, the quality of the Air Force researchers, and the seminars with other participants. One fellow noted that the program promotes better relations with the university which were severely weakened during the Vietnam War. (SAM)

Relative freedom to explore research areas in a situation that removes the faculty member from university politics as well as from teaching responsibilities. It's an oasis. (WHMC)

All of the summer fellows mentioned the opportunity to work with the Air Force researchers. Also mentioned was the opportunity to learn of the needs of the Air Force, to get out of the class room, and meet with peers at a research facility. (WL)

Six mentioned the research opportunities. The chance to become involved in Air Force related research interests was also seen as a strong point. Also mentioned was the organization and handling of details by the Air Force and UES. The stipend, mini-grant, and "real world" experience were seen as strong points. (WRDC/AL)

Several mentioned the Air Force research opportunities. Training in new advanced technology and/or new areas of interest was also mentioned. Additional items mentioned were: Mini-grant, GSRP, flexible scheduling, opportunity to do experimental research not possible at the university, working with the Air Force researchers, facilities, flexibility of the research topics. (WRDC/APL)

Among the strong points were the research and library facilities, the research freedom, the open communications, the chance to associate with Air Force researchers, and the length of the program. (WRDC/ETL)

Four of the researchers remarked on the opportunity to work with Air Force Researchers. Three indicated the facilities and equipment available. Two mentioned the establishing of contacts at the Air Force and two indicated the involvement of students in the program. Also mentioned as strong points were the library facilities, the interesting practical projects, the interaction with laboratory personnel and the positive effect on teaching. (WRDC/FDL)

Several mentioned the opportunity for introduction to research interests of the Air Force and the opportunity to work with Air Force researchers and the use of the facilities and equipment. Also mentioned was the RIP follow on funding that the program offers. The overall program philosophy and the choice of research areas and locations were pointed out. (WRDC/ML)

14b. Comments on the weak points of the program:

Two thought that the time frame was too short. Stipend was mentioned by three. The amount of mini-grant is too small. One had problems with the effort focal point and a lack of communication with other visiting summer faculty. (AAMRL)

Lack of interaction with other summer fellows and base personnel. Lack of quick access to some needed publications. Job was too development oriented. The time constraints. Low stipend; necessity to travel. (AEDC)

Two mentioned the location of the base. Three felt the research period needed to be longer. One suggested a 10 to 12 week option. One felt the stipend was too low. (AL)

Noted as weak points were: project was developmental not basic research, inadequate stipend, poor communications within the lab, difficult to determine the long-term interests of the lab, computer hardware and software availability. (ATL)

Included in the weak points were: housing, lack of computers, 10 weeks too short, no material funds, no tax deducted from pay, and stipend too low. One felt their colleague was not technically competent and one felt the colleagues should all have PhD's. (ESC)

Each participant should be qualified working for at least two summers. The second summer would be more valuable to both sides. (ESD)

The ten week period was seen as too short by three summer fellows. One stated the pre summer visit was too short. One complained of payment problems with UES. (FJSRL)

Two thought that the reimbursement for expenses was inadequate. Other comments included: There was no program for the summer fellows as a group. Information about the individual laboratories such as facilities and local scientists would be very useful for visiting faculty. A more detailed description of the research areas of various labs, and names of contacts in the labs, would be useful in choosing a research site. No support for non green card graduate students. (GL)

Two indicated the stipend was too low. Additional comments included: The housing was a problem. Apartment was too expensive and too far from the lab (20 miles). Participants should be allowed to stay on base. Limited resources. Lack of networking and knowing about ongoing work. Orientation could be improved. Too many rules and regulations - biweekly reports, for example. Too much paper sent. The buffet dinner with introduction of all participants. The initial packet of information had many errors, that made it confusing. The invoice sheet should be redone so that the space is better utilized given the requested info. Too short. Selection is not based primarily on merits. Lack of a military security clearance limited research opportunities and activities. Limited number of participants. (HRL)

Two commented on the need for a better understanding of the organizational structure and needs of the laboratory prior to the start of the summer term. Another suggested that several of the personnel in the labs are not familiar with the program and should be alerted to what the summer faculty do and who they are. (OEHL)

Two indicated the stipend is too small. Two also indicated the time of 10 weeks is too short. Another two indicated a lack of administrative support from the lab. Also seen as weak points were the limited follow on funding, lack of housing information, no travel funds to return home during the 10 weeks, and reduced opportunity for repeating the program in subsequent summers. One indicated a lack of technical expertise in the lab. (RADCC)

Four fellows noted the time period was too short. The stipend was considered to low by four fellows. One complained on turnaround time on pay check. One thought the billing forms needed improvement. Also mentioned as weak points were the inflexible hours, Air Force bureaucracy, no opportunity to chose which research group assigned to, and inadequate information on housing, banking, and accommodations for pre-summer visit. (SAM)

One was not sure that the colleagues at the lab were prepared for the start. However, they accommodated them very quickly. Office space was difficult to find and they had to scramble a bit. (WHMC)

Comments indicated a need for regular meetings involving the summer participants. The stipend level was also mentioned as a weak point. (WL)

Socialization/orientation, labs aren't necessarily ready for visitors. Weaker than reasonable funding, and funding too few of the follow-on Mini grants. (WRDC/AL)

Among the items mentioned were: RIP funding too small, too few awards; 10 weeks too short, 10 to 12 weeks suggested; stipend too small; and no health insurance provided. (WRDC/APL)

Meager stipend level. (WRDC/ETL)

Two mentioned the stipend was too small and one that the mini grant was too small. Three thought the 10 week period too short while one thought it too long. (WRDC/FDL)

Two mentioned the time (10 weeks) is too short, another that the time given to decide on the acceptance (March 15) is too short. One complained the stipend is too low, but also pointed out that money is not the main reason for accepting an appointment to the program. Another felt that more interaction with the researchers at the lab was needed. (WRDC/ML)

15. Has this been a fruitful, worthwhile, constructive experience?

Yes - 161

No - 0

16. Other Remarks.

One indicated that the AFOSR/UES banquet needed to be better organized. Another stated that the UES/AFOSR banquet was very enjoyable, enlightening and should be heavily promoted. One indicated concern that a special effort should be made to ensure security clearances are noted early and granted well before the start date. (AAMRL)

The format and example of final report given to us is ridiculous. One complained the sample final report was inadequate. The rules for typing the final report are outdated. Pleased to have had this opportunity. Excellent program. (AEDC)

Simplify the payment procedure. Have payments automatic every 2 weeks (or every month) after the start of the 10 week period. (AL)

Additional remarks included the rewarding experience of the program, the value to the students, the excellent treatment received by the laboratory personnel and the desire to repeat on the program next year. (ATL)

Several commented on the enjoyable experience of the opportunity to work with Air Force researchers. One suggested that arrangement be made with the credit union to allow for cashing of checks. One pointed to the need of housing information prior to arrival at the base. Due to problems with the technical focal point, one would not recommend any colleagues to apply to the program in this technical field. (ESC)

Having given me the opportunity to know the Air Force technical office and from whom I got the valuable topic. It was a great summer and I am most grateful. (ESD)

One complained of the lack of computer hardware and software. Another pointed out the importance of having a graduate student included in the program. One indicate the intention of continuing the work under the mini-grant program, and one commended UES for minimizing difficulties during the appointment to the program. (FJSRL)

Three commented on the enjoyable experience of participation in the program. One complimented the lab and UES on their running of the program. One indicated a need for additional help in finding housing. Another indicated benefitting a lot from the program. (GL)

Several mentioned the excellence of the program and the enjoyable experience at the laboratories. Several also stated that the summer had led to interesting research that they wished to continue. Continuation and expansion of the program was strongly encouraged. (HRL)

All three responding to the general remarks had praise for the program. One indicated that the UES coordinator had been of great help in smoothing the way for the summer. Another indicated that the laboratory had been very responsive to the needs of the researcher and the graduate student. (OEHL)

Remarks in general praised the program with such comments as enjoyable, positive, and rewarding experience. One saw it as a chance of a lifetime to work at a major research facility. One complained of a lack of direction from the laboratory. (RADC)

In general the comments reflected a very favorable impression of the program. Summer fellows made comments such as best DoD program, rewarding experience, and stimulating experience. One fellow noted that due to obligations at the university, it is very difficult to spend 10 continuous weeks away. Another praised the job done by the effort focal point. One suggested incorporating undergraduates in the program to encourage them to attend graduate school. The efficiency of UES in processing the checks was noted by one fellow. (SAM)

Thank you for this terrific experience. (WHMC)

Additional remarks included thanks to the Air Force and UES for the opportunity to participate in the program. (WL)

These included: a time well spent, excellent program, have more opportunities to meet other participants - the social hour was great, pleasing experience. (WRDC/AL)

The program does not allow for paid sickness, holidays, or leave time. The \$20,000 available from Research Initiation Program is too little to get the job done. Excellent experience. Excellently arranged and run. Excellent cooperation from research colleague. UES very helpful in taking care of all the necessary details. (WRDC/APL)

Excellent program. (WRDC/ETL)

Suggestions included sending the housing information and a map of air force base before pre-summer visit; An orientation and tour be given by all laboratories; the 20 page limit for the final report is too low; stipend gap is now so side between what can be earned and what I is earned on the SFRP, that in spite of an even greater interest in the work, another summer at current levels of compensation is not possible; an additional week at the research laboratory for the purpose of completing the final report; provide a certificate of appreciation and picture of summer fellows. One comment included a special thanks to the UES Coordinator. (WRDC/FDL)

Two expressed their thanks for the opportunity, with one expressing, "It has changed my life for the better." (WRDC/ML)

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APPENDIX 1.C

LABORATORY REPRESENTATIVE'S QUESTIONNAIRE REPLY SUMMARY

**1990 USAF/UES SUMMER FACULTY RESEARCH PROGRAM
EVALUATION QUESTIONNAIRE LABORATORY REPRESENTATIVES**

1. How do you rate the correspondence, verbal and telephone communication, and other aspects concerning program administration?

Excellent	-	14
Good	-	4
Average	-	0
Poor	-	0
No Response	-	1

How could it be improved?

Communications and program administration were outstanding. Communications were very clear and the program was administered professionally. (AEDC)

UES is always responsive. Sometimes the instructions could be more explicit in the UES correspondence. (HRL)

Under the hectic schedules and administrative workload associated with running the program, have no complaints. (WL)

Have always gotten good response to my questions and inquiries. (WRDC/ETL)

No Comment: (AAMRL, AL, ATL, ESC, ESD, FJSRL, GL, OEHL, RADC, SAM, WHMC, WRDC/AL, WRDC/APL, WRDC/FDL, WRDC/ML)

2. Did you have sufficient time to conduct an evaluation of applications?

Yes	-	19
No	-	0

Comments?

The time to conduct the evaluations was barely adequate - more time would be better. (AEDC)

We would always like to start earlier so we can compete with other agencies for the services of the faculty. (AL)

Evaluation is conducted within each division to whom the candidate would be assigned. Typically this is not a problem. (HRL)

No Comment: (AAMRL, ATL, ESC, ESD, FJSRL, GL, OEHL, RADC, SAM, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/FDL, WRDC/ML)

3. Was the number of faculty researchers assigned to your organization satisfactory?

Yes - 13
No - 5

If no, how many would be desired?

We would like to have 8 faculty researchers assigned to the lab. We should get at least one of every three applicants. We lost some quality applicants to NASA because we couldn't make them a timely offer. (AEDC)

We would like to have 8 faculty researchers assigned to the lab. We had only 7 regular faculty slots. Eight slots would allow us two faculty members per technical division within our laboratory. (ATL)

Number assigned was satisfactory, but we could have accommodated up to two more faculty researchers. (GL)

We would like to have 14 faculty researchers assigned to the lab. Number of critical technology areas and number of directorates. (RADC)

We would like to have 2 faculty researchers assigned to the lab. Each of the past several years we have had requests for summer faculty exceeding the number authorized. A minimum of two would help us meet the desires of the staff. (WHMC)

We would like to have 5 faculty researchers assigned to the lab. An absolute minimum. (WL)

We would like to have 4 faculty researchers assigned to the lab. Across four divisions, at least four summer faculty could be effectively utilized. (WRDC/ETL)

No Comment: (AAMRL, AL, ESC, ESD, FJSRL, HRL, OEHL, SAM, WRDC/AL, WRDC/APL, WRDC/FDL, WRDC/ML)

4. Please rate the expense-paid pre-program visit:

Essential - 17
Convenient - 1
Not worth expense - 0

5. In your opinion, is the ten week period an optimum length of time to develop a viable working relationship among the faculty researchers, students, laboratory/center personnel and program?

Yes - 16
No - 3
N/A - 1

Other comments:

Ten-weeks is the optimum time that most faculty have to devote to the program. However, a follow-on second year should be extended to the participants automatically. (AEDC)

11 or 12 weeks. (AL)

Longer would be better, but given academic schedules, it is unreasonable to expect a longer period of employment. (ATL)

12 weeks would be better to allow for one week of adjustment in the beginning and a week at the end to wind up the research and prepare a final report in an unhurried manner. (GL)

Basically, I think it is, possibly a couple more weeks might be nice. (HRL)

I think 12 weeks would be better. (SAM)

10-12 weeks is desirable. (WRDC/AL)

This is long enough to lay important groundwork, hopefully leading to further interactions. (WRDC/ETL)

Period should be flexible, from 10 weeks to 14 weeks. (WRDC/FDL)

No Comment: (AAMRL, ESC, ESD, FJSRL, OEHL, RADC, WHMC, WL, WRDC/APL, WRDC/ML)

6. Did your laboratory/center establish a seminar program, or other means, to "tap" the faculty associate's academic knowledge other than his research assignment?

Yes - 10
No - 6

If yes, give description and evaluation?

We had a weekly lunch and learn session with lab personnel as well as professors as speakers. We also set-up a weekly "Multi-Graph Training Sessions" presented by the professor and graduate students from a local university. (AEDC)

The individual branches ran their own program. Some better than others for the seminar program. (AL)

We scheduled a seminar for each faculty member, to be given on the topic of their choice. This promoted technical interchanges and gave a feeling of unity to the program. (ATL)

Voluntary presentations by SFRPs. Those given were well received and attended. (FJSRL)

Not a laboratory program, but a division and branch program in which faculty researchers were invited to participate. (GL)

Presentations are given to lab research scientists. (RADC)

One seminar each week, completely volunteer but 90% did it. (SAM)
Each of the summer faculty gave a briefing on their accomplishments in the laboratory. (WRDC/ETL)

A technical division, established a "brown bag" lunch program where faculty members participated. (WRDC/FDL)

No Comment: (AAMRL, ESC, ESD, HRL, OEHL, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ML)

7. Did the laboratory/center conduct a general briefing, tour, and/or other formal means of welcome and introduction for the associate assigned to your organization?

Yes - 13

No - 6

8. Did you have a formal exit exercise for each associate such as a final technical briefing presented to the organization management, a private interview, or other?

Yes - 11

No - 7

9. In your opinion, what was the overall quality of this year's participants as measured by attitude, technical competence, work habits, production and meaningful research accomplishment?

<u>Superior</u>	<u>Excellent</u>	<u>Average</u>	<u>Poor</u>
37	32	2	

10. Do you believe the Graduate Student Research Program enhances the Summer Research Program?

Yes - 18

No - 0

N/A - 1

11. Was a student assigned under the Graduate Student Research Program to your laboratory this summer?

Yes - 17

No - 1

N/A - 1

If so, was their participation productive?

Yes - 16

No - 0

12. Please furnish any recommendations you may have on improving the Graduate Student segment of the program.

Graduate students should participate in the technical presentations. This is good experience for them and gives the students exposure to many other technical areas of interest. Combine graduate students with faculty and graduate students with high school students for a more productive team effort. (AEDC)

Help to provide GSRP support during the school year. The mini grant helps, but all graduate students don't come with faculty. Also, is there some way we can know which faculty are going to bring students, and how many? (AL)

On the application it should be made clear which SFRP the GSRP wants to accompany. We had a GSRP student almost sent to the wrong lab because he had a department head endorse his application rather than his advisor. (FJSRL)

Usually the laboratory has more applicants than it has allotted spaced in the program; some good graduate students have to be turned away. (GL)

Good program that should continue. (HRL)

Should include graduate students if they come unaccompanied by major professor. (SAM)

Presence of graduate students is important. Not only do they get research experience in a clinical environment, they provide significant technical assistance to the Summer Faculty. No recommendations for improvement, but definitely should continue. (WHMC)

Make time period flexible, from ten to fourteen weeks. Automatic selection of students assigned to faculty is a good feature. (WRDC/FDL)

Good job for the coordinator. His efforts are more than valuable in helping our faculty/students. (WRDC/ML)

No Comment: (AAMRL, ATL, ESC, ESD, OEHL, RADC, WL, WRDC/AL, WRDC/APL, WRDC/ETL)

13. Site visits were made by Program Director and/or Administrator and the AFOSR representative. Do you feel these visits are beneficial to the program participants and Laboratory in understanding the management of the program?

Yes - 14
No - 3
N/A - 1

Do you feel these visits should be done again next year?

Yes - 14
No - 2

14. UES has a coordinator assigned at your base to assist the Summer Faculty participants in the administration of the program. Did you find this beneficial to the program?

Yes - 12
No - 0
N/A - 5

Are there any problem areas coordinators should administer in future years?

UES should provide the Base Coordinator with the names of the appointees and the research advisor's name and telephone numbers. (AAMRL)

More social activities are needed - perhaps funds could be provided for more formal gatherings. (AEDC)

The program would be enriched if we had a program coordinator added to the summer staff. Too many details slip by with the current process. (AL)

The coordinator did an excellent job in assisting participants to find housing, base passes, car decals, etc. (WRDC/FDL)

No Comment: (ATL, ESC, ESD, FJSRL, GL, HRL, OEHL, RADC, SAM, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/ML)

15. Please furnish any other comments or suggestions to improve the program in future years. Develop a questionnaire relevant to the duties of the laboratory representative. These questions can best be answered by the research advisors. Provide labs with appointee start dates (proposed) updated as needed. (AAMRL)

I still believe that a two-year summer research program should be offered to the faculty. We need more emphasis of other minority college/university professors, not just black. (AEDC)

Start the process sooner. Even an extra two weeks in the winter gets us into contact with the applicants before they start hearing from other agencies. Something like a 15 or 20 January cut off would help. (AL)

Hope the program continues in the future. (HRL)

No Comment: (ATL, ESC, ESD, FJSRL, GL, OEHL, RADC, SAM, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/FDL, WRDC/ML)

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APPENDIX 1.D

PARTICIPANTS RESEARCH COLLEAGUES QUESTIONNAIRE REPLY SUMMARY

1990 USAF/UES SUMMER FACULTY PROGRAM EVALUATION QUESTIONNAIRE
PARTICIPANTS RESEARCH COLLEAGUES
SUMMARY

A. TECHNICAL ASPECTS

1. Did you have personal knowledge of the associate's capabilities prior to his arrival at work site?

Yes - 103

No - 53

If yes, where/what/how?

Resume and telephone interview. Papers, presentations and discussions. Material sent with application, and telephone discussion, and pre-visit. Through technical societies. Familiar with associate's work in human fall dynamics. Pre-visit. Was a visiting faculty last year. (AAMRL)

Previous assignments. (2) Resume. 1989.

(AEDC)

Previous participant. Have known associate professionally for the last four years.

(AL)

(2) Previous visits and presentations. Telephone discussions. Previous participant. Publications, short courses, and professional associates.

(ATL)

Involved in past work for four years. From publications. Worked here last two summers. Resume. Past participant.

(ESC)

No Comment.

(ESD)

(2) previous participant.

(FJSRL)

By resume and telephone conversations and pre-program visit. (4) Previous participant. Published works. Application.

(GL)

Resume and application. Met him at university. Previous research at university. Several publications. Journals. She works at local university.

(HRL)

Through papers published in the journals he sent me and his curriculum vitae. Resume. (OEHL)

He participated in the 1989 program. Through students and faculty at the university.

(2) Past participant. Application and pre-summer visit. Resume and interview via telephone. Forwarded reprints of his papers for me to review.

(RADC)

(5) From application and resume. (5) Prior fellow with the program. (6) Journal articles, lectures, personal conversations. From graduate students.

(SAM)

Aware of her work at local university; research and teaching.

(WHMC)

Through other contracts. Prior applicant, telephone conversation in 1989.
(WL)

Participant last summer. Applicant last summer, and I interviewed him. Telephone communication. I took courses with him at the university. Attend lectures at his university. From resume and meeting prior to start of work.

(WRDC/AL)

(2) Via telephone conversations. Resume. Through conference and journal publications. Contact with major professor. (3) Prior participant.

(WRDC/APL)

I am aware of the participant's work. I co-authored two papers with him during the last two years. From resume and reprints.

(WRDC/ETL)

(5) Prior visiting scientist. From reading his work on acoustic emission monitoring to discussions with experts in the field. Met him at professional conferences and talked to him over the telephone. Met him at colloquium. He made a site visit prior to arriving.

(WRDC/FDL)

(4) Had worked here the previous summer. Telephone conversation. Resume. Published work in technical journals.

(WRDC/ML)

2. Was the faculty associate prepared for project?

Yes - 147

No - 9

3. Please comment on preparedness, competency, scope, depth of knowledge of subject area:

All 10 responses indicated that the professors were well prepared for the summer effort. Two mentioned the reading of suggested material prior to arrival for the summer. One indicated that the summer fellow brought a computer and software for the effort.

(AAMRL)

All six responses indicated that the researchers were prepared and competent in the areas. One indicated the associate adapted to a new technical area for the summer project and another that the associate was prepared for the analytical work, but had to work at the experimental effort.

(AEDC)

Six indicated the summer associates were competent, knowledgeable and well prepared. Several indicated prior experience in the area. One indicated the summer associate had only limited knowledge in the area of the summer project.

(AL)

Several mentioned the experience, theoretical background, publications, and preparations of the summer fellows. One indicated that the pre summer visit was used to prepare for the summer effort. One focal point indicated that the fellow had no prior background for the summer research effort.

(ATL)

Four of the focal points mentioned such things as competent, knowledgeable, prepared, excellent, etc. Two indicated some disappointment with the fellows, commenting that the professor's abilities were less than expected and that originally the fellow had been assigned to a different lab.

(ESC)

Focal point indicated the summer fellow had excellent background and published papers.

(ESD)

All eight responses indicated that the fellows were prepared for the summer effort and several indicated discussions prior to the summer effort.

(FJSRL)

All ten responses described the professors as knowledgeable and prepared; however, one focal point indicated the professor's attitude led to some difficulties.

(GL)

Focal points made 13 positive comments including: knowledgeable, new insights, prepared, competent qualified, excellent, an authority, range of knowledge, etc. The only negative comment indicated the summer fellow had limited knowledge with Air Force training.

(HRL)

Three of the responses indicated the fellows were well prepared and knowledgeable. One focal point indicated the fellow had little depth of knowledge prior to start.

(OEHL)

The responses indicated the summer fellows were highly regarded by the focal points. Comments included: well prepared, excellent match, highly motivated, leading scientist, knowledgeable, significant contribution, etc.

(RADC)

All 17 of the responses indicated that the fellows were a good fit to the needs of the research addressed during the summer effort.

(SAM)

The focal point found the fellow highly competent.

(WHMC)

Five of the six responses indicated the fellows were well prepared. One indicated the fellow did no preparation prior to arrival and relied on others for support.

(WL)

Eight of the focal points commented on the experience, expertise, preparation, and ability of the summer fellows. One indicated that the summer fellow brought several software packages to begin immediate analysis of available data. One focal point indicated that the fellow had no background in computer use and contributed little to the research effort.

(WRDC/AL)

The knowledge, experience and/or competence of the summer fellows were mentioned in all 11 responses. Prior research and experience was mentioned by several.

(WRDC/APL)

All three described the professors as: knowledgeable, hardworking, experienced, etc.

(WRDC/ETL)

Ten of the focal points referred to the professors as experts, competent, knowledgeable, experienced, etc. One indicated that the professor had done considerable literature review. One indicated that the fellow was not well prepared and did not have the project defined.

(WRDC/FDL)

All 10 of the responded indicated the fellows were competent, knowledgeable, prepared, etc.
(WRDC/ML)

4. Please comment on the associate's cooperativeness, diligence, interest, etc.
Nearly all of the 155 responses indicated that the focal points were very pleased with the fellows. Four focal points indicated slightly negative ratings. Only one indicated an unsatisfactory experience.
(AAMRL, AEDC, AL, ATL, ESC, ESD, FJSRL, GL, HRL, OEHL, RADC, SAM, WHMC, WL, WRDC/AL, WRDC/APL, WRDC/ETL, WRDC/FDL, WRDC/ML)
5. In your opinion, has the associate's participation in this summer program contributed to an increase in the associate's potential to perform research?
Yes - 147
No - 9
Comments on the increase were made by 107 of the focal points. Most were specific to the research involved. Several commented on the gain in understanding the Air Force research needs and the means to apply their abilities to these needs. Several of the focal points that responded "no" to this question indicated that the fellows were already at the top of their research abilities.
6. Did work performed by the associate contribute to the overall mission/program of your laboratory?
Yes - 153
No - 3
Over 145 comments were made concerning the contributions the laboratory missions. These were specific to the research involved. Nearly all made positive comments about the value of the summer researchers' efforts.
7. Would you classify the summer effort under SFRP as research?
Yes - 150
No - 5
The vast majority of the comments indicated that the professors were involved in research projects. Some of the negative comments included: engineering, literature review, theoretical study, applications orientated, etc. From these responses, it seems the program is doing an excellent job of aligning the professors in research positions at the laboratories. No change or action is dictated by these responses.
8. Was a graduate student assigned to your group this summer?
Yes - 67
No - 88

If so, did this enhance the research productivity?
Yes - 67
No - 0

Was it an administrative burden?

Yes - 2
No - 65

9. Were your relations with the associate satisfactory from a technical point of view?

Yes - 154
No - 2

Several commented on the importance of regular (weekly) interactions with the fellows. Several mentioned the importance of the pre summer visit to establish the research parameters. Several indicated the 10 weeks was too short. Only one indicated the work habits and cooperation of the summer fellow were unsatisfactory.

10. Do you think that by having a faculty associate assigned to your group, others in the group benefitted and/or were stimulated by his presence?

Yes - 148
No - 7

Comments indicated that the vast majority of the professors participating in the summer program stimulated interest and ideas with other Air Force researchers. Several negative comments indicated that the time limitation was the primary factor in restricting the interaction with others.

11. Do you feel that introduction to each other, together with the summer work experience and performance could form a sound basis for continuation of effort by associate at his home institute?

Yes - 148
No - 7

Most of the comments on continued efforts were specific to the research involved. The vast majority had taken steps to arrange of additional funding to continue efforts started in the summer research. Several indicated the expectation of funding through mini-grants under the RIP. Of the negative responses, several indicated that the university did not have the research facilities to support continued efforts. Only three indicated that the professor did not have the background needed for the research.

12. One of the objectives of this program is to identify sources of basic research capability and availability to the USAF. On a scale of A to D, how effective do you think this program will be in that respect?

(high) A B C D (low)

A 61 B 28 C 2 D 0

13. Also, please evaluate:

Evaluation of the following three areas ranged from high (A) to low (D) with the following breakdown:

Opportunity to stimulate group activity	A 98	B 52	C 1	D 1
Professional association	A 118	B 33	C 1	D 0
Program administration	A 76	B 58	C 11	D 2

B. ADMINISTRATIVE ASPECTS

1. **When did you first hear of this program?**

Responses indicated that the focal points are well informed on the program, with most aware of the program for several years.

2. **Were you involved in the screening and prioritizing of the faculty applicants for your lab?**

Yes - 113

No - 43

Several of the focal points involved in the evaluation expressed their desire to remain a part of the evaluation process. Several commented on the need for more time for the evaluation process. One comment from WRDC/FDL indicated that high level management pre screening makes it difficult to identify best candidate. Several suggested making phone contact prior to recommending candidates for the program.

3. **How do you rate the importance of the expense-paid pre-program visit to the work site?**

Not worth expense - 2

Convenient - 41

Essential - 109

Most focal points viewed the pre-summer visit as essential to the program. Several commented that the time is used to prepare the professor for the summer research effort and to arrange for housing. At some of the labs (AL, GL, etc.) this is seen as a non trivial problem.

4. **Considering the calendar "window" of ten weeks (limited by varying college and university schedules), please comment on the program length. Were you as a team able to accomplish:**

more than - 25

less than - 22

about expected - 106

Several commented that while they achieved about what was expected, they viewed 10 weeks as too short. Several mentioned that they planed for a 10 week effort and accomplished about what they expected. Many of the ones indicating that they achieved less than expected indicated that this was their first time in planning an effort this short. Others indicated that less was accomplished due to equipment and supply problems.

5. **Would you desire another faculty associate to be assigned to you and/or your group division?**

Yes - 141

No - 12

Several if the negative comments indicated a desire to continue working with the same summer fellow.

6. **Would you desire additional graduate students in this program?**

Yes - 123

No - 15

N/A - 17

7. Should the graduate students only be assigned to research with the summer research faculty member?

Yes - 62

No - 72

N/A - 21

8. Should graduate students continue to be assigned without summer research faculty supervision?

Yes - 82

No - 41

N/A - 31

9. Other remarks:

Additional remarks included many comments on the value of the program to the laboratories. Several commented on the value of the graduate students assisting the professors during the summer. Several suggested making the 10 week visit more flexible by allowing a 10 to 14 week effort. Several complimented UES on the management and administrations of the program. One suggested raising the stipend to attract more senior researchers.

No Comments. (ESD, FJSRL, WHMC)

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APPENDIX II

- A. Program Statistics**
- B. List of 1990 Participants**
- C. Participant Laboratory Assignments**

APPENDIX II A

Summer Faculty Research Program

**Sponsored by
Air Force Office of Scientific Research**

**Conducted by
Universal Energy Systems, Inc.**

Program Statistics

Program Statistics

1. Applications Received (by Laboratory)

Organization		Choice			Total
		1st	2nd	3rd	
Aerospace Medical Research Laboratory	(WPAFB)	19	19	19	57
Aero Propulsion Lab.	(WPAFB)	34	17	5	56
Armament Laboratory	(Eglin)	25	23	24	72
Arnold Engineering Development Center	(Arnold)	25	15	10	50
Astronautics Laboratory	(Edwards)	27	15	10	52
Avionics Laboratory	(WPAFB)	17	8	10	35
Eastern Missile and Space Center	(Patrick)	4	3	6	13
Electronic Systems Div.	(Hanscom)	6	10	7	23
Electronic Technology Lab.	(WPAFB)	7	6	3	16
Engineering and Services Center	(Tyndall)	30	24	9	63
Flight Dynamics Lab.	(WPAFB)	24	16	13	53
Frank J. Seiler Research Laboratory	(USAFA)	18	12	10	40
Geophysics Laboratory	(Hanscom)	21	12	6	39
Human Resources Lab. (Williams, Brooks and WPAFB)		50	37	27	114
Materials Laboratory	(WPAFB)	29	25	9	63
Occupational and Environment Health Lab.	(Brooks)	17	14	7	38
Rome Air Development Ctr.	(Griffiss)	56	37	17	110
School of Aerospace Med.	(Brooks)	39	17	7	63
Wilford Hall Medical Ctr.	(Lackland)	10	14	8	32
Weapons Laboratory	(Kirtland)	26	31	13	70
Late Applications		12			
Totals		489	349	217	

2. Number of Participants - 165

Number with Bachelors Degree - 0
 Number with Masters Degree - 10
 Number with Doctorate Degree - 155

Program Statistics
Continued

3. Academic Ranking

Assistant Professor	- 65
Associate Professor	- 52
Chairman	- 1
Department Head	- 1
Instructor	- 3
Lecturer	- 2
Professor	- 40
Researcher	- 1

4. Number of Participants at Each Laboratory

Organization

Aerospace Medical Research Laboratory	(WPAFB)	10
Aero Propulsion Laboratory	(WPAFB)	11
Armament Laboratory	(Eglin)	11
Arnold Engineering Development Ctr.	(Arnold)	7
Astronautics Laboratory	(Edwards)	7
Avionics Laboratory	(WPAFB)	9
Eastern Space & Missile Center	(Patrick)	0
Electronic Systems Division	(Hanscom)	1
Electronic Technology Laboratory	(WPAFB)	3
Engineering and Services Center	(Tyndall)	11
Flight Dynamics Laboratory	(WPAFB)	11
Frank J. Seiler Research Laboratory	(USAF)	8
Geophysics Laboratory	(Hanscom)	11
Human Resources Laboratories	(Brooks)	14
Materials Laboratory	(WPAFB)	11
Occupational & Environment Health Lab.	(Brooks)	4
Rome Air Development Center	(Griffiss)	12
School of Aerospace Medicine	(Brooks)	17
Weapons Laboratory	(Kirtland)	6
Wilford Hall Medical Center	(Lackland)	1

Totals 165

5. Discipline Represented - 48

Aerospace Engineering	- 6	Material Science	- 5
Applied Mathematics	- 4	Mathematics	- 9
Applied Mechanics	- 1	Mechanical Engineering	- 20
Biochemistry	- 1	Mechanics	- 1
Biological Engineering	- 1	Metallurgy	- 1
Biology	- 3	Meteorology	- 2
Biomechanics	- 1	Microbiology	- 2
Chemical Engineering	- 4	Optics	- 1
Chemistry	- 10	Organic Chemistry	- 1
Civil Engineering	- 5	Pharmacology	- 2
Communication	- 1	Philosophy	- 1
Computer Science	- 6	Physical Chemistry	- 5
Control Theory	- 1	Physical Education	- 1
Education	- 2	Physics	- 17
Electrical Engineering	- 18	Psychology	- 6
Engineering	- 3	Science Education	- 1
Engineering Psychology	- 1	Sociology	- 2
English	- 1	Solid Mechanics	- 2
Environment Chemistry	- 1	Statistics	- 1
Exercise Physiology	- 1	Structural Mechanics	- 2
Experiment Psychology	- 3	Technology	- 1
Industrial Engineering	- 2	Transportational Eng.	- 1
Industrial Psychology	- 1	Water Resources	- 1
Inorganic Chemistry	- 1	Zoology	- 2

Total - 165

Program Statistics
Continued

6. Colleges and Universities Represented - Total 116

Alabama, University of	- 4	Kent State University	- 1
Alfred University	- 1	Kentucky, University of	- 2
Arizona, State University of	- 1	Louisiana State University	- 1
Arizona, University of	- 3	Lowell, University of	- 2
Arkansas State University	- 1	Maine, University of	- 2
Auburn University	- 1	Marshall University	- 1
Boston College	- 1	Maryland-Baltimore, Univ. of	- 1
Brigham Young College	- 1	Massachusetts Maritime Academy	- 1
Butler University	- 1	Melbourne Univ. of Australia	- 1
California Polytechnic	- 1	Memphis State University	- 2
California State University	- 2	Miami, University of	- 1
Capital University	- 1	Michigan State University	- 1
Carnegie Mellon University	- 1	Michigan Tech. University	- 1
Carroll College	- 1	Minnesota, University of	- 2
Cedarville College	- 1	Mississippi State University	- 3
Central State University	- 1	Missouri-Kansas City, Univ. of	- 1
Cincinnati, University of	- 1	Missouri-Rolla University of	- 1
Colorado-Denver, Univ. of	- 1	Morehouse College	- 3
Colorado State University	- 1	Nebraska-Lincoln, University of	- 1
Colorado, University of	- 3	Nevada-Las Vegas, University of	- 1
Concordia College	- 1	New Orleans, University of	- 1
Dayton, University of	- 3	New York, City College of	- 1
District of Columbia, Univ. of	- 1	New York-Buffalo, State Univ. of	- 1
Duke University	- 1	Nicholls State University	- 1
Embry-Riddle Aeronautical Univ.	- 1	North Carolina State University	- 1
Fairleigh Dickinson Univ.	- 1	North Dakota State University	- 2
Florida A&M University	- 1	North Texas, University of	- 2
Florida Inst. of Technology	- 2	Northwestern University	- 2
Florida, University of	- 1	Notre Dame, University of	- 1
Fort Valley State College	- 1	Ohio State University	- 4
Georgia Tech.	- 1	Oklahoma State University	- 1
Hamilton College	- 1	Pennsylvania State Univ.	- 3
Houghton College	- 1	Portland, University of	- 1
Houston, University of	- 1	Puerto Rico, University of	- 1
Houston-Victoria, University of	- 1	Purdue Calumet	- 1
Idaho State University	- 1	Rensselaer Polytech. Inst.	- 1
Illinois State University	- 1	Rhode Island, University of	- 1
Indiana University	- 1	Ricks College	- 1
Indiana-Purdue, Univ. of	- 1	Saint Paul's College	- 1
Indiana Univ. of Pennsylvania	- 2	San Jose State University	- 1
Iowa, University of	- 1	Scranton, University of	- 2

Program Statistics
Continued

6. Colleges and Universities Represented (Continued)

South Dakota, University of	- 1	Tufts University	- 1
South Florida, University of	- 1	Tuskegee University	- 1
Southeastern Massachusetts Univ.	- 1	Utah State University	- 2
Southern Illinois University	- 1	Utica College	- 1
Southern Methodist University	- 2	Vanderbilt College	- 1
Southwest Texas State University	- 1	Villanova University	- 1
St. Louis University	- 1	Virginia Polytechnic Inst.	- 2
St. Mary's University	- 1	Washington State University	- 2
Staten Island, College of	- 1	Wellesley College	- 1
Syracuse University	- 2	West Texas State University	- 1
Talladega College	- 1	West Virginia University	- 2
Texas A&M University	- 1	Western Illinois University	- 1
Texas Tech. University	- 1	Wittenburg University	- 1
Texas Woman's University	- 1	Worcester Polytech. Inst.	- 3
Texas - Austin, University of	- 2	Wright State University	- 5
Texas - San Antonio, Univ. of	- 3	Wyoming, University of	- 1
Trinity University	- 3	Xavier University	- 3

Total 165

Program Statistics
Continued

7. States Represented - Total 43 Australia - 1

Alabama	- 7
Arizona	- 4
Arkansas	- 1
California	- 4
Colorado	- 5
District of Columbia	- 1
Florida	- 7
Georgia	- 5
Idaho	- 2
Illinois	- 6
Indiana	- 4
Iowa	- 1
Kansas	- 1
Kentucky	- 2
Louisiana	- 6
Maine	- 2
Maryland	- 1
Massachusetts	- 11
Michigan	- 3
Minnesota	- 2
Mississippi	- 3
Missouri	- 2
Montana	- 1
Nebraska	- 1
Nevada	- 1
New Jersey	- 2
New York	- 8
North Carolina	- 2
North Dakota	- 2
Ohio	- 18
Oklahoma	- 1
Oregon	- 1
Pennsylvania	- 9
Puerto Rico	- 1
Rhode Island	- 1
South Dakota	- 1
Tennessee	- 3
Texas	- 20
Utah	- 3
Virginia	- 3
Washington	- 2
West Virginia	- 3
Wyoming	- 1

8. Age of Participants - Average - 44

APPENDIX II B

LIST OF PARTICIPANTS

LIST OF 1990 PARTICIPANTS

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Vernon Matzen Associate Professor North Carolina State Univ. Box 7908 Raleigh, NC 27695 (919) 737-2331	<u>Degree:</u> PhD <u>Specialty:</u> Structural Mechanics <u>Assigned:</u> Flight Dynamics Laboratory
Michael McFarland Assistant Professor Utah State Univ. Utah Water Research Lab. Logan, UT 84322 (801) 750-3196	<u>Degree:</u> PhD <u>Specialty:</u> Biological Engineering <u>Assigned:</u> Engineering & Services Center
Perry McNeill Professor North Texas, Univ. of PO Box 13198 Denton, TX 76203 (817) 565-2846	<u>Degree:</u> PhD <u>Specialty:</u> Education <u>Assigned:</u> Engineering & Services Center

NAME / ADDRESS**DEGREE, SPECIALTY, LABORATORY ASSIGNMENT**

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Dept. of Civil Engineering
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Degree: PhD
Specialty: Water Resources
Assigned: Occupational & Environmental
Health Laboratory

Richard Miers
Associate Professor
Indiana Univ. - Purdue Univ.
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Degree: PhD
Specialty: Physics
Assigned: Avionics Laboratory

William Moor
Associate Professor
Arizona State Univ.
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Degree: PhD
Specialty: Industrial Engineering
Assigned: Human Resources Laboratory
Operations Training Division

Carlyle Moore
Associate Professor
Morehouse College
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Degree: PhD
Specialty: Physics
Assigned: Arnold Engineering Development Ctr.

Kevin Moore
Assistant Professor
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Pocatello, ID 83209
(208) 236-4188

Degree: PhD
Specialty: Electrical Engineering
Assigned: Armament Laboratory

NAME / ADDRESS

Rex Moyer
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Kirk Nordyke
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DEGREE, SPECIALTY, LABORATORY ASSIGNMENT

Degree: PhD
Specialty: Microbiology
Assigned: School of Aerospace Medicine

Degree: MS
Specialty: Physical Education
Assigned: School of Aerospace Medicine

Degree: MS
Specialty: Zoology
Assigned: Occupational & Environmental
Health Laboratory

Degree: PhD
Specialty: Mechanical Engineering
Assigned: Arnold Engineering Development Ctr.

Degree: PhD
Specialty: Physics
Assigned: Electronic Technology Laboratory

NAME / ADDRESS**DEGREE, SPECIALTY, LABORATORY ASSIGNMENT**

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Assigned: Aerospace Medical Research Lab.

Shietung Peng
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Degree: PhD
Specialty: Computer Science
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Degree: PhD
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Assigned: Arnold Engineering Development Ctr.

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Degree: PhD
Specialty: Physical Chemistry
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Degree: PhD
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Degree: PhD
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Assigned: Geophysics Laboratory

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Logistics & Human Factors

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Larry Roe
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NAME / ADDRESS**DEGREE, SPECIALTY, LABORATORY ASSIGNMENT**

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Specialty: Chemical Engineering
Assigned: Rome Air Development Center

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Assigned: Weapons Laboratory

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David Senseman
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Kaveh Tagavi Associate Professor Kentucky, Univ. of 242 Anderson Hall Lexington, KY 40506 (606) 257-2739	<u>Degree:</u> PhD <u>Specialty:</u> Mechanical Engineering <u>Assigned:</u> Aero Propulsion Laboratory
Devki Talwar Assistant Professor Indiana Univ. of Pennsylvania Dept. of Physics Indiana, PA 15705 (412) 357-4589	<u>Degree:</u> PhD <u>Specialty:</u> Physics <u>Assigned:</u> Electronic Technology Laboratory
Richard Tankin Professor Northwestern University Dept. of Mechanical Engineering Evanston, IL 60208 (708) 491-3532	<u>Degree:</u> PhD <u>Specialty:</u> Engineering <u>Assigned:</u> Aero Propulsion Laboratory

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Specialty: Pharmacology
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Health Laboratory

Kevin Whitaker
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Degree: PhD
Specialty: Aerospace Engineering
Assigned: Arnold Engineering Development Ctr.

Trevor Williams
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Degree: PhD
Specialty: Control Theory
Assigned: Astronautics Laboratory

John Wills
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Degree: PhD
Specialty: Physics
Assigned: Geophysics Laboratory

Martin Wilner
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Assigned: Rome Air Development Center

NAME / ADDRESS	DEGREE, SPECIALTY, LABORATORY ASSIGNMENT
William Wolfe Associate Professor Ohio State University 470 Hitchcock Hall Columbus, OH 43210 (614) 292-0790	<u>Degree:</u> PhD <u>Specialty:</u> Engineering <u>Assigned:</u> Flight Dynamics Laboratory
James Wolper Assistant Professor Hamilton College Dept. of Math & Comp. Sci. Clinton, NY 13323 (315) 859-4417	<u>Degree:</u> PhD <u>Specialty:</u> Mathematics <u>Assigned:</u> Rome Air Development Center
Hsien-Yang Yeh Associate Professor California State Univ. 1250 Bellflower Blvd. Long Beach, CA 90840 (213) 985-4611	<u>Degree:</u> PhD <u>Specialty:</u> Structural Mechanics <u>Assigned:</u> Astronautics Laboratory
Lawrence Zavodney Assistant Professor Ohio State Univ. 209 Boyd Laboratory Columbus, OH 43210 (614) 292-2209	<u>Degree:</u> PhD <u>Specialty:</u> Mechanical Engineering <u>Assigned:</u> Flight Dynamics Laboratory
Wayne Zimmermann Associate Professor Texas Woman's University PO Box 22865 Denton, TX 76204 (817) 898-2166	<u>Degree:</u> PhD <u>Specialty:</u> Applied Mathematics <u>Assigned:</u> Weapons Laboratory

APPENDIX II C

PARTICIPANT LABORATORY ASSIGNMENT

C. PARTICIPANT LABORATORY ASSIGNMENT (Page 1)

1990 USAF/UES SUMMER FACULTY RESEARCH PROGRAM

AERO PROPULSION LABORATORY (WRDC/APL)

(Wright-Patterson Air Force Base)

1. Muhammad Choudhry	7. Paul Hedman
2. Mingking Chyu	8. K. Sankara Rao
3. Donald Dareing	9. Larry Roe
4. Paul Dellenback	10. Kaveh Tagavi
5. Dennis Flentge	11. Richard Tankin
6. Kevin Hallinan	

ARMAMENT LABORATORY (ATL)

(Eglin Air Force Base)

1. Charles Camp	7. Manuel Huerta
2. Arnold Carden	8. Kevin Moore
3. Eustace Dereniak	9. William Siuru
4. Charles Fosha	10. Kenneth Sobel
5. John George	11. Steven Trogon
6. Frederick Gibson	

HARRY G. ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY (AAMRL)

(Wright-Patterson AFB)

1. Richard Backs	6. Tzesan Lee
2. Larry Byrd	7. Sigmund Lephart
3. John Duncan	8. Amit Patra
4. Martin Hagan	9. Leonard Shyles
5. Ashok Krishnamurthy	10. Bonnie Walker

ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC)

(Arnold Air Force Base)

1. William Grissom	5. John Russell
2. Carlyle Moore	6. Chun Su
3. Olin Norton	7. Kevin Whitaker
4. Richard Peters	

ASTRONAUTICS LABORATORY (AL)

(Edwards Air Force Base)

1. Daniel Fuller	5. Hung Vu
2. Shannon Lieb	6. Trevor Williams
3. Thomas Pollock	7. Hsien-Yang Yeh
4. Roger Thompson	

C. PARTICIPANT LABORATORY ASSIGNMENT (Page 2)

AVIONICS LABORATORY (WRDC/AL)

(Wright-Patterson Air Force Base)

1. Thomas Abraham	6. Mohammad Karim
2. Michael Breen	7. Kevin Kirby
3. R. H. Cofer	8. Richard Miers
4. Thomas Gearhart	9. Brian Shelburne
5. Lawrence Hall	

ELECTRONIC SYSTEMS DIVISION (ESD)

(Hanscom Air Force Base)

1. Chih-Fan Chen

ELECTRONIC TECHNOLOGY LABORATORY (WRDC/ETL)

(Wright-Patterson Air Force Base)

1. Ashok Goel
2. Muhammad Numan
3. Devki Talwar

ENGINEERING AND SERVICES CENTER (ESC)

(Tyndall Air Force Base)

1. William Bannister	7. Kyung Kwon
2. Mark Brusseau	8. Michael McFarland
3. Wayne Charlie	9. Perry McNeill
4. Joseph Dreisbach	10. John Scharf
5. David Kirkner	11. George Veyera
6. Paul Kromann	

FLIGHT DYNAMICS LABORATORY (WRDC/FDL)

(Wright-Patterson Air Force Base)

1. John Bay	7. Yulian Kin
2. Franklin Eastep	8. Byung-Lip Lee
3. Marvin Hamstad	9. Vernon Matzen
4. Chin Hsu	10. William Wolfe
5. Ming-Shu Hsu	11. Lawrence Zavodney
6. David Hui	

FRANK J. SEILER RESEARCH LABORATORY (FJSRL)

(USAF Academy)

1. Theodore Burkey	5. Ngozi Kamalu
2. Richard Carlin	6. Siavash Kassemi
3. Daniel Dolata	7. Bernard Piersma
4. Ephraim Garcia	8. Thomas Posbergh

C. PARTICIPANT LABORATORY ASSIGNMENT (Page 3)

GEOPHYSICS LABORATORY (AFGL)

(Hanscom Air Force Base)

1. Theodore Aufdemberge	7. C. Randal Lishawa
2. Frank Battles	8. Gandikota Rao
3. Reuben Benumof	9. Craig Rasmussen
4. Chia-Bo Chang	10. Glenn Stark
5. George Jumper	11. John Wills
6. Jeffrey Kuhn	

HUMAN RESOURCES LABORATORY (HRL)

(Brooks, Williams, and Wright-Patterson Air Force Bases)

1. Margaret Batschelet	8. Gillray Kandel
2. Pinyuen Chen	9. William Moor
3. James Dykes	10. James Price
4. Daniel Garland	11. Joan Rentsch
5. Harold Goldstein	12. Eleanor Smith
6. Verlin Hinsz	13. Stanley Stephenson
7. Delayne Hudspeth	14. Pamela Tsang

MATERIALS LABORATORY (WRDC/ML)

(Wright-Patterson Air Force Base)

1. Donald Chung	7. Gary Leatherman
2. John Connolly	8. Won-Kyoo Lee
3. Sherif Elwakil	9. Michael Resch
4. David Grossie	10. Martin Schwartz
5. Prasad Kadaba	11. Hai-Lung Tsai
6. Joseph Lambert	

OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (OEHL)

(Brooks Air Force Base)

1. David Buckalew	3. Kirk Nordyke
2. Miguel Medina	4. Lorin Weber

ROME AIR DEVELOPMENT CENTER (RADC)

(Griffiss Air Force Base)

1. Charles Alajajian	7. Daniel Ryder
2. Gary Craig	8. Behrooz Shirazi
3. Lionel Friedman	9. Wayne Smith
4. Frances Harackiewicz	10. Ronald VanEtten
5. Hao Ling	11. Martin Wilner
6. Shietung Peng	12. James Wolper

C. PARTICIPANT LABORATORY ASSIGNMENT (Page 4)

SCHOOL OF AEROSPACE MEDICINE (SAM)

(Brooks Air Force Base)

1. Phillip Bishop	10. Paul Lemke
2. Robert Blystone	11. Rex Moyer
3. Bruno Breitmeyer	12. Arnold Nelson
4. Vito DelVecchio	13. Donald Robinson
5. Randall Dupre	14. David Senseman
6. Reinhard Graetzer	15. Richard Swope
7. Paul Griffin	16. John Szarek
8. Pushpa Gupta	17. Steven Waller
9. Ramesh Gupta	

WEAPONS LABORATORY (WL)

(Kirtland Air Force Base)

1. William Campbell	4. Johanna Schruben
2. Gene Carlisle	5. Peter Walsh
3. William Cofer	6. Wayne Zimmerman

WILFORD HALL MEDICAL CENTER (WHMC)

(Lackland Air Force Base)

1. Janet Dizinno

APPENDIX III

- A. Listing of Research Reports Submitted in the
1990 Summer Faculty Research Program**
- B. Abstracts of the 1990 Summer Fellow's
Research Reports**

RESEARCH REPORTS

APPENDIX III A

RESEARCH REPORTS

1990 SUMMER FACULTY RESEARCH PROGRAM

<u>Technical Report Number</u>	<u>Title</u>	<u>Professor</u>
Volume I Armament Laboratory		
1	Simple Models for Predicting Runway Failure Due to Blast Loading	Dr. Charles Camp
2	Physical Aspects of the Penetration of Reinforced Concrete Slabs	Dr. Arnold Carden
3	Solid-State Imager Replacement for a High-Speed Film Camera	Dr. Eustace Dereniak
4	Evaluation of Weapon Target Allocation Algorithms	Dr. Charles Fosha
5	Methods Which Accelerate Convergence in Iterative CFD Solvers	Dr. John George
6	Designing a Binary Phase Only Filter Via the Genetic Algorithm	Mr. Frederick Gibson
7	Two-Dimensional Simulation of Railgun Plasma Armatures	Dr. Manuel Huerta
8	Neural Networks for Guidance, Navigation, and Control of Exoatmospheric Interceptors *** Not Publishable at this Time ***	Dr. Kevin Moore
9	Gunner Performance in the BSTING Fire Control System	Dr. William Siuru
10	Robust Eigenstructure Assignment with Application to Missile Control	Dr. Kenneth Sobel
11	Multiple Point Detonation Modeling	Dr. Steven Trogon

Volume I
Arnold Engineering Development Center

12	Development of a Combustion Model for Liquid Film Cooled Rocket Engines	Mr. William Grissom
13	Feasibility of Measuring Pulsed X-Ray Spectra Using Photoactivation of Nuclear Isomers	Dr. Carlyle Moore
14	Combustion of Carbon Particles in the Plume of a Flare	Dr. Olin Norton
15	Noise Reduction in Rocket Test Videos using Mathematical Morphology	Dr. Richard Peters
16	On the Hazard of Combustion Chamber Oscillations in a Large Freejet Test Cell	Dr. John Russell
17	Laser-Induced Fluorescence of Nitric Oxide	Dr. Chun Su
18	An Algorithm for Defining the Shape of a Plume Exhausting from a Rectangular Nozzle	Dr. Kevin Whitaker

Astronautics Laboratory

19	Strain Enhancing Binder Blends for Use in Rocket Propellants	Dr. Daniel Fuller
20	A Development of Molecular Modeling Techniques to Study Intermolecular Forces Found Between Solid Rocket Oxidizers and Their Binding Agents	Dr. Shannon Lieb
21	Design and Analysis of Reaction Wheel Actuators for ASTREX	Dr. Thomas Pollock
22	Component Design for the Multi-Body Dynamics Experiment	Dr. Roger Thompson
23	Control Design of ASTREX Test Article	Dr. Hung Vu
24	Identification and Control of Flexible Spacecraft	Dr. Trevor Williams

Volume I

25	Investigating the Loading Rate Effect on the Crack Growth Behavior in a Composite Solid Propellant	Dr. Hsien-Yang Yeh

Electronics Systems Division

26	Walsh Function Analysis of Impulse Radar	Dr. Chih-Fan Chen

Engineering and Services Center

27	High Oxygen/Carbon Ratio Fuel Candidates for Clean Air Fire Fighting Facility Project	Dr. William Bannister
28	Rate-Limited Mass Transfer and Solute Transport	Dr. Mark Brusseau
29	Centrifuge Modeling of Explosive Induced Stress Waves in Unsaturated Sand	Dr. Wayne Charlie
30	Pathways of 4-Nitrophenol Degradation	Dr. Joseph Dreisbach
31	Permanent Deformations in Airfield Pavement Systems with Thick Granular Layers	Dr. David Kirkner
32	The High-Speed Separation and Identification of Jet Fuel	Dr. Paul Kromann
33	Utilization of Ion Exchange Resins for the Purification of Plating Baths	Dr. Kyung Kwon
34	Methanotrophic Cometabolism of Trichloroethylene (TCE) in a Two Stage Bioreactor System	Dr. Michael McFarland
35	Submicron Antennas for Solar Energy Conversion	Dr. Perry McNeill
36	Dynamic Analysis of Impulse Loading on Laminated Composite Plates Using Normal-Mode Techniques	Mr. John Scharf
37	A Specimen Preparation Technique for Microstructural Analysis of Unsaturated Soil	Dr. George Veyera

Volume II
Frank J. Seiler Research Laboratory

38	Thermal Decomposition of NTO and NTO/TNT Mixtures	Dr. Theodore Burkey
39	Transition Metal Carbonyl Complexes in Ambient-Temperature Molten Salts and Alkali Metal Reductions at Tungsten and Mercury Film Electrodes in Buffered Neutral Aluminum Chloride: 1-Methyl-3-Ethylimidazolium Chloride Molten Salts	Dr. Richard Carlin
40	Expert Guide: Using Artificial Intelligence Techniques to Help Chemists Utilize Numerical Programs	Dr. Daniel Dolata
41	Control of a Complex Flexible Structure Utilizing Space-Realizable Linear Reaction Mass Actuators	Dr. Ephraim Garcia
42	Particle Image Displacement Velocimetry (PIDV) Measurements in Dynamic Stall Phenomena	Dr. Ngozi Kamalu
43	A Preliminary Analysis of Symbolic Computational Technique for Prediction of Unsteady Aerodynamic Flows	Dr. Siavash Kassemi
44	Investigation of Lithium in Buffered MEIC-AlCl ₃ Melts	Dr. Bernard Piersma
45	Control Formulations for the Active and Passive Damping of Flexible Structures	Dr. Thomas Posbergh

Geophysics Laboratory

46	Background Research on Global Warming	Dr. Theodore Aufdemberge
47	Correlations Between Levels for Stellar Scintillometer Derived Profiles of C _H ²	Dr. Frank Battles
48	Total Dose Effect on the Soft Error Rate of Metal-Oxide-Semiconductor Memory Cells	Dr. Reuben Benumof

Volume II

49	PBL Short-Wave Disturbances over the Desert Southwest	Dr. Chia-Bo Chang
50	Simulation of REFS Missile Flight	Dr. George Jumper
51	Evaluating the Diagnostic Potential of High Spatial and Spectral Near Infrared Observations of the Solar Photosphere	Dr. Jeffrey Kuhn
52	A New Ion-Molecule Chemiluminescence Experiment	Dr. C. Randal Lishawa
53	Relationship Between Brightness Temperatures and Typhoon Intensification	Dr. Gandikota Rao
54	Electric Fields in the Middle-and-Low Latitude Ionosphere and Plasmasphere	Dr. Craig Rasmussen
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ABSTRACTS

**ARMAMENT LABORATORY
ABSTRACTS**

SIMPLE MODELS FOR PREDICTING RUNWAY FAILURE DUE TO BLAST LOADING

by

Charles V. Camp

ABSTRACT

Analysis and prediction of runway damage due to buried explosives placed by penetrating weapons is a complicated and difficult problem. A survey of simple models that approximate the character of the structural response of the runway slab subjected to a blast pressure loading is presented. The structural response of the runway is approximated as a single-degree-of-freedom dynamic system, which may include soil/structure interface damping effects with a shear breach failure criterion. The unreinforced concrete is approximated as a rigid, perfectly-plastic material with limited flexural capability. In many cases, formulations originally developed for reinforced concrete structures are adapted for use with plain concrete runways. Conclusions and recommendations on the simple model approach to runway damage are presented.

Physical Aspects of the Penetration of Reinforced Concrete Plates

by

A. Eugene Carden

and

C. R. Wanstall

ABSTRACT

The process of dynamic penetration of concrete plates proceeds by several processes. On impact a wave of high pressure and particle velocity proceeds from the penetrator into the concrete. This wave expands more or less spherically. A hemispherical volume of high pressure (and high density) precede the penetrator into the material. At the edges of this pressure hemisphere, above the corner of the penetrator, regions of large pressure gradient and large shearing stress accompany the penetration. Failure of the material is accomplished by shear. Some material may be ejected backwards. Complete failure of the plate does not occur until the penetrator approaches the back side and the pressurized zone pushes a cone of material ahead of the penetrator.

Steel reinforcement mesh parallel to and near the front and back surfaces of the plate can modify the process in four ways which increase the plate's resistance to penetration. The first is to provide a high impedance surface to reflect the energy of impinging waves. The second is to provide containment and allow build-up of the pressurized volume. The third is to provide a lateral membrane (to sustain tensile stress) that limits scabbing and failure of the concrete. Finally, if the rebar is of sufficient size and strength, the penetrator does work (and loses kinetic energy) to deform and break the steel. Too, eccentric contact can change the direction of the penetrator.

Solid-State Imager Replacement for a High-Speed Film Camera

by

Eustace L. Dereniak

ABSTRACT

We discuss our investigation of the replacement of high-speed film cameras used by the Air Force with high-speed, high-definition solid-state cameras. Development of specifications for such an imager, and the analysis of the associated radiometry are discussed. In addition, we represent an experiment to determine the signal levels expected for this imager. Analysis of the experimental data indicates that light levels sufficient to achieve a reasonable signal-to-noise ratio are available.

Evaluation of Weapon Target Allocation Algorithms

by

Charles E. Fosha, Jr.

Abstract

The SDI offers extraordinary challenges in the battle management area. Battle management here is defined as the process of allocating and assigning weapons to targets in an engagement to optimize the result. To optimize means to allocate interceptors in such a way that a Measure of Effectiveness (MOE) function representing probability of miss or probability of leakage is minimized. The MOE could also be a function of intercept time, projected miss distance, importance of target or other measures. The battle management process may include real time decisions by the battle manager, as well as autonomous decisions based on a predetermined criteria in situations where human decision making is not possible due to time or other limitations. Decisions may be made on the lowest level (autonomous) or on a higher level (coordinated). This study deals with the coordinated decision of allocating interceptors to targets.

The objective of this research is to evaluate specific target allocation algorithms and from them attempt to gain insight into more general underlying principles. The scope of this effort encompasses defense against ICBMs during the boost phase using high velocity kinetic kill weapons. A specific battle scenario is used to conduct the research. This scenario is the launching of 54 missiles from three missile fields. The interceptors are in orbits whose planes pass nearby the missile fields. This allows for all aspects of shots and a wide range of closing velocities. This is a taxing scenario on a boost phase defensive system. Targets must be identified early during the boost phase, and

interceptors allocated to those boosters so that the intercept will occur before the booster burns out. Many complex decisions must be made in a very short period of time. Taking out boosters prior to bus deployment is a parato-superior decision. Thus a kill prior to bus deployment yields the destruction of 2 to 20 re-entry vehicles (RV). This requires high speed optimization solvers.

Different algorithms are evaluated from a rather straight forward minimum cost approach to advanced linear network configuration algorithms. Since the decision process of allocation of interceptors to targets is not precise, the role of fuzzy logic in the decision process is considered.

Two cases are analyzed, the static and dynamic case. For the static case, for each interceptor, a cost to intercept each missile is assigned arbitrarily. For the dynamic case, the Interceptor Manager (IM) engagement simulation being evaluated by Science Applications International Corporation (SAIC), generated a cost matrix that was evaluated. Execution time and allocation cost are the evaluation criteria. Since the algorithms were not incorporated into the IM, no consideration was given to the cost in time to load the data for the algorithm or the core memory required to run these algorithms.

Methods Which Accelerate Convergence in
Iterative CFD Solvers

by

John H. George

ABSTRACT

Several methods have been investigated to speed up the convergence of vector sequences generated in the solution of the Navier-Stokes equations. These methods include the generalized minimum residual (GMRES), the conjugate gradient squared (CGS), the generalized nonlinear minimal residual (GNLMR) as well as other vector extrapolation schemes. These methods have been coded, and the GNLMR is being included in a flow solver.

In addition, new techniques of unstructured grid generation are being developed based on the generalized Veronoi diagram concept for gridding complex regions. Several pieces of this code are already developed.

Designing A Binary Phase Only Filter
Via the Genetic Algorithm

by

Frederick W. Gibson

ABSTRACT

The design of a binary phase only filter for three different binarized test targets (re-entry vehicle, booster and decoy) is obtained using the Genetic Algorithm (GA). The GA is a search procedure based upon the mechanics of natural genetics, blending a Darwinian survival-of-the fittest principle with a random yet structured information exchange among a population of artificial chromosomes. Our results show that GAs are able to design binary phase only filters for each of the three binarized test targets by searching over a 256 total pixel search space. The filter designed for each binarized test target is compared against the other two binarized test targets to determine how well that particular binary phase only filter rejects the other binarized test targets. Because of its ease in operation and simple requirements as compared to many other optimization methods, the GA may find wide application within the field of applied optics.

Two Dimensional Simulation of
Railgun Plasma Armatures

by

Manuel A. Huerta
G. Christopher Boynton

ABSTRACT

We report on our work in incorporating a more realistic initial state and rail ablation into our two dimensional MHD code to simulate the internal dynamics of a railgun plasma armature. Our code uses the equations of resistive MHD, with Ohmic heating, and radiation heat transport. All quantities are advanced in time using an explicit Flux Corrected Transport scheme. Careful examination of our output has revealed very short lived weak secondary arcs that grow and move very rapidly to the rear and contribute to heating the rear region. Preliminary runs with a new initial state show an interesting accumulation of current toward the rear of the armature. Most of our work was spent in developing and coding our model for the ablation. The problem of heat transport in the rail was considered in detail in calculating the rise of rail temperature at the surface, and in calculating the amount of ablation. The rate of heat flux into the rail is basically σT_e^4 , where T_e is the effective radiation temperature that the rail sees. This temperature is calculated in the two dimensional simulation using various approximations that remain to be tested. We also include the heat due to the anode and cathode drops. The time required for the rail to reach the vaporization temperature depends on T_e^8 . This is an extraordinarily high sensitivity to any variations in the temperature.

Gunner Performance in the BSTING Fire Control System

by

William D. Siuru,. PhD, PE

ABSTRACT

A major portion of the results from the flight tests of the Beam Sight Technology Incorporating Night Vision Goggles (BSTING) system conducted in September and October 1990 were reduced and analyzed. A theoretical model of the aiming system was developed and used as a standard of the comparison for measurements and calculations performed by the BSTING system. The ability of the gunner to keep the laser spot on the target was evaluated from the location of the laser spot recorded by the Low Light Video system. The ability of the system to accurately place bullets on target was scored using information obtained from both Infrared and Low Light Video imagery. Recommendations are made on how the accuracy of the BSTING can be improved.

Robust Eigenstructure Assignment with Application to Missile Control

by

Kenneth M. Sobel

ABSTRACT

Eigenstructure assignment is a method which allows the incorporation of classical specifications on damping, settling time, and mode decoupling into a modern multivariable control framework. However, this method does not consider that the plant parameters are uncertain or that the plant contains dynamics which are not included in the design model. New time domain stability robustness results have been obtained for a non-strictly proper linear time invariant plant which is subject to simultaneous structured state space uncertainty and norm bounded unmodelled dynamics. Sufficient conditions for robust stability are obtained both for a constant gain output feedback controller and an output feedback dynamic compensator. The robustness conditions are explicitly in terms of the closed loop eigenvalues and eigenvectors so that these new results are especially well suited for a robust eigenstructure assignment design method. An example is presented of a robust eigenstructure autopilot design for the yaw/roll dynamics of the enhanced medium range air to air technology (EMRAAT) bank-to-turn missile.

MULTIPLE POINT DETONATION MODELING

by

Steven A. Trogdon

ABSTRACT

The HULL hydrodynamics code has been modified to accommodate multiple point detonations or multiple detonations resulting from a single impact. The modifications have been made relative to the physics burn option in HULL. A density criteria is used as the mechanism to trigger a detonation. The resulting detonation is instantaneous with the propagation of the detonation front proceeding at a rate determined by the physics burn option in HULL. The modifications have been documented in a change file so that they can be directly incorporated in the HULL hydrocode. The change file appears in the Appendix. Comparisons of the multiple point detonation model have been made with a previously developed model which could handle only single point detonations. The results were identical when there was only a single detonation. The multiple point detonation model predicted significantly more damage than did the single point detonation model when the potential existed for a second detonation. The multiple point detonation model represents a contribution to continuing efforts to study the complex problem of the lethality of kinetic energy weapons.

ARNOLD ENGINEERING AND DEVELOPMENT CENTER
ABSTRACTS

**APPLICATION OF A TURBULENT COMBUSTION
MODEL TO LIQUID FILM COOLED ROCKET ENGINES**

by
William M. Grissom

ABSTRACT

A 3-D turbulent spray combustion model developed for internal combustion engines (Los Alamos KIVA) was modified for a liquid film cooled rocket. The transpiration of vapor from the liquid film on the combustion chamber walls required modification of the boundary conditions.

A previous model of liquid film cooling by the author was modified to include transient heat conduction into the wall. The heat conduction was modeled by a 2-D finite difference formulation of the diffusion equation. For an epoxy combustion chamber, transient wall conduction is insignificant after the first second of a rocket firing. However, for a metal combustion chamber the times are significant and transient wall conduction should be modelled.

FEASIBILITY OF MEASURING PULSED X-RAY SPECTRA
USING PHOTOACTIVATION OF NUCLEAR ISOMERS

by

Carlyle E. Moore

ABSTRACT

The photoactivation of nuclear isomers as a possible method of measuring the spectra of pulsed bremsstrahlung has been examined. Potential target nuclei include ^{77}Se , ^{79}Br , ^{107}Ag , ^{111}Cd and ^{115}In . The method has been found to be suitable, in principle. Its successful implementation hinges on the accurate measurement of the fluorescence yield from each isomer and the availability of complete and reliable data on the nuclear parameters involved. At present, unfortunately, the available data is incomplete and there appears to be a lingering controversy over the dominant gateways in ^{111}Cd and ^{115}In . These difficulties must be removed if the method is to be applied with confidence.

Combustion of Carbon Particles in the Plume of a Flare

by

Olin Perry Norton

ABSTRACT

A burning flare produces a plume which contains a substantial quantity of solid carbon particles. As the flare products mix with the surrounding air, these carbon particles will burn. The rate of combustion of these carbon particles is expected to have a significant influence on the infrared emissions of the flare plume.

The gases in the plume contains six species which can attack a solid carbon surface. The list includes the stable molecular species CO_2 , H_2O , and O_2 and the radicals OH , O , and H . Based on published reaction rates for these species with solid carbon, the rate of burning of the particle is found as a function of the composition and temperature of the surrounding gas. Also, the increase in temperature of the particle due to these reactions is found.

Noise Reduction in Rocket Test Videos using Mathematical Morphology

by

Richard Alan Peters II

ABSTRACT

Video images of rocket tests are noisy. Thermal processes in the image sensor, imperfections in the recording medium, atmospheric distortion, and various environmental factors degrade the imagery. Blurring (lowpass filtering) individual frames of a video reduces high-frequency noise. However, it also degrades features such as edges that have high frequency components. Image noise and image features are not separable with linear filters if their frequency components overlap, and they usually do. Since most meaningful image features have shape and many types of noise do not, shape sensitive operators possibly could separate features from noise. Moreover, noise that is not correlated between frames could, in principle be detected and eliminated through a multiframe analysis.

Mathematical morphology includes shape-dependent, nonlinear filters that are effective noise reducers for two-dimensional imagery. We extended these filters into the time-domain for multiframe noise reduction of video imagery. We examine the opening transform, the open-close transform, the rolling-ball transform, and the rank filter (all are morphological operators) as spacetime operators. We show that these transforms reduce image noise effectively without degrading other features substantially.

On the Hazard of Combustion Chamber Oscillations in a Large Freejet Test Cell

by

John M. Russell and Grant M. Watson

ABSTRACT

The Aeropropulsion Systems Test Facility (ASTF) at the Arnold Engineering Development Center (AEDC) is to be used to test the powerplant for the National Aerospace Plane (NASP). The NASP powerplant is an airbreathing hydrogen fueled engine and is to be tested in a 'freejet' mode, i.e. not all of the inlet air in the test cell is to be ingested by the engine. Some of that air - the 'freejet spillage' - will flow past the engine to simulate the environment in which the engine will operate. Unplanned releases of hydrogen into the test cell (which may result from a flameout or leak in the fuel line) will allow it to mix with freejet spillage air and, if not disposed of, expose the facility to any of several potentially destructive combustion phenomena. One concept for a hydrogen disposition system (HDS) involves burning the hydrogen at an array of flameholders installed in the test facility for that purpose.

The present report focuses specifically on the hazard of combustion chamber oscillations in the region downstream of such an array of flameholders. Combustors in rocket engines and ramjets and afterburners in turbojets commonly experience such oscillations during development and, if not controlled, can destroy the device in which they arise. The physical processes involved in combustion chamber oscillations and theories for modeling them are reviewed. The usual trial-and-error approach for the development of combustion chambers for engines is not feasible when the device at risk is the ASTF. Technologies for suppressing such oscillations (e.g. the use of acoustic liners, baffles, and water spray) are reviewed. One conclusion of the report is that an HDS concept based on afterburning without any artifices for the suppression of resonant combustion introduces a credible threat to the ASTF and that further study of oscillation suppression devices in this geometry is called for.

Laser-Induced Fluorescence of Nitric Oxide

by

Chun Fu Su

ABSTRACT

Preliminary computational models of the laser-induced fluorescence spectrum of nitric oxide have been developed for two different electronic transitions:

$B^2\Pi (\nu'=7) - X^2\Pi (\nu''=0)$ and $D^2\Sigma (\nu'=0) - X^2\Pi (\nu''=1)$.

Laser-induced fluorescence spectra of nitric oxide at room temperature and at high temperature (up to 623°K) with various pressures have been recorded. Comparison of the experimental results with predicted spectra will be presented herein.

An Algorithm for Defining the Shape
of a Plume Exhausting from a Rectangular Nozzle

by

Kevin W. Whitaker

ABSTRACT

Investigations into facility modifications required to support future propulsion system testing are currently being conducted at the Arnold Engineering Development Center. These investigations have identified a need for tools which will assist in the analysis of facility components. With regards to new diffuser designs, there is a need to describe the shape of a plume issuing from a rectangular nozzle. In this report a simple modeling technique is derived for rectangular nozzle plumes under static conditions. The model is based on detailed flow fields of round nozzle plumes. Subsequently, an attempt is made to extend the method to cover nonzero flight speeds at which the external stream affects the mixing rates and the shape of the plume. Detailed construction of a plume model for rectangular nozzles is described in terms of scaling an axisymmetric plume, application of conservation of mass, and a spreading procedure to simulate static and nonzero flight speeds. It has been shown that a single calculation of an axisymmetric plume can provide the basic solution for the plume issuing from a rectangular nozzle. Further work needs to be conducted on generalizing the algorithm and developing a computer program utilizing the algorithm.

**ASTRONAUTICS LABORATORY
ABSTRACTS**

Strain Enhancing Binder Blends
For Use in Rocket Propellants

by

Daniel Lee Fuller

ABSTRACT

Rocket propellants were prepared by polymerization of the hydroxy terminated polybutadiene (HTPB) with isocyanates and copolymers of HTPB and amine terminated polypropylene glycol (ATPPG) isocyanate. The binder composition was modified both by varying the isocyanate to hydroxyl ratio and by varying the percent of ATPPG. Mechanical properties were determined using an "Instron." We reported the maximum stress, maximum strain, initial modulus, stress at rupture, and elongation at rupture for these propellant systems.

A Development of Molecular Modeling Techniques to Study Intermolecular
Forces Found Between Solid Rocket Oxidizers and Their Binding Agents

by

Shannon G. Lieb

ABSTRACT

In light of the many failures of solid rocket motors due to improper adhesion of the oxidizer to the binding agent, this study was embarked upon with the idea of modeling the nature of binding to a solid ionic surface at the molecular level. This approach should yield ways of improving the method of mixing the oxidizer and propellant and should give a better understanding of the concept of binding itself. With this general goal in mind, the specific system of ammonium perchlorate (oxidizer) and hydroxy-terminated polybutadiene (binder) are made the model system to study. These materials are commonly used in these roles and are well characterized in terms of their thermodynamic and spectroscopic properties. These ingredients are essential to modeling the inter- and intramolecular forces needed to carry out molecular mechanics calculations of this system. Appropriately small prototype systems must first be studied to test the parametrization scheme to be used in the large scale problem. Once the essential interactions are characterized, the scaling up to the complex system of long chain binders adhering to a solid surface requires a partitioning of efforts into two parts. One part is the study of the lattice statistics of a long chain alkene adhering to the ammonium perchlorate surface. The second is the investigation of the most energetically stable interactions between the binder and oxidizer. Together these approaches yield a molecular description of the oxidizer/binder interaction.

Design and Analysis
of Reaction Wheel Actuators for ASTREX

by

Tom C. Pollock and Johnny E. Hurtado

ABSTRACT

Reaction wheel actuators have been designed for the ASTREX experimental article. The reaction wheel torquers are PMI servodisc motors outfitted with reaction wheels. The type JR25 series will be employed to provide controlled fine point maneuvering while a JR16 series will be used to actively suppress vibration of the structure. Software has been written that aid in the design and analysis of reaction wheel torquers. *Designer* helps to design and size the reaction wheel. *Analyst* helps to analyze the response of the motor and wheel pair in the time domain. *Myfrf* is a Matrix_x executable function which analyzes the response of the motor and wheel pair in the frequency domain. User guides have been written which explain the input to the codes and their algorithms. In addition, the necessary mounting brackets have been designed and documentation regarding the assembly of the reaction wheel actuators has been provided.

Component Design for the Multi-Body

Dynamics Experiment

by

Roger C. Thompson

ABSTRACT

An experimental facility is currently under development for the study of the behavior of multi-body systems. In the initial phase of the project, the operational characteristics were established and the parameters for the design of the components were determined. Conceptual outlines for the structure, interconnections of the components, and the complete design and specification of the elements were to be achieved during this phase of the project. A detailed layout of the experiment was produced such that individual components could be sized for the final design and fabrication. Several problems were encountered in finding suitable components due to the high performance requirements set for the facility. The drive units have been specified for the shoulder and elbow joints, and the mounting system for the shoulder motor was completed. Additional tests were performed on the air cushion flotation system because the mass of the elbow structure will be substantially higher than predicted by the initial estimates. An analysis of the performance of the structure with larger mass elements was completed; from the results, it was determined that the frequencies of the structural vibrations would be shifted in range, but the frequency spread would not change significantly. The flexible elements can be scaled such that the first mode frequency remains the same (0.5 Hz).

CONTROL DESIGN OF ASTREX TEST ARTICLE

by

Hung V. Vu

Joseph P. Baldonado

Hung M. Nguyen

ABSTRACT

A scaled-down control system of ASTREX (Advanced Space Structures Technology Research Experiments) test article was successfully designed. The control system consisted of a scaled-down ASTREX test article, a PID (proportional-plus-integral-plus-derivative) controller, electrolytic tilt sensors, and stepper motors. MATRIX_x/SystemBuild and MAX_100 (products of Integrated Systems, Inc.) were used for real-time control. The results were satisfactory. It was found that in order to control the stepper motors effectively, the real-time controller must have sufficiently high sampling rate.

IDENTIFICATION AND CONTROL OF FLEXIBLE SPACECRAFT

by

Trevor Williams

ABSTRACT

The first objective of this research was to investigate how to identify the structural parameters of flexible spacecraft from vibration test time-response data. A study carried out on the ASTREX testbed structure revealed that natural frequencies could be estimated quite accurately. Care needs to be taken, though, to prevent numerical sensitivity issues from leading to overestimates for damping levels.

A second topic of research was that of sensor/actuator placement for flexible spacecraft. A new simple technique was developed for solving this important problem and tested, in prototype form, on a model of the Astronautics Laboratory grid structure. The new method appears to be readily generalizable for application to any sensor/actuator combination envisaged for the ASTREX structure.

Finally, the performance of various widely used control schemes was investigated and compared, and certain very simple generic properties discovered when these are applied to flexible structures. The conclusions obtained have important implications for vibration suppression control system design.

**INVESTIGATING THE LOADING RATE EFFECT ON THE CRACK
GROWTH BEHAVIOR IN A COMPOSITE SOLID PROPELLANT**

by

Hsien-Yang Yeh

Minh D. Le

ABSTRACT

The crack growth behavior in a highly filled composite solid propellant was studied through the use of a centrally cracked strip biaxial specimen. The specimen was tested under a constant crosshead speed at room temperature. In this study, three different crosshead speeds and two different crack lengths were considered. During the experiment, a video camera was used to monitor the crack growth and a tape-recorder was used to record the load as a function of time. The raw experimental data (crack length, load, time) together with a response surface equation (relating the normalized stress intensity factor to the two half crack lengths) were used to calculate the instantaneous crack growth rate and the associated stress intensity factor. The experimental data were analyzed to investigate the effect of crosshead speed on the crack growth behavior in the material.

**ELECTRONIC SYSTEMS DIVISION
ABSTRACTS**

WALSH FUNCTION ANALYSIS OF IMPULSE RADAR

by

CHIH - FAN CHEN

ABSTRACT

A conventional radar is with extremely narrowband, while an impulse radar is with ultrawideband. The impulse radar has a potential to achieve the goals such as resolution, risetime and bandwidth. As experts in this field indicated: we have to think about ways of increasing range resolution or widen the bandwidth of the signal. However the tools for analyzing impulse radars are not quite ready. It is known that the mathematical tools for conventional radars are based on Fourier theory which is not very suitable for impulse radars, because it can not cope with a short time situation and it always has Gibb's phenomenon and it is comparatively slow in processing. Following Harmuth's suggestion, instead of using Fourier theory, we apply Walsh functions for impulse radar studies. An operational matrix is used for integration; by use of which ordinary differential equations and simple partial differential equations are solved by Walsh analysis. The final goal is to attack the Maxwell equations in order to solve impulse radar problems.

**ENGINEERING AND SERVICES CENTER
ABSTRACTS**

HIGH OXYGEN/CARBON RATIO FUEL CANDIDATES FOR CLEAN AIR
FIRE FIGHTING FACILITY PROJECT

William W. Bannister

Abstract

This project will evaluate performance and burn characteristics of isobutyl acetate [IBA] and ethoxyethyl propionate [EEP] as high oxygen/carbon ratio [high O/C] low smoke candidates for replacement of JP-4 and other hydrocarbon fuels in firefighting training facilities. The tests will compare the following characteristics of IBA and EEP with JP-4: relative fire safety of the test candidates; extinguishabilities by 3% Aqueous Film Forming Foam (AFFF), and other extinguishing agents; qualitative and quantitative analyses of smoke generation; and qualitative and quantitative analyses of air and fire pit water pollutants.

RATE-LIMITED MASS TRANSFER AND SOLUTE TRANSPORT

by

Mark L. Brusseau

ABSTRACT

Mass transfer processes such as sorption/desorption and immiscible liquid-aqueous phase transfer can have significant impact on solute transport and remediation of contaminated groundwater, especially when local equilibrium is defied. The objective of the work reported herein was to investigate nonequilibrium sorption of representative organic chemicals by aquifer materials comprised of low organic carbon. The miscible displacement technique was employed for this purpose. Results suggest that the first-order reverse sorption rate constant is log-log linearly related to the sorption equilibrium constant. Furthermore, it appears that nonequilibrium sorption is similar for all five aquifer materials investigated. Thus, the empirical relationship obtained from these data may serve as a means to obtain estimates of sorption rate constants. It is important to note, however, that a time scale effect was observed, such that the sorption rate constant varied with pore-water velocity.

Centrifuge Modeling of Explosive Induced
Stress Waves in Unsaturated Sand

by

Wayne A. Charlie and Andrew J. Walsh

ABSTRACT

Influence of moisture content on explosive induced stress wave propagation in compacted sand is reported. A series of 0.87 gram explosive charges were detonated on the centrifuge at 15 and 30 times earth's gravitational field (15 and 30 g's) to model prototype explosive charges of 3 and 27 kilograms respectively. Stress wave velocity, peak stress and stress transmission increased from 0 to 20 percent saturation and then decreased from 60 to 80 percent saturation. Results follow trends obtained from Split-Hopkinson Pressure Bar tests.

Pathways of 4-Nitrophenol Degradation

by

Joseph H. Dreisbach

ABSTRACT

Three soil bacteria isolates, designated 402, 428, and 443, were used in this investigation to determine the pathway of 4-nitrophenol oxidative degradation. Pathways were studied using respirometry with whole cells and cell free extracts, O-18 incorporation studies, and gas chromatography-mass spectrometry analysis of extracts of the reaction media. A mutant of 402 which accumulates 1,2,4-benzenetriol and hydroxybenzoquinone was obtained. Results support the proposed pathway which involves two oxygenase reactions to yield 1,2,4-benzenetriol from 4-nitrophenol. Benzenetriol is then converted through 3-hydroxymuconic acid to maleylacetate by an ortho ring fission reaction.

Permanent Deformations in Airfield Pavement Systems with Thick Granular Layers

by

David J. Kirkner

ABSTRACT

A finite element code was developed to analyze airfield pavement systems allowing an elasto-plastic material law to be employed to describe the mechanical behavior of the pavement layer as well as the granular base and sub-base layers. The principal material law utilized in this report was based on linear elastic behavior below yield and during unloading and a Drucker-Prager failure line with an elliptic cap yield surface. Subsequently, using measured physical constants for the material in the pavement test bed at Tyndall Air force Base and some reasonable values for the cap parameters not measured, simulations were conducted for the Tyndall test site. It was found that this model could reasonably capture the peak deformation which occurred during loading and also predicted reasonable results for the permanent deformation occurring after unloading.

The High-Speed Separation and Identification of Jet Fuel

by

Paul R. Kromann

ABSTRACT

Gas chromatography and pattern recognition were used to effect the high-speed separation and identification of aviation fuels. A 0.10-mm diameter capillary column was used and the chromatographic conditions were found which allowed chromatographic analysis to be carried out five times faster than before. Use of a flame ionization detector lowered the cost of the equipment considerably.

In addition to faster analysis using less-expensive equipment, the system used here gave better identification accuracy compared with the earlier work. The SIMCA pattern recognition system classified all available aviation fuels (154 samples distributed among seven different fuel types) with 100% accuracy. The SIMCA system correctly classified 16 out of the 18 available weathered samples.

UTILIZATION OF ION EXCHANGE RESINS FOR THE PURIFICATION OF PLATING BATHS

by

Kyung C. Kwon

ABSTRACT

Experiments were performed for the removal of Cr^{+6} , Fe^{+2} , Cu^{+2} and Ni^{+2} with Dowex XFS 4195.02 ion exchange resin as an adsorbent at 25°C . No removal of Fe^{+2} was observed in the presence of the Dowex resin. A mathematical model on the removal of both Cr^{+6} and Cu^{+2} from aqueous solutions was developed in the presence of the Dowex resin, assuming that intraparticle diffusion is a controlling step for the adsorption of the heavy metal ions on the resin. The intraparticle diffusivities of Cr^{+6} and Cu^{+2} through the resin were obtained to be 0.5 and $0.03 - 0.05 \text{ cm}^2/\text{min}$, respectively, by applying experimental data to the developed mathematical model.

Experiments on isotherm equilibrium adsorption of Cu^{+2} on the Dowex ion exchange resin were performed at pH 1.5 and 25°C . A mathematical equation on the isotherm equilibrium adsorption of Cu^{+2} on the resin was developed, using the Freundlich equation.

A series of experiments on the regeneration of Cu^{+2} -saturated Dowex XFS-4195.02 ion exchange resin were conducted at 25°C , using 0.5-2N NH_4OH aqueous solution as a regeneration reagent. A mathematical model on the regeneration of exhausted Dowex XFS 4195.02 ion exchange resin was developed, using experimental data of regeneration.

Methanotrophic Cometabolism of Trichloroethylene in a Two Stage Bioreactor System

by

Michael J. McFarland

ABSTRACT

A two stage bioreactor system inoculated with a locally obtained mixed methanotrophic culture was found to be effective in biodegrading trichloroethylene (TCE) when supplied with sodium formate as reducing power. During methane additions, a maximum TCE removal rate of 21.1 mg TCE per gram volatile solids per day was found when the influent formate concentration was 20 mM. Termination of methane while maintaining the same formate loading resulted in a TCE removal rate of 25.5 mg TCE per gram volatile solids per day suggesting that methane may competitively inhibit TCE removal. Under formate limiting conditions, TCE removal occurred mainly by adsorption to microbial flocs.

Submicron Antennas for Solar Energy Conversion

by

Dr. Perry R. McNeill, P.E.

ABSTRACT

This report deals with the synthesis and evaluation of literature in the area of using submicron antennas to convert solar energy to electrical power. A number of articles in three areas are discussed; Solar Cells, Submicron Antennas, and Related Work. The primary document analyzed is "Antenna Solar Energy to Electricity Converter (ASETEC)", Dr. Erich A. Farber, University of Florida. A secondary set of documents included in the report were patents issued to Dr. Alvin M. Marks for submicron antennas and fabrication techniques for use in solar energy conversion.

Dynamic Analysis of Impulse Loading on Laminated Composite Plates
Using Normal-Mode Techniques

by

John L. Scharf

ABSTRACT

The normal-mode technique has been applied by previous investigators to the dynamic analysis of impact loading on beams and plates. In this work, the method is applied to one-way, simply supported, laminated, composite plates under uniformly distributed, impulse loads. Governing equations are formulated based on kinematic assumptions that allow the transverse shear deformations to vary through the thickness of the laminated plate. A solution is obtained for a two-ply, $-\theta/+\theta$ laminate. This solution shows that immediately after the impulse is applied, sharp peaks in the transverse shear stresses occur at the two end supports. These shear stress peaks then propagate from the supports across the span at the shear wave speed for the material that comprises the laminated plate. This result is consistent with those obtained by the earlier investigators, and it leads to two recommendations. The first is that any numerical techniques applied to the analysis of laminated composite plates must accommodate the large strain gradients and high speeds of the transverse shear waves. The second is that design modifications should be investigated that will mitigate the effects of transverse shear stress peaks on laminated composite plates under impulse loads.

A SPECIMEN PREPARATION TECHNIQUE FOR MICROSTRUCTURAL ANALYSIS OF UNSATURATED SOIL

by

George E. Veyera, Ph.D.

and

Blaise J. Fitzpatrick, Graduate Student

Department of Civil and Environmental Engineering

University of Rhode Island

ABSTRACT

Recent research has demonstrated that compacting moist sands at different saturations prior to dynamic testing can increase the stress transmission ratio by as much as a factor of two and can also lead to increased stress wave propagation velocities. Other research studies have also shown that the compaction method and the amount of moisture has a measurable influence on the both static and dynamic properties of sands. Experimental evidence suggests that the behavior can be attributed to variations in soil microstructure and compressibility as a result of conditions during compaction. However, a clear and concise explanation of the phenomenon is not currently available. Therefore, the need for further investigations to study the fundamental relationships between macroscopic behavior and microstructural features is evident. Considering this, the investigation outlined herein was conducted to develop a simple laboratory procedure to prepare specimens of compacted unsaturated soil for microstructural analysis. The technique involves preserving the structure formed during compaction for detailed study at the microscopic level. The method can be used to investigate and qualitatively describe the development of microstructure in compacted unsaturated soils and its effect on stress transmission from conventional weapons detonations. The results of such studies will lead to a better fundamental understanding of the role of microstructure as it affects the macroscopic engineering behavior of soils and has direct applications to groundshock prediction techniques including stress transmission to structures. The microstructural characterization of unsaturated soils will be a key element in establishing and developing an understanding of stress transmission in unsaturated soils. The research is important to the U.S. Air Force since there are currently no theoretical, empirical or numerical methods available for predicting large amplitude compressive stress wave velocity and stress transmission in unsaturated soils.

**FRANK J. SEILER RESEARCH LABORATORY
ABSTRACTS**

Thermal Decomposition of NTO and NTO/TNT Mixtures

by

Theodore J. Burkey

ABSTRACT

The thermal decomposition of NTO (3-nitro-1,2,4-triazol-5-one) and mixtures of NTO with TNT (trinitrotoluene) was examined using isothermal DSC (differential scanning calorimetry). No significant deuterium isotope effect was observed for the decomposition of NTO-d₂. This suggested that the rate determining step in NTO decomposition did not involve the breaking of the nitrogen-hydrogen bond. A mixture of 2% TNT in 98% NTO (mole %) decomposed at lower temperatures than pure NTO and faster than pure TNT indicating that TNT catalyzed the decomposition of NTO. The minimum decomposition temperature of 2% TNT-d₃ in NTO-d₂ was the same as for the undeuterated mixture indicating N-H or C-H bond ruptures are not part of the rate determining step. A mixture of 2% NTO in TNT decomposed more rapidly at 265 °C than pure TNT or 2% NTO-d₂ in TNT-d₃. These results indicate that NTO catalyzes the decomposition of TNT and that this process may involve N-H or C-H bond rupture in the rate determining step.

Transition Metal Carbonyl Complexes in Ambient-Temperature Molten Salts

by

Richard T. Carlin and Joan Fuller

ABSTRACT

Employing $\text{AlCl}_3:\text{ImCl}$ molten salts as solvents, the catalytic activities of $\text{RhCl}(\text{PPh}_3)_3$ and $\text{RhH}(\text{CO})(\text{PPh}_3)_3$ for olefin hydrogenation and hydroformylation, respectively, were tested. It was not possible to observe catalytic activity in either case; however, FT-IR spectroscopy of the complexes in the melts provides some clues as to why they are not catalytically active. The acidic melts were found to be effective catalysts for the acid catalyzed polymerization of olefins.

Reaction of Na with an acidic melt produces an "active" Al reductant. Under carbon monoxide (1 atm), this Al reduces Cp_2TiCl_2 to the new Ti(III)-CO species $\text{Cp}_2\text{Ti}(\text{CO})_2^+$. Continued reduction produces the previously known $\text{Cp}_2\text{Ti}(\text{CO})_2$. The FT-IR spectrum of $\text{Cp}_2\text{Ti}(\text{CO})_2$ in the acidic melt indicates an unexpected interaction of AlCl_3 with the Cp rings resulting in a shift of the CO stretching frequencies to higher energies.

With the acidic melt as solvent, the "active" Al was used to reduce CoCl_2 to a cobalt carbonyl species. This preparative method may prove useful for producing metal carbonyls from metal halides under mild conditions.

EXPERT GUIDE: USING ARTIFICIAL INTELLIGENCE TECHNIQUES
TO HELP CHEMISTS UTILIZE NUMERICAL PROGRAMS

by

Daniel P. Dolata

ABSTRACT

The use of complex programs in chemistry, such as MOPAC, is becoming standard practice in large research communities where both laboratory chemists and computer scientists can work on a problem together. However, these programs are often too complex to utilize with a training course or an "in house expert". We have demonstrated that it is feasible to create an expert system which can provide a chemist with the necessary "in house expertise" based on the type of study they want to perform, the molecule(s) to be considered, and the capabilities of the numerical programs. The prototype was trained in two domains; selection of Semiempirical Hamiltonians based on molecular features, and generation and evaluation of Ab Initio plans based on CPU constraints and molecular features. The quality of the predictions were tested against published cases, and complete agreement was obtained in over 82% of the cases and essential agreement in 12% of the cases. This demonstrates that the approach is feasible, and that high quality guidance can be delivered by such a program.

**CONTROL OF A COMPLEX FLEXIBLE STRUCTURE UTILIZING SPACE-
REALIZABLE LINEAR REACTION MASS ACTUATORS**

by

Ephraim Garcia, Ph.D.
Research Assistant Professor

Brett James Pokines
Graduate Assistant

Robert Carlin
Graduate Assistant

ABSTRACT

Passive and active control have been performed on a flexible structure possessing complex modal behavior. Specifically, the structure has closely spaced modes which created a "beat phenomena" in the structure's vibrations. Reaction mass actuators (RMAs) were used to suppress the structural vibrations with both passive and active control schemes where the actuator to structural mass ratio was 2%. The results of using both types of control systems were compared both analytically and experimentally. It was determined that passive tuning of the RMAs did suppress the structure's vibrations, but adding active control to the optimally tuned RMAs did not significantly increase the system's vibration suppression performance. The active control strategy is a low authority controller utilizing a structural velocity signal. However, by choosing the actuator's characteristics from active control considerations this active control strategy suppressed structural vibrations and reduced the active system's settling time to 20% of the settling time with passive damping. High order controllers, controllers with full state feedback, were also investigated, and it was found that the performance of these were comparable to the simpler controllers.

Particle Image Displacement Velocimetry (PIDV)
Measurements in Dynamic Stall Phenomena

by

Ngozi Kamalu

Rand Conger

ABSTRACT

This research effort was focused on developing a Particle Image Displacement Velocimetry (PIDV) technique to be used to obtain two-dimensional velocity measurements and associated vorticity levels around a pitching airfoil. This work was initially divided into three parts respectively, to adapt the PIDV technique to the measurement of two-dimensional velocity fields around a pitching airfoil, quantify the vorticity levels in the separated region created by an airfoil pitching at constant rates, and to determine the relationship between the vorticity field and behavior of the dynamic stall vortex. Due to technical problems and time constraints, significant progress was made only on the first part towards the setup of the PIDV technique for the measurement of two-dimensional velocity fields around a pitching airfoil.

**A PRELIMINARY ANALYSIS OF SYMBOLIC COMPUTATION TECHNIQUE
FOR PREDICTION OF UNSTEADY AERODYNAMIC FLOW**

by
S. A. Kassemi
G. M. Cuning

ABSTRACT

A procedure based on a symbolic computational technique analysis is introduced in which approximate analytical techniques are utilized in conjunction with analytic iterations to obtain closed form solutions to boundary and initial value problems arising from fluid flow and transport processes. In particular, the general problem of unsteady flow over an airfoil undergoing a pitching motion is considered, and a procedure for direct analytical iteration on the governing system of equations is outlined. The procedure is shown to result in solving time dependent diffusion type boundary value problems in two or three dimensions at each iteration.

The utility of the proposed method is demonstrated by considering the boundary value problem resulting from the flow of an incompressible fluid over a flat plate and a pure diffusion problem. In both cases excellent agreement with existing solutions are reported. The symbolic computational technique proposed herein is then favorably compared with more conventional numerical techniques such as the finite difference method, with several advantages of the proposed method being pointed out. The generalization to more complicated problems is discussed.

Investigation of Lithium in
Buffered MEIC-AlCl₃ Melt

by

Bernard J. Piersma

ABSTRACT

LiCl is essentially insoluble in basic and neutral MEIC-AlCl₃ melts at room temperature but is soluble in acidic melts to the extent equivalent to the mole fraction of AlCl₃ in excess of 0.500. Studies of LiCl at tungsten and glassy carbon electrodes and of Li metal electrodes in LiCl-buffered neutral melt using various electrochemical techniques are reported. NaCl-buffered neutral melts were also examined to provide a basis for comparison of results.

The cathodic reduction of Li⁺ from neutral melt is readily accomplished, however, this is extremely sensitive to melt composition and, to a lesser extent, to conditions of the electrode surface. The reduction product (presumably Li) is stable on the electrode surface at open circuit but can be re-oxidized (however this is not a reversible process). Electrochemical behavior of Na⁺ in a neutral melt appears to be similar to that for Li⁺.

Li metal establishes a stable open circuit potential which is dependent on melt acidity and on cations present in the melt. Polarization studies are reported for Li in neutral melt, LiCl-buffered and NaCl-buffered neutral melts.

Control Formulations for the Active and Passive Damping of Flexible Structures

by

Thomas A. Posbergh

ABSTRACT

Several issues related to the use of reaction mass actuators for the control of large, flexible space structures were investigated during the summer. The damping of vibrations caused by disturbances to the structure were the major focus of research. One effort investigated the advantages of active control for damping a flexible structure with a reaction mass actuator. Another effort looked at reformulating the classical Den Hartog absorber problem as a feedback control problem. With this reformulation recent algorithms developed for H_{∞} control problems can be applied to determine the optimal tuning of the damping devices. Extensions to multiple degree of freedom systems are straight forward.

**GEOPHYSICS LABORATORY
ABSTRACTS**

Background Research on Global Warming

by

Theodore P. Aufderberge

ABSTRACT

This paper reports only one half, if that much, of the impression left by the title. It assumes the greenhouse theory of climatic change is correct and reports on the consequences of that assumption for global warming. The paper describes the various ways climate models are alike and different. It points out that it is their uniqueness that causes them to predict differing amounts of global warming and it is their similarities that cause them to predict that the earth will warm.

Correlations Between Levels for Stellar Scintillometer Derived Profiles of C_n^2

by

Frank P. Battles

ABSTRACT

A stellar scintillometer measures the variance of stellar intensity for a first magnitude or greater star. This variance, by the use of spatial filters, can be converted into a profile of C_n^2 , the index of refraction structure constant, for 7 different altitudes or levels. The C_n^2 values are not entirely instrument independent because there will be some overlap in the weighting functions used to separate the spatial frequencies. It is usually assumed that those readings from levels 1,4 and 7 are instrument independent. 192 such profiles were obtained by AFGL scientists during a measurement program at PSU over the period of April 30-May 6, 1986. When linear correlation coefficients are calculated between levels for C_n^2 and $\log(C_n^2)$ for this data set, results obtained seem to contradict the above stated assumption. Much less correlation is observed when calculated on a nightly basis. In fact some nightly coefficients are significantly negative which could not be due to weighting function overlap. We have investigated other mechanisms which could lead to a high degree of correlation across the entire data set. During the measurement program atmospheric conditions changed from evening to evening. For example, there were several jet stream passages noted during this time period effecting the entire altitude range covered by the scintillometer. This means that C_n^2 is not a stationary variable which in turn suggests two approaches. In the first, we treat C_n^2 as a completely random variable on each evening with mean and standard deviation as actually measured for that evening. We can then generate the appropriate number of profiles for each evening to see how much correlation is produced when the nightly results are merged giving 192 profiles. A substantial amount results. The second approach taken was to subtract the appropriate nightly means from each profile and recalculate the correlation coefficients. This generally results in reduced correlations and in some cases substantially reduced correlations between levels. We conclude that correlation studies do not indicate that, except for low lying adjacent levels, C_n^2 values obtained using the scintillometer are instrument dependent.

Total Dose Effect on the Soft Error Rate of
Metal-Oxide-Semiconductor Memory Cells

by

Reuben Benumof

ABSTRACT

The purpose of this paper is to elucidate the reasons why the rate of change of the soft error rate with respect to the total radiation dose is positive for a metal-oxide-semiconductor static random access memory cell and negative for a metal-oxide-semiconductor dynamic random access memory cell. The crucial question is the sign of the derivative of the critical charge with respect to the total dose. The analysis shows that, in the case of a static random access memory cell, the critical charge decreases with increased dose because the charge stored by the gate capacitors decreases as a result of the upward shift of the magnitude of the threshold voltages. In the case of a dynamic random access memory cell, the critical charge increases with increased dose because the charge stored in the cell capacitor increases. The greater the critical charge, the less likely is a single event upset.

PBL Short-Wave Disturbances over the Desert Southwest

by

Chia-Bo Chang

ABSTRACT

In summer over the southwestern United States, the development of mesoscale convective systems (MCSs) under the baroclinically inactive condition of weak synoptic-scale circulation and mild temperature gradient may result in heavy precipitation causing extensive flood damages. One of the significant features often observed prior to the formation of MCSs under the condition is the low-level subsynoptic scale disturbances with a horizontal wavelength in the range 500 to 1000 km. The short waves appear to originate in the deep convective planetary boundary layer (PBL) over the desert southwest. In the absence of synoptic scale forcings such as the upper air trough and the associated jet streaks, these disturbances may serve as a triggering mechanism for the onset of organized convection upon encountering a potentially unstable air mass.

The present study focuses on questions concerning the origin and dynamics of the PBL short waves. These questions are addressed using the linearized perturbation analysis as well as numerical model simulation experiments. The preliminary results indicate that the PBL short waves are caused by the strong air-land thermal interaction. Such interaction results in a deep near-neutral layer with mild baroclinicity.

SIMULATION OF REFS MISSILE FLIGHT

by

George Y. Jumper, Jr.

ABSTRACT

A 6 degree of freedom computer simulation for the standard configuration of the 2.75" Folding Fin Aircraft Rocket was performed. Aerodynamic coefficients were based on existing flight data. The simulation was modified for a new configuration designed to carry the payload for the REFS (Rocket Electric Field Sounding) program. Since the new configuration has the payload section of the rocket spinning at a different rate than the motor casing, Magnus forces could cause dynamic instabilities.

Evaluating the Diagnostic Potential of
High Spatial and Spectral Near Infrared Observations of
the Solar Photosphere

by Jeffrey R. Kuhn

ABSTRACT

A new photometric quality, near-infrared, focal plane array camera was brought to Sacramento Peak Solar Observatory for a series of observations totaling approximately 5 weeks. This cryogenic camera was used to obtain high spectral resolution observations of quiet and active photosphere from each of the primary spectrographs at the observatory. Broad band, high image spatial resolution observations were also obtained using the Vacuum telescope.

A NEW ION-MOLECULE CHEMILUMINESCENCE EXPERIMENT

by

C. Randal Lishawa, Ph.D.

ABSTRACT

A new ion-molecule chemiluminescence experiment was brought on-line and tested. The system is designed to look at the chemiluminescence from both ions and neutrals formed in suprathreshold energy collisions, as well as from the primary neutral excited through inelastic collisions. We have observed chemiluminescence from the reactions: $O^+ + N_2$, $O^+ + H_2O$, $N_2^+ + H_2O$, $Ar^+ + N_2$, and $Ar^{++} + CO$. Low resolution spectra obtained from the reactions $Ar^+ + CO$, $Ar^{++} + N_2$, and $N_2^+ + H_2O$ are presented as examples of the new system's capabilities without further comment or interpretation.

Relationship between Brightness Temperatures
and Typhoon Intensification

by

Gandikota V. Rao

ABSTRACT

The 85 GHz vertically (V) polarized brightness temperatures (TBs) of the Defense Meteorological Satellite Program (DMSP) were examined to uncover any association or correlation between the brightness temperature anomaly and the intensity (current or future) of a tropical cyclone. The tropical cyclones selected were those in the northwest Pacific and were all typhoons. The anomaly is defined in the following way: The mean value of TBs in a prescribed rectangular area (say, 222 km along the direction of movement and 111 km across the direction) to the right of direction of movement of a cyclone is found. Similarly the mean TB in the corresponding area to the left of the storm is found. Most tropical cyclones show considerable asymmetry in precipitation. Therefore it is expected that the right side of a traveling storm contains a slightly different TB field compared to the left side. An anomaly is thus generated. The sign and magnitude of this anomaly is dependent on the area under consideration. In this study the magnitude of the anomaly is correlated with the current and future (24 h) intensity of a storm.

Results for three typhoons suggest that the correlation is strong when the TB anomaly of area 222 km x 111 km is compared against the future (24 h) intensity. This future intensity is derived from another satellite (Dvorak) technique which did not use the microwave data. As a follow up study it is suggested to compute the correlation with an enlarged sample. Additional recommendations are made to use the brightness temperatures to forecast the intensity of storms.

Electric Fields in the Middle- and Low-Latitude Ionosphere and Plasmasphere

by

Craig E Rasmussen

ABSTRACT

Middle- and low-latitude electric fields are primarily caused by tidal motions of the thermosphere. These tidal winds normally act to produce an electric field pattern which is diurnally repeatable. However, during periods of high geomagnetic activity, the source and nature of electric fields at lower latitudes may change. In the early phase of a substorm, high-latitude electric fields increase dramatically and are observed to penetrate to lower latitudes. These fields are short lived and tend to decrease after about 20 minutes as charges in the Alfvén layer begin to shield fields of magnetospheric origin from the inner plasmasphere. However, the dramatic increase in high-latitude fields during substorms affects the thermosphere as well, and these effects may last for hours after the substorm has subsided. Thus, via coupling to the *E*-region ionosphere, the disturbed thermosphere can alter electric fields at lower latitudes for relatively long periods of time. This report describes research related to the generation of middle- and low-latitude electric fields following magnetic storms and substorms. The work was done at the Geophysics Laboratory in conjunction with the Summer Faculty Research Program. The research was primarily divided into two areas: (1) A numerical model of dynamo electric fields was created. This model solves for dynamo electric fields in Earth's ionosphere given thermospheric wind patterns. (2) DMSP satellite data were examined to ascertain the mixed role of magnetospheric and dynamo electric fields in the low-latitude ionosphere during the major storm of March, 1989. Electric fields during this storm lead to vertical drifting of ionospheric plasma which is believed to be responsible for a deep density trough measured by the F9 DMSP satellite on 14 March, 1989.

Resonance Enhanced Multiphoton Ionization of Molecular Nitrogen/
Electronic Quenching of the N₂ A State by CO

by

Glenn Stark

ABSTRACT

A multiphoton ionization signal from molecular nitrogen was recorded. The (2 + 2) ionization process occurred via the resonant intermediate "a" state of N₂. The signal intensity was monitored as a function of ionization voltage and nitrogen pressure. The minimum detectable signal (signal/noise=1) corresponded to a nitrogen pressure of 0.02 Torr. Fluorescence from the "a" state was also observed following two-photon absorption, to a detection limit of 0.005 Torr.

The collisional deactivation of the N₂ "A" state by carbon monoxide was studied in a discharge flow system. Preliminary photographic and photoelectric spectra of the CO "a" state indicate that approximately 60% of the CO product resides in the lowest vibrational level.

Optical Propagation in Non-Uniform Media

by

John G. Wills

ABSTRACT

This 1990 study is a continuation of last summers SFRP research. The general topic is light propagation through non-uniform media. The purpose of the research is to provide a method of rapid calculation of the passage of light through non-uniform cloud fields. A brief description of the method is given here.

First, the results of Monte Carlo simulations of light scattering by several uniform cubical clouds are parameterized. Each cubical cloud may have different optical properties. Then, various shapes of non-uniform clouds are constructed by stacking up these cubes in any desired manner. The calculation of the scattering of light by a cloud field then only involves a single scattering by each cube, but this single scattering depends on the particular cubes multiple scattering history. This approach is much faster than the direct Monte Carlo simulation of a full cloud field.

This summer new features were added to the programs. These include the effect of true absorption, the calculation of photon path lengths, and the position, time and angular distributions of the photons leaving the cloud. Two other new features are that the radiation can be incident from any direction and more than one source of incident radiation is allowed.

**ROME AIR DEVELOPMENT CENTER
ABSTRACTS**

Implementation of ACT Adaptive Filters

by

Charles J. Alajajian

ABSTRACT

ACT adaptive filters are implemented using the linear random search (LRS) algorithm which chooses a random direction to travel in the weight space. The source code which specifies the "tentative" and "final" tap weights to be set by the external digital controller during each iteration, as required by the algorithm, is written in the "C" programming language.

The error signal power is measured with an RF power meter and an external power detector covering a suitable frequency range. A data acquisition unit is connected to the analog output of the power meter and calibrated to yield the power meter reading. A computer simulation program is written in the "FORTRAN" programming language so that the rate of convergence and filter response after adaptation can be compared with that obtained experimentally. This program implements the LRS algorithm by estimating the mean-square error from a finite number of voltage samples, where the number of samples used is equal to L , the filter length.

The performance of several adaptive filters with different lengths and inputs are considered. It is found that a significantly fewer number of sample points is required for adaptation experimentally, when direct power measurements are utilized, compared to that required by computer simulation when the power (mean-square error) is estimated from L samples of the output signal.

Exploiting Parallel Architectures
within a Distributed
Computational Environment

by

Gary L. Craig & Charles K. Shank

ABSTRACT

The addition of diverse parallel machines to a distributed, object-based, computing environments has been our focus as part of the AFOSR Summer Faculty Research Program. We discuss our view of the object computation model, characteristics of distributed computing, and current parallel architectures and programming models to provide a context for discussing the related research issues. The seamless inclusion of parallel architectures into a heterogeneous distributed computing environment has impact on software development, network resource management, and system reliability. These issues are discussed and recommendations are suggested for further research and development efforts.

The recommendations include specific discussions about the compatibility of both Cronus and Alpha to support such a computing environment.

Optical Simulations of Guided-Wave Structures

by

Lionel Friedman and Richard Lareau

ABSTRACT

Using the Plane_Waveguide program, optical simulations have been performed on several semiconductor structures as potential phase modulators, amplitude modulators, and coupled waveguide devices. For SOI coupled waveguides, coupling distance and loss have been calculated at 1.3 and 1.55 μm as a function of the coupling oxide thickness and polarization (TE or TM) for 1 and 2 μm silicon waveguides. Next, the active and passive optical waveguiding properties $\text{Si}/\text{Ge}_x\text{Si}_{1-x}/\text{Si}$ HBT structures have been analyzed. Using suitably derived index of refraction and absorption data for the alloy, the length of waveguide required for phase or amplitude modulation, and concomitant losses, have been obtained. Finally, work on the mode-extinction-modulator has been initiated. Analytic approximations of the concentration and index changes due to carrier injection are compared with those obtained from two-dimensional simulations using the PISCES-2B semiconductor modelling program. The mode profiles and propagation constants were obtained for the former case and work is continuing for the latter case.

MAGNETICALLY CONTROLLABLE MICROSTRIP PATCH ANTENNAS

by

Dr. Frances J. Harackiewicz

ABSTRACT

Experimental and theoretical work was done in an effort to characterize radiation and scattering modes of microstrip antennas (both arrays and single patches) on controlled-biased ferrite substrates. Scattering from infinite arrays of microstrip antennas was measured using the waveguide simulator technique while an electromagnet provided various bias field strengths in different directions to the ferrite substrate. Both tuning of the scatterer's resonant frequency and tuning of the frequency of absorption of the incoming plane wave were observed for certain bias orientations. Radiation and input impedance of single microstrip patch antennas were measured for various magnetic bias fields applied to the ferrite substrate. Both tuning of the resonant frequency and varying of the radiated polarization with changing bias field were observed. For both cases, a simple theoretical model was found to be useful and a full-wave analysis still needs to be completed for the single patch.

Scattering from Conductor-Backed Dielectric Gaps

by

Hao Ling

ABSTRACT

The electromagnetic scattering from two-dimensional conductor-backed dielectric gaps is studied using a boundary integral formulation. To facilitate numerical implementation, the specular solution and the surface wave contribution are removed from the boundary integral equation. Thus the discretization domain of the infinite structure is reduced to a localized region near the gap. In addition, the surface waves excited at the gap are extracted. The results of this approach have been validated against an alternative spectral integral formulation. Excellent agreement is observed between the two methods. The boundary integral approach can potentially be extended to treat more complicated structures including (i) three-dimensional gaps, (ii) gaps and joints between different material coatings, and (iii) multiple gaps on complex targets.

An Efficient Parallel Algorithm and Its Implementation
for Real-Time Adaptive Space-Time Processing

by
Shietung Peng

ABSTRACT

This technical report describes a fast parallel algorithm for solving vector SB-Toeplitz systems. Initially, the algorithm computes an approximate solution using multidimensional deconvolution techniques. Then, a condensed block Toeplitz system is generated through a condensing process. Finally, a procedure for solving block Toeplitz systems is called to solve the condensed system, and the solution is used to refine the approximate solution. The algorithm can be implemented in a hypercube array processor in $O(m \log n)$ time, where n is the order of the input matrix and m is the maximum of the bandwidth of the matrix along individual dimensions. This algorithm can be utilized in the design of a radar signal processor to perform adaptive space-time processing in real-time.

Processing and Characterization of Pb-doped Bi-Sr-Ca-Cu-O Superconducting Thin Films by the MOD Method

by

Daniel F. Ryder, Jr.

ABSTRACT

A modified metalorganic deposition (MOD) method for the processing of Pb-modified Bi-Sr-Ca-Cu-O (BSCCO) superconducting thin films was investigated. Amorphous films were deposited on single crystal (100) MgO substrates by multiple spin-coating, using a commercial photoresist spinner. The subsequent pyrolysis and film crystallization processes were conducted in a controlled temperature and atmosphere tube furnace. Precursor solutions and processed films were characterized by a combination of thermoanalytical, x-ray diffraction, and electron microscopy techniques. The superconducting properties of the film were analyzed using a standard four-probe method to measure electrical resistance as a function of temperature.

Superconducting films typically exhibited two critical onset temperatures (i.e., a high $T_{c(\text{onset})}$ at ~ 118 K followed by a low $T_{c(\text{onset})}$ at ~ 85 K), and $T_{c(\text{zero})}$ at ~ 73 K. XRD analysis confirmed a multiphasic composition including both the 2212 and 2223 structural forms of the BSCCO system. In addition, the films were observed to be slightly c-axis textured. SEM analysis of a fully crystallized sample showed the film morphology to be of a layered, plate-like structure. Finally, and consistent with the observations of other researchers, EDAX analysis indicated that essentially all of the initial Pb had volatilized during the oxygen annealing process. Nevertheless, the addition of Pb to the initial system stoichiometry was necessary for the significant formation of the 2223 phase.

ARCHITECTURAL SUPPORT FOR AI AND KNOWLEDGE BASE SYSTEMS

by

Behrooz Shirazi

ABSTRACT

The CARE system has been developed at Stanford University to investigate the execution of artificial intelligence and knowledge base applications on parallel machines. This report summarizes the findings resulting from a study and evaluation of this system. It also proposes a number of future directions for continuing the CARE project. Overall, CARE is a highly sophisticated, well-designed, and complex system. It perfectly matches the initial design decisions and goals by its developers. However, the system lacks flexibility in the design and development of detailed low-level functions. In addition, in environments dominated by Unix work-stations, a Lisp based system would more than likely cause many potential users to shy away. The project can be continued in several directions, including modifications to incorporate low-level function simulations, port CARE to a Unix environment, parallelize CARE itself, incorporate dynamic load balancing techniques, and study new applications and architectures. Our plan is to install CARE on a set of TI Explorers at the investigator's home institution and use it as a parallel programming development tool and for experimentation with new multiprocessor architectures. The parallel execution of a novel evolutionary learning technique using dynamic knowledge bases will be studied on CARE.

Markov Models for Simulating Error
Patterns on Data Communications Links
by

Wayne D. Smith

ABSTRACT

RADC is currently in the process of procuring Error Injector Units (EIU) to model the error behavior of data communications channels. A major component of this effort deals with finding Markov models that will simulate the behavior of these channels. The objectives of this research effort were specified to be a two phase approach to provide Markov tables for use in the EIUs. Phase one was intended to find any previous research that had produced Markov models suitable for use with the EIUs. The second phase was to find any available error distribution data suitable for conversion to a Markov model. Phase two was also to find a method for reducing error distribution data to the Markov table format. Phase one succeeded in locating only a few Markov tables that were well know and 20 years old. While the search for a procedure for producing the Markov tables from bit error data was successful, the search for data to reduce to Markov uncovered only one possible source of data. Due to the lack of success in finding actual channel data, a secondary goal was added to the project. This goal was to develop some "heuristic" Markov models that could be used in testing the EIUs until other data can be acquired. A computer program to produce such models was developed.

Use of Audio Feedback to Confirm Verbal Commands
for Computer Workstations.

by

Ronald S. VanEtten

ABSTRACT

This project investigated the use of sound as a viable feedback mode for computer workstations. In this project, special attention was given to the incorporation of various sound formats as issued in response to voice commands. The three types of sound studied were verbal, musical, and environmental sounds. The result of this research was a series of recommendations leading to the design of a computer workstation that is natural, comfortable and efficient.

Theoretical Models of Fast Photoconducting Avalanche Switches

by

Martin Wilner

ABSTRACT

We have calculated the time dependence of the external current for models of bulk type and surface type avalanche photoconducting switches. Within the approximations made in order to obtain answers in closed form, we find that the response of the surface type device is not delayed by avalanche build up.

A Gabor transform based recognition system

James Wolper

ABSTRACT

An image-recognition system which uses a preprocessor based on Gabor filters and Information Theory to prepare data for identification by a Probabilistic Neural Network is discussed. The system correctly recognizes transformed images of aircraft planforms and faces.

**WEAPONS LABORATORY
ABSTRACTS**

Palindrome Pre-Scheduling

by

William H. Campbell

ABSTRACT

A mathematical model for scheduling processors for concurrent processing is developed. A scheduling is a function that assigns processors to tasks. A task load distribution is a function that assigns task sizes to tasks. Based on these ideas, specific schedulings (pre-scheduling, self-scheduling, GSS) are defined. Some properties of the schedulings are derived. Workloads for the processors are computed for various schedulings, assuming linear task load. A new type scheduling (palindrome type) is defined and proved to be more efficient than self-scheduling for linear, increasing task load.

SECOND-HARMONIC GENERATION IN CORONA-POLED POLYMER FILMS

by

Gene O. Carlisle

ABSTRACT

Second-harmonic generation (SHG) and spectroscopic absorption measurements are used to study the nonlinear optical (NLO) properties of thin films containing azo dye guest molecules in poly(methylmethacrylate) hosts. The same measurements were also made on a thin film containing NLO chromophores covalently attached as side-chain groups to a poly(methylmethacrylate) polymer. The NLO molecules were oriented by corona poling at temperatures near the T_g s. The orientational order was determined from polarized absorption spectra, and the second-harmonic intensities were measured by the Maker-fringe technique. Because of the very high number density, the side-chain polymer was considerably more efficient in producing SHG than the guest-host films.

Application of the Microplane Concrete Model to an Explicit
Dynamic Finite Element Program

by

William F. Cofer

ABSTRACT

The microplane concrete model is an improvement over plasticity based models because it is applicable to general loading conditions. It was implemented into the explicit dynamic finite element program, DYNA3D. A localization limiter, based upon the nonlocal continuum approach, was added to allow an accurate representation of cracking. Static, triaxial stress-strain data was modelled successfully after provision was made for the confinement that results from a dynamic loading. The localization limiter was programmed and debugged, but not tested with regard to fracture due to time constraints.

FROM COUNTERPROPAGATION TO VECTOR QUANTIZATION: NEURAL NETWORKS FOR
PATTERN RECOGNITION

by

Johanna Stenzel Schruben

ABSTRACT

The purpose of this study was to investigate the application of various neural networks for large data pattern recognition. In particular, a method of vector quantization derived from the Counterpropagation Neural Network was simulated on two FORTRAN 77 computer programs (each with a different type of normalization of data) written for a VAX computer. The programs were trained on patterns each consisting of 4096 intensity data. These were simulated focal plane intensity patterns of fiber optic detectors of laser beams with incidence angles of 2 to 28 degrees in steps of 2 degrees. The computer programs were both able to classify the given data even when random noise was added; however, one version was able to handle more noise than the other. When the system can handle a large data set directly, the training and classification is very efficient. Using the programs adaptively or for data broken into smaller block sizes requires a large number of iterations which slow down the training process considerably.

Analysis of Data on Compact Toroid Formation in Hydrogen

Peter Walsh

ABSTRACT

Analysis is presented on the position, velocity, acceleration, mass, size and shape of the hydrogen plasma formed by a 88 kilojoule pulse within a coaxial injection and accelerated into a coaxial expansion chamber. Within the expansion chamber of the one and a quarter meter long apparatus, the velocity was obtained near the positions of 3 sets of current probes and exceeds 44 cm/us. The acceleration of the plasma in the acceleration chamber increases with time to values approaching 30 cm/us^2 and the plasma length averages to nearly 30 cm. Numerical inversion of the circuit current measured by a current probe near the base of the injection chamber yields the time variation of the circuit inductance produced by the motion of the plasma. From the inductance, the plasma position of the plasma during the pulse is inferred throughout the whole of the apparatus up to the end wall of the expansion chamber. The inversion analysis agrees with the probe analysis if it is assumed that the plasma extrudes from the injection chamber at approximately the radius of that chamber. Mass is lost by the accelerated plasma and specific mass values are derived, versus time, for cases when plasma momentum is conserved and not conserved. Both values extrapolate, at zero time, to the measured mass of injected hydrogen. There is good indication that the plasma survives reflection from the end wall.

AOA Determination using Associative Neural Networks

by

W. J. Zimmermann

ABSTRACT

This paper contains the results of a study in which neural network paradigms were used for the classification of angle of arrival (AOA) patterns. The neural networks considered include: Bidirectional Associative Memory, Hinton/Anderson's Associative Memory Model, and Convex Mean Clustering Algorithm (CMCA) algorithm. The various schemes are tested on selected simulated data. The data was selected to test the CMCA network's capabilities to classify given the input is large, highly correlated and containing significant amounts of noise. Through extensive experimentation with noiseless and noisy data (14 classes of 64 x 64 images of floating point data), the following conclusions are reached: 1) The CMCA outperforms BAM and Anderson's Associative Memory in all cases, 2) the CMCA is highly fault tolerant, 3) CMCA is fast and 4) CMCA learns faster than a number of conventional vector quantization schemes.

**AERO PROPULSION LABORATORY
ABSTRACTS**

Evaluation of MOS-Controlled Thyristor (MCT) at 270 Volt DC
for Resistive and Inductive Loads

by

Muhammad A. Choudhry

ABSTRACT

The voltage and current characteristics of MOS-Controlled Thyristors of 50 to 150 A rating are obtained at 270 volt dc over a wide range of switching frequencies. Total turn-off time of MCT increases with load current and switching frequency and is less than 2 μ sec in most cases. The forward voltage drop across MCT varies from 1 volt to 2 volts for a load current variation of 15 to 90 A. Large voltage transients are observed during switching of inductive loads. The use of snubber circuit across MCT reduces voltage transients and power loss inside the device. However, large currents are observed during turn-on of MCT at high frequency with inductive load.

**DEVELOPMENT OF A THREE-DIMENSIONAL FINITE-DIFFERENCE CODE
FOR MODELING FLOW AND HEAT TRANSFER IN ROTATING DISK SYSTEMS**

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ABSTRACT

A pressure-based, three-dimensional, finite-difference (finite-volume) code for modeling the fluid flow and heat transfer in a turbine disk system has been developed. The computer program developed, however, is capable of solving the governing equations for convection transport in elliptic nature. The computational procedure employs a colocated grid system extended for generalized non-orthogonal coordinates thus can handle irregular geometries. The velocity-pressure coupling uses a modified version of the pressure implicit split operator (PISO) originally proposed by Issa in 1985. The PISO algorithm not only gives time-accuracy results but also provides the computation with a much faster converging speed as compared to the SIMPLE based counterparts. Ongoing research using this computational program is to investigate the effects of radial and axial clearance on the heat transfer in a turbine rotor-stator system. Near-future study plan will focus on counter-rotating disk systems which appear to be the viable configurations used for future turbine engines.

THIN FILM BEHAVIOR OF POWDER LUBRICANTS

MIXED WITH ETHYLENE GLYCOL

by

Don W. Dareing

ABSTRACT

The rheological properties of two powder lubricants mixed separately with ethylene glycol were determined experimentally. The two powder lubricants were graphite and molybdenum disulfide. Bingham plastic, power law and hyperbolic rheological models were compared with the experimentally determined shear stress-shear rate rheological data. All three models compare favorably with experimental data at high shear rates. The power law and hyperbolic rheological models are realistic candidates at low shear rates. The three rheological models were incorporated into fluid flow equations and solved for the case of pressure induced flow between parallel surfaces. Predicted flow rates of these non Newtonian slurries were checked against laboratory data which was obtained through a test rig designed and built during the study.

Laser Velocimetry Measurements in Shock Tubes

by

Paul A. Dellenback

ABSTRACT

The overall objective of this research was to measure turbulence intensities in shock tubes with non-intrusive optical instrumentation. Laser velocimetry measurements applied to shock tube driven flows present several new problem areas that require attention. Among these are the implementation of appropriate circuitry for triggering and controlling high speed data acquisition, and the development of a suitable seeding material for these flows. Control circuitry was readily developed and demonstrated, but equipment limitations severely impeded success in resolution of particle seeding issues.

Thermal Analysis of Potential Solid Lubricant Candidates

by

Dennis R. Flentge, Ph. D.

ABSTRACT

A series of tungsten, molybdenum, phosphorus, and zirconium compounds were studied using thermogravimetric analysis, differential thermal analysis, and mass spectrometry. Interaction of these materials with silicon carbide and silicon nitride were also examined. Some evidence was found for the catalytic effect of lead cations on the conversion of the carbide and nitride to silicon dioxide. Oxythiomolybdates and oxythiotungstates released sulfur dioxide when heated and promoted the conversion of silicon carbide and silicon nitride to silicon dioxide.

EFFECT OF EVAPORATION ON THE DRIVING CAPILLARY PRESSURE IN CAPILLARY PUMPED AEROSPACE THERMAL MANAGEMENT SYSTEMS

by

Kevin P. Hallinan

David Welter

ABSTRACT

Research has been conducted to determine the effect of evaporation on the driving capillary potential in capillary pumped heat transport devices used in aerospace thermal management. These devices primarily include heat pipes and capillary pumped loops. Current design criterion for such devices rely upon what has been termed a maximum capillary potential to evaluate the maximum heat transport limitations. Preliminary analytical results, based upon an idealized model of pores within a heat pipe evaporator wick indicate that in high powered heat pipes and capillary pumped loops where evaporator heat fluxes are approaching than 100 W/cm^2 that dynamic forces owing to evaporation from the liquid-vapor interfaces within the heat pipe evaporator wick can noticeably increase the driving capillary potential relative to static conditions (if boiling is not occurring). For apparent contact angles of less than 10° and assumed isothermal interfacial conditions, normal viscous forces were shown to affect the capillary pressure for capillary numbers greater than 10^{-5} . This conclusion is particularly true if the working liquid in these devices nearly perfectly wets the wick structure in the vicinity of the liquid-vapor interfaces. As a verification of the analytical efforts, an experimental facility has been constructed to actually measure the influence of evaporation on the capillary pressure existing at a curved, liquid-vapor interface.

**Investigation of the Combustion Characteristics of a Confined Coannular Jet
with a Sudden Expansion**

b y

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Chemical Engineering Department
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ABSTRACT

This report contains a brief summary of the work done to investigate the operational characteristics of a burner that was designed to "specifically reproduce recirculation patterns and LBO processes that occur in a real gas turbine combustor." Measurements of lean blowout limit were conducted. The lean blowout limit was found to closely correspond to the lean flammability limit found in a well stirred reactor. LDA measurements of the gas velocity were made to determine the pattern of the complex flows in the combustor, and to identify regions of recirculation flame flow patterns. Measurements were made using spontaneous OH uv emission to characterize the fuel equivalence ratios where the flame was attached to the bluff step just outside the air jet and where a fully lifted flame occurred. At very fuel rich fuel equivalence ratios, the flame was attached to a greater or lesser degree. As the fuel equivalence ratio approached about 1.06, there was a point of demarcation where the flame became full lifted. Two-dimensional images of the flame and flow structure were taken with laser sheet lighting and a CCD camera. These images have shown the complex nature of the shear layers between the outer recirculation zone, the air jet, and the fuel jet. The eddies in these shear layers are of about the same scale as the annular space between the edge of the air jet and the fuel tube.

AIRCRAFT POWER SYSTEMS - STABILITY

by

K. Sankara Rao

Alan Olheiser

ABSTRACT

Analysis and modeling of aircraft 270V dc electrical power systems are the main topic of the research project. HVDC at 270 volts has many advantages over the currently used three phase electrical power systems in an aircraft. There are some problems, particularly instability in the presence of a constant power load, which are addressed in this research. Computer models have been developed for the various components of the HVDC system and constant power load. The analysis using EMTP is included in this report.

DESIGN OF A DYNAMIC TEMPERATURE MEASUREMENT SYSTEM
FOR REACTING FLOWS

by

Larry A. Roe

ABSTRACT

A system for the acquisition of spatially and temporally resolved temperature data in combustion systems was designed. This approach utilizes a dual-junction thermocouple probe for determination of instantaneous convective characteristics of the junction, necessary for compensation of the inherently low transient response. A data acquisition system for coincident recording of velocity with a laser Doppler velocimeter was configured; incorporating the probe, amplifiers, filters, analog-to-digital converters, and software. An extensive literature review was conducted, the system designed, requisite hardware specified and purchasing initiated. Recommendations for an experimental evaluation of the concept were presented.

Hydrogen Permeation in Metals at Low Temperatures

by

Kaveh A. Tagavi

ABSTRACT

Hydrogen permeation through metals at cryogenic to low temperatures is considered in this report. Unlike permeation in high temperatures, there are very few data on low temperature permeation. Supercritical hydrogen has been suggested as a prime candidate for cooling of vacuum tubes aboard spacecraft. The knowledge about hydrogen permeation at low temperatures, therefore, is essential in establishing feasibility of this idea. In this project, a comprehensive literature search is conducted in order to document the state of the art research efforts on hydrogen permeation in metals at low temperatures. The phenomenon of permeation is investigated and the relevant parameters affecting it are identified. An apparatus based on vacuum method is constructed, fabricated, and calibrated. Gathering of actual permeation data are planned for future activities. As a part of this effort usage of exotic material such as gold, diamond, or zinc plated metals; graphite copper compounds; and beryllium oxide will be investigated.

MEASUREMENTS OF DROPLET VELOCITY AND SIZE
DISTRIBUTIONS FOR A PRESSURE/AIR BLAST ATOMIZER

by

Richard S. Tankin

Abstract

A phase doppler instrument was used to measure droplet sizes and velocities in a water spray. This nozzle consisted of a hollow cone water spray and two swirling, concentric air channels. Three different water flow rates were examined; and three different air flows. Horizontal traverses were made across the spray near the sheet break-up region. More than 200,000 samples were taken in each traverse. The results show that the spray is axially symmetric which is important for the planned theoretical analysis. The analysis of the data will follow the same procedure that was developed to analyze the data that was collected last summer.

**AVIONICS LABORATORY
ABSTRACTS**

PATTERN RECOGNITION: MACHINE VS. MAN

by

Thomas Abraham

ABSTRACT

Sixty-six images of varying degrees of pattern-ness were compiled and their AFD* ratings obtained. The respective human ratings were also gathered from 11 people. The data was consolidated and studied. Also, through the survey, we investigated to see whether there is a generally understood meaning for pattern-ness among the respondents.

* Ada Function Decomposition (program)

Some Results in
Pattern-Based Machine Learning

by
Mike Breen

Abstract

The principle on which fire control hardware and software operate is that of a function. Our purpose is to find the fastest, most efficient form of the function possible. It is not feasible to have the function in (input,output)-form. We want to find the rule under which the function operates. Towards this end, we concentrate on machine-learning systems and function decomposition. This paper lists several results in each area seeking to establish a lower bound on training set size at which the machine-learning system is still performing well. There is no universal lower bound for each function and each machine-learning system, but we give instances where a convergence conjecture holds. Also, we give a proof of the main result in function decomposition.

Probabilistic IR Evidence Accumulation

by

Dr. R. H. Cofer and Jim Perry

ABSTRACT

The work reported here is a continued outgrowth of Bayesian Target Recognition research started in the 1989 Summer Faculty Research Program. During the current 1990 research effort, the emphasis has been on probabilistic evidence accumulation in the IR ATR problem. Two important and fundamental types of probabilities were found: underlying target temperatures, and spatial homogeneity of target temperatures. The first is important for target to decoy discrimination, while the second can overcome unavoidable lack of the target's thermal history. Correctly used, these two probabilities will result in overall consistency of IR evidence accumulation. Also shown is the general robustness of probabilistic evidence accumulation to practical considerations of uncertainty, ignorance, and functional approximation.

Investigations of a Lower Bound
on the Error in Learned Functions

by

Thomas K. Gearhart

ABSTRACT

An exact expression for the difference between the average sum-of-squares error for a collection of learned functions and a lower bound on that error is derived. A bound on the difference of the average sum-of-squares errors for two distinct collections of learned functions is obtained. This bound can be computed without knowledge of the desired function outside the training sets. A condition is isolated which assures that average sum-of-squares error will decrease as the size of the underlying training sets increases. The lower bound on the average sum-of-squares error is experimentally compared with the traditional measure of error for specific machine learning systems.

Machine Learning Applied to High Range Resolution Radar Returns

by

Lawrence O. Hall and Steve G. Romaniuk

ABSTRACT

This report examines the use of a neural network learning algorithm and a hybrid neural network, symbolic learning algorithm on the problem of recognizing airplanes from high resolution radar returns. Quickprop and SC-net are the techniques used. The intent of the study is to determine how to both recognize the planes and recover the aspect angle in an algorithm with small set up and good space/time characteristics. Three different representations of the radar returns to the learning algorithm were tried. The problem of representation is very important in this study. The first two representations were geometric hashing schemes. The last is a binning and averaging scheme. It has shown some invariance to aspect angle shifts, which is important in limiting the number of training times and examples. In both learning systems the third representation has been used to get 100% recognition for some sets of aspect angles.

**MODEL FOR CHARACTERIZING A DIRECTIONAL COUPLER BASED
OPTICAL HETERODYNE DETECTION SYSTEM**

by

Mohammad A. Karim

ABSTRACT

This report summarizes the research performed during the USAF-UES Summer Faculty Research Program. The work involved developing an analytical model for characterizing a directional coupler based optical heterodyne (coherent) detection system. The coherent detection system in question consists of two fiber optic links carrying respectively optical signal and local oscillator beams which are then combined by means of a directional coupler. The directional coupler based heterodyning scheme is compared with that based on Y-coupler as well as that based on only beam splitter in terms of their signal-to-noise ratios. The current analytical and simulation results along with those expected to be generated through a follow-up mini-grant study would be able to dictate the design characteristics of the most optimum directional coupler based coherent detection system.

Context Dynamics in Neural Sequential Learning

by

Kevin G. Kirby

ABSTRACT

A new neural architecture was developed for efficient learning of spatiotemporal dynamics. This architecture reduces the learning problem to two subproblems: (1) the formation of a "context" containing compressed input histories, and (2) the classification of context by an associational algorithm. The first subproblem was handled by introducing a nonlinear dynamical system into the neural network, which can be a low-connectivity random net or a continuous reaction-diffusion system. This enables the solution of the second subproblem to become simpler, requiring only a variant of the classical perceptron learning algorithm. A theoretical framework was developed in which the learning capabilities were analyzed in terms of finite automata theory. A computer simulation system was developed and used to show efficient learning of the sequential parity problem. Further simulations clarified the role of the context subsystem and demonstrated promising non-connectionist architectures for this problem.

Fiber Laser Preamplifier for Laser Radar Detectors

by

Richard E. Miers

ABSTRACT

A study was made of the feasibility of using a fiber laser preamplifier as a means of improving the detectability of laser radar signals. Although fiber laser amplifiers at the wavelength of interest, 1.064 μm , have not been developed, a study of the development of Er-doped fiber laser amplifiers for 1.55 μm indicates the usefulness of such amplifiers. Also the properties of Nd-doped fibers indicates that such fibers should amplify 1.06 μm wavelength signals as well as or better than the Er-doped amplifiers. Recommendations for development and testing of such an amplifier are given.

Reusable Ada Software -
Evaluating the Common Ada Missile Packages (CAMP-3)

by
Brian J. Shelburne

ABSTRACT

One of the largest and earliest projects involving reusable Ada software was the United States Air Force sponsored CAMP effort with McDonnell-Douglas Corporation. This summer's AFOSR project evaluated CAMP for its usefulness and suitability for avionics applications.

During the process of evaluation, errors were discovered in some of the CAMP software parts. The tight dependencies among the various CAMP parts caused by "withing" and the poor internal documentation made tracking down these errors extremely difficult.

CAMP is overly complex, poorly documented, and contains errors. The final conclusion arrived at is that CAMP software is not suitable for avionics applications.

**ELECTRONIC TECHNOLOGY LABORATORY
ABSTRACTS**

COMPUTER SIMULATION OF NMOS INTEGRATED CIRCUIT CHIP

PERFORMANCE INDICATORS

by

Ashok K. Goel

ABSTRACT

For an integrated circuit chip based on the silicon NMOS technology, a computer-efficient model of the various chip performance indicators has been developed and a user-friendly computer program called "NCHIPSIM" suitable for the simulation of the chip performance indicators for an NMOS microprocessor or a gate-array chip has been developed. In addition to predicting the various chip performance indicators such as its maximum clock frequency, power consumption, computational capacity, power efficiency, fabrication yield, functional throughput rate and the size of an NMOS chip with the given technology parameters, the program NCHIPSIM has also been used to simulate the dependence of the various chip performance indicators on the technology feature size in the range 0.1-2.5 microns and the chip integration level in the range 100-100,000,000 transistors on the chip. The results have been compared with and found in excellent agreement with those known for several single-chip microprocessors based on the silicon NMOS technology.

Application of Photoreflectance to Novel Materials

by

Muhammad Z. Numan

ABSTRACT

Photoreflectance spectroscopy was applied to the InGaAs/GaAs single quantum well structures of different well thickness and to the low temperature molecular beam epitaxy grown GaAs cap layers on both n- and p- type GaAs substrates. The PR spectra at both room temperature and 77K have been studied. The GaAs study clearly indicates a lowering of surface potential associated with the unpinning of the Fermi levels reported for these systems. Both 200°C and 400°C caps demonstrate a disappearance of the Franz-Keldysh oscillation. Suggestions for future experiments are made.

Electronic structure and deep impurity levels in GaAs related
compound semiconductors and superlattices

by

Devki N. Talwar
Alan Coleman

ABSTRACT

The band structure of periodic, ultra-thin, lattice matched $(\text{Al}_x\text{Ga}_{1-x}\text{As})_m/(\text{GaAs})_n$, and strained layer $(\text{GaAs})_m/(\text{In}_x\text{Ga}_{1-x}\text{As})_n$ superlattices (SL's) grown along the three main crystallographic orientations (001), (110), and (111) is studied by using a second-neighbor tight binding theory. The SL wave functions are described as a linear combinations of bulk Bloch functions (*sixteen*, if spin is included) for each of the *two* constituent materials while the alloy $\text{Al}_x\text{Ga}_{1-x}\text{As}$ (or $\text{In}_x\text{Ga}_{1-x}\text{As}$) is treated in the virtual crystal approximation. To incorporate the effects of strain in strained layer SL's, a new method is developed, based on Harrison's scaling scheme which properly includes the variation of bond lengths and bond angles. While studying the band structure, we found that the band gap in SL's depends not only on the layer thicknesses through quantum mechanical effects but also through the strains in the constituent layers. Our calculated results for the band structure of $(\text{GaAs})_1/(\text{AlAs})_1$ and $(\text{GaAs})_2/(\text{AlAs})_2$ SL's are found in excellent agreement when compared with the existing sophisticated self-consistent pseudopotential data. Using the above information of band structure, a Green's function theory of impurity levels is being developed. This theory will allow us to predict the role of deep levels in SL's and QW's and may prescribe a method to overcome the effects of deep traps which we believe are responsible for limiting the performance of Si-doped HEMT's, and other technologically important devices.

**FLIGHT DYNAMICS LABORATORY
ABSTRACTS**

Sensor Integration Issues in Robotic Rapid Aircraft Turnaround

by

John S. Bay

ABSTRACT

Concepts for robotic rapid aircraft turnaround are examined for the anticipated sensor specification and data processing requirements. Of particular concern are the inspection, monitoring, and supervision of robotic operations in an integrated combat turn where there is the possibility of chemical and biological hazards. Because of the harsh environment expected, it is suggested that the robotic refueling operations exploit infrared sensing systems, including thermal imaging and range sensing, as opposed to ultrasonic measurement techniques. Parts mating operations should also incorporate active and passive compliance devices, as well as force and torque sensing. For some operations, such as ordnance loading, it is suggested that force-amplifying telemanipulators be considered over full autonomy. Also, some sensing apparatus should not be mounted to the robotic components themselves, but are more appropriately fixed in space. These fixed sensors should include vision and floor-mounted load cells. For laboratory feasibility studies and demonstration, tactile sensor research is suggested, along with a data processing technique based on distributed computation of the extended Kalman filter.

**INFLUENCE OF STATIC AND DYNAMIC AEROELASTIC
CONSTRAINTS OF THE OPTIMAL STRUCTURAL
DESIGN OF FLIGHT VEHICLE STRUCTURES**

**Franklin E. Eastep, Ph.D.
Ann Stephenson, Graduate Student
Department of Aerospace Engineering
University of Dayton, Dayton, OH 45469-0227**

ABSTRACT

This investigation focused upon the structural weight optimized design of a fighter-type wing of low aspect ratio using ASTROS. The optimal weight redesign of a preliminary finite element model representing the wing structure is obtained with the constraints on strength, control reversal and flutter imposed using both subsonic and supersonic aerodynamic theories. It is demonstrated that the optimization capabilities of the ASTRO procedure are well suited for the preliminary structure design environment. ASTROS gives to the structural designer the capability to develop unique solutions to the design problem facing flight vehicle structures with the many constraints. Recommendations are made to include a transonic aerodynamic formulation with ASTROS for the structural design of a flight vehicle over the entire Mach number regime.

Location of Crack Tips by Acoustic Emission
for Application to Smart Structures

by

Marvin A. Hamstad

ABSTRACT

The use of commercial acoustic emission (AE) equipment for location of crack tips in a fatigue test environment was studied. The results from six channels of commercial AE equipment were compared to those derived from waveforms obtained by a two-channel transient recorder. Prior to fatigue cycle monitoring, the AE wave propagation characteristics were extensively studied using pencil lead breaks in a center notch. For the fatigue studies center crack samples of 2024-T351 aluminum were used with hydraulic grips to eliminate extraneous noise over the whole fatigue cycle. Results show that waveform approaches are superior to standard AE systems for location of crack tips. Results also indicated that reopening of a closed crack generates much more AE than that generated at the crack tips. This "unclosure" AE may be of potential use to detect cracks and characterize crack length.

H_∞ Design Based on Loop Transfer Recovery and Loop Shaping

by

Chin S. Hsu
Jenny L. Rawson

ABSTRACT

This report addresses the issue of H_∞ loop transfer recovery and loop shaping when an H_∞ output feedback controller is used. A method of selecting the H_∞ design parameters to achieve asymptotic loop transfer recovery is presented. It is shown that the problem of approximate loop transfer recovery is equivalent to that of H_∞ state feedback design. A new H_∞ design procedure is also presented.

A FEASIBILITY STUDY ON INTERFACING ASTROS WITH NAVGRAPH

by

Ming-Shu Hsu

ABSTRACT

A computer program referred to as ASTROS (Automated STRuctural Optimization System) was developed under contract by the Flight Dynamics Laboratory at Wright-Patterson AFB, Ohio. ASTROS employs the well-known "Automated Design Synthesis" (ADS) procedure and optimality criteria methods, in addition to the finite element analysis, to provide an optimal design for interdisciplinary applications. Since its first introduction in 1987, ASTROS has received great response and a growing user population, and has set a revolutionary milestone in the field of aerospace structural analysis and design. However, the lack of a pre and post processor makes it inconvenient in preparing the model input data and in interpreting the results. This project investigated the feasibility of interfacing ASTROS with NAVGRAPH which is a general purpose geometry modeling and mesh generation computer graphics package. Three phases of development were recommended for the short and long term goals.

ACCELERATED FATIGUE TEST PROCEDURE FOR
THE STRUCTURAL POLYCARBONATE COMPONENT
OF THE F-16 CANOPY COMPOSITE MATERIAL

by

Yulian B. Kin

ABSTRACT

The long-term fatigue test procedure requires the breaking of 20 to 30 identically prepared specimens and one month to complete. Thus, manufacturers often do not perform a conventional fatigue test in spite of its obvious utility. Therefore, there is a definite need for an accelerated fatigue test which can be completed in approximately one day. The accelerated test procedure proposed can be developed on the basis of the data gained by the principal investigator during the conventional fatigue test run with the help of the UES mini-grant S-210-9M6-038 in 1989. The mini-grant was awarded to continue the research started by Yulian Kin during his summer appointment at Wright-Patterson Air Force Base in 1988.

Study of Fracture Behavior of Cord-Rubber Composites for
Lab Prediction of Structural Durability of Aircraft Tires

by
Byung-Lip ("Les") Lee

ABSTRACT

An aircraft tire durability study is underway to investigate the deformation and fracture behavior of cord-rubber composites. This study will identify the important parameters responsible for the structural failure of aircraft tires by the use of analytical and laboratory prediction methods. These methods will also identify the interaction between material property degradation and damage accumulation in cord-rubber composites. Preliminary results using coupon specimens of tire carcass have revealed that prolonged static and cyclic loading sequences produce extensive interply shear deformation at the free edges resulting in cord-matrix debonding followed by delamination type failure. These loading sequences represent the circumferential tension in the footprint region of aircraft tires. It was also determined experimentally that a *fatigue endurance limit* can be established for cord-rubber composites. Analytical methods using finite element models of coupon specimens have demonstrated reasonable accuracy in predicting load-displacement response and interply shear strain variations. Future plans will include the correlation between the fatigue resistance data of composite specimens and dynamometer test results of actual tires.

DELAMINATION OF LAMINATED COMPOSITES

by

William E. Wolfe

ABSTRACT

In previous summer faculty research program appointments we have looked at the initiation of damage in laminated composites subjected to low velocity impact. A review of the literature as well as an analysis of our own tests showed that a significant mode of failure resulting from the impact event is delamination. A prediction of the extent of delamination requires an evaluation of interlaminar stresses and the material properties governing delamination.

The research performed during this summer's appointment followed two different lines. In the first effort, the theoretical studies begun in a 1989 mini-grant to determine the state of stress at each interface in a laminated composite plate subjected to a dynamic load were continued. In the second line of study, an analytical and experimental investigation of the tendency for delamination as predicted by the delamination moment coefficient originally defined by Sandhu was performed.

Experimental Identification of Internally Resonant Nonlinear Systems
Possessing Quadratic Nonlinearity

by

Lawrence D. Zavodney

ABSTRACT

The identification of MDOF nonlinear systems possessing internal resonance is discussed and possible solution strategies are proposed. It is shown that it is possible for nonlinear coupling between two internally resonant modes to go undetected during a modal analysis using broad-band random-excitation. If this type of nonlinearity is not identified, it is possible that the response to harmonic excitation may be many times larger than that predicted by the random response. Due to the combined presence of quadratic coupling and an internal resonance, it is possible for subharmonic and Hopf bifurcations, combination resonances, and subharmonic resonances to occur. Nonlinear coupling terms can also cause excited modes to become saturated. Chaotic responses were observed and documented. In this report, the results of experiments conducted at WRDC using conventional and state-of-the-art-means for system identification are summarized.

**MATERIALS LABORATORY
ABSTRACTS**

The In-situ Laser Deposition of High T_c Superconducting Thin Film

by

Donald D. W. Chung

ABSTRACT

ArF excimer laser ablation of an YBa₂Cu₃O_{7-x} target pellet in 100 mTorr of O₂ ambient was used to deposit thin superconducting films on SrTiO₃ and MgO substrates at 650 - 780 °C. The as-deposited 0.6 - 0.9 μm thick films were superconducting, without further high-temperature annealing. Cooled to ambient temperature in-situ for 1.5 hours in flowing oxygen gas, the films showed complete diamagnetism and zero resistance up to 89 K with a critical current density of 5×10^5 A/cm² in zero magnetic field at 81 K. Low angle X-ray diffraction analysis showed that all the films were highly oriented with the C-axis perpendicular to their surface. Smooth surface morphology was observed in all films.

AM1 CALCULATIONS ON RIGID ROD POLYMER MODEL COMPOUNDS

by

John W. Connolly

ABSTRACT

Using AM1 semi-empirical Molecular Orbital calculations, conformational energies were obtained for structures designed to model the rigid rod polymers, poly(p-phenylenebenzobisoxazole), PBO, poly(p-phenylenebenzobisimidazole), PBI, and poly(p-phenylenebenzobisthiazole), PBT, including examples in which the phenylene group is mono and dimethylated. Minimum energy torsional angles and barriers to rotation can be understood in terms of steric factors and disruption of pi-electron delocalization. The model system used shows that when adjacent segments of the polymer chain are mutually perpendicular, the barrier to rotation is less than the thermally available energy at 300K.

Potentials of Mushy-State Forming of Composite Materials

by

Sherif D. El Wakil

ABSTRACT

Experimental work was carried out to investigate the problems involved in the mushy-state forming of dispersion-strengthened composites, as well as to assess the possible potentials of such processes. Billets, all having the same Al-Cu-Mn matrix but different alumina contents, were obtained by hot compaction of canned powder mixtures in a blind extrusion die. They were then homogenized for two hours before being extruded at the required temperature. Three temperatures were chosen, to yield different liquid fractions for the extrusion billets, namely 0.4, 0.2 and zero. Billets that had 0.2 liquid fraction were successfully extruded, resulting in sound, defect-free products. Also, metallographic examination of those mushy-state extruded bars revealed an excellent degree of homogeneity. In addition, the density and chemical composition were found to be uniform along the length for those bars, indicating the absence of any sensible segregation.

STRUCTURAL ANALYSIS OF POLYMER PRECURSORS WITH POTENTIAL NONLINEAR OPTICAL PROPERTIES

by

David A. Grossie, Ph.D.

ABSTRACT

Single-crystal x-ray diffraction data was collected on two compounds having potential nonlinear optical (NLO) properties, $C_{23}H_{29}NOS$ and $C_{38}H_{50}N_2O_2S_3$. Both compounds crystallize in triclinic crystal lattices, the first having cell constants of $a=10.340(2)$, $b=11.632(1)$, $c=8.894(3)$ Å, $\alpha=97.18(2)$, $\beta=103.18(2)$, and $\gamma=88.05(1)^\circ$. The second compound has cell constants of $a=10.292(2)$, $b=20.231(8)$, $c=9.270(2)$ Å, $\alpha=102.48(1)$, $\beta=98.67(2)$, and $\gamma=88.66(1)^\circ$. The space group observed in each compound is $P1$. The structure of compound 1 was solved and refined, yielding a R-factor of 0.061. $C_{23}H_{29}NOS$ is planar with little distortion in the internal bond distances and angles.

The second compound, $C_{38}H_{50}N_2O_2S_3$, has not been completely solved, in spite of application of the most recent and capable direct methods programs.

Eddy Current Testing in Nondestructive Evaluation

by

T.J. Haas and P.K. Kadaba

ABSTRACT

Advantages and limitations of the eddy current technique for the purpose of nondestructive testing have been evaluated. A cursory study of some of the analytical models and actual test systems that have been developed by researchers over the years has been made.

Using the commercially available eddy current testers - the Nortec NDT-16 and the Hocking AV100SE - tests were made on samples of rubidium and stainless steel with standard machined notches of depths 0.2mm, 0.4mm, and 1.0mm. Also tested was an unknown sample with a barely visible crack. The HP4192A Impedance Analyzer was adapted to eddy current testing by incorporating a power amplifier and specially designed transmit and receive probes. A minute hole in a sample of aluminum was easily detected with this set-up. A pulse technique capable of detecting defects in nonmagnetic metals to a depth of 0.5cm or better was developed. This technique seems to have potential to detect second layer cracks.

Preparation and Characterization of Polypeptide Thin Films

by

Joseph B. Lambert

ABSTRACT

Polypeptides based on the glutamic acid backbone have nonlinear optical properties. In order to test practical applications of such materials, thin films have been cast by use of spin coating. Films were prepared for poly(benzyl-L-glutamate) (PBLG) and for poly(N-(p-trans-azobenzene)-L-glutamide) (PALG). These films were characterized by polarized microscopy, spectroscopic ellipsometry, and Fourier transform infrared spectroscopy.

Chemically Induced Grain Boundary

Migration in Al_2O_3

by

Gary L. Leatherman

ABSTRACT

Chemically induced grain boundary migration (CIGM) was observed in bulk polycrystalline alumina. The presence of gallia coupled with a bismuth oxide flux was able to induce the migration of grain boundaries in the alumina. Use of the same system for inducing grain boundary motion in alumina fibers with a "bamboo" microstructure proved unsuccessful due to experimental difficulties in observing the effect. Additional attempts were made to observe CIGM in these fibers using sols of Ga_2O_3 , Fe_2O_3 , and Cr_2O_3 doped with bismuth oxide. The microstructure of the fibers prevented in the time frame of the program the conclusive identification of CIGM.

On the Use of QPA (Qualitative Process Automation) for Batch Reactor Control

by

Won-Kyoo Lee

ABSTRACT

Control of batch reactors and the self-directed process control system, QPA, were reviewed to determine if the QPA system could be used for intelligent control of batch reactors. The control of batch reactors has been formulated as optimal control problems, with the solution being an open-loop temperature trajectory. However, this optimal temperature profile is based on very complicated, but still incomplete mathematical models to account for the unique nonlinear and time-varying dynamics of batch reactors. This means that the greatest remaining challenge in controlling batch reactors is to develop a totally adaptive control strategy that can result in the optimal operation using a minimum of mathematical models. In this regard, the capability of the QPA control is expected to be more beneficial for batch reactors, especially in the presence of process changes, and the dynamic, nonlinear nature of the batch reactors. It is suggested that the QPA system be tested to further demonstrate its concept and consequently extend its applicability by being applied to an experimental unit.

ULTRASONIC TECHNIQUES FOR AUTOMATED DETECTION OF
FATIGUE MICROCRACK INITIATION AND OPENING BEHAVIOR

by

Michael T. Resch, Ph.D.

ABSTRACT

A surface acoustic wave non-destructive evaluation technique was used to detect the natural nucleation of surface microcracks in highly stressed regions of hourglass shaped aluminum specimens during fatigue cycling. The experimental procedure involved excitation of Rayleigh waves on the surface of each specimen and observation of the presence of a specular reflection from the nucleating crack superimposed on nonspecular reflections from microstructural features surrounding the flaw. Contacting wedge transducers were used to excite the incident waves and to detect the reflected wave signals. The effectiveness of a split-spectrum processing algorithm to improve the minimum detectable crack size of isolated cracks in the scattering field was demonstrated. Additionally, measurements of crack opening behavior were performed both acoustically and with the laser interference displacement gage. Initial results indicate that the acoustic technique is more sensitive to small traction forces on adjacent crack faces than is the laser interference technique.

**NMR and IR Investigations of Conformational Dynamics
and Surface Interactions of Perfluoropolyalkylethers**

by-

Martin Schwartz

ABSTRACT

Fluorine-19 NMR spin-lattice (T_1) relaxation times were measured for several perfluoropolyalkylethers (PFPAE's). Derived rotational correlation times (τ_c) revealed that perfluoromethylene (CF_2) groups adjacent to $-OC_2F_4O-$ chain segments rotate more slowly than those attached to $-OCF_2O-$ fragments. The decreased chain mobility was investigated using molecular mechanics to model bond rotations in linear PFPAE's. The calculations revealed that $-OC_2F_4O-$ units introduce steric repulsions which severely restrict rotation about neighboring C-O bonds. These results can be used to explain the generally observed correlation between C:O ratios and fluid viscosities in perfluoroethers.

Preliminary semi-empirical quantum mechanical calculations of conformational energies and potential barriers have been performed for several perfluorocompounds. The results will be compared with those from ab initio computations and, when available, to experimental data. The ultimate goal of these studies is to develop realistic conformational potential energy functions, which will permit the prediction of static and dynamic fluid properties and, therefore, aid in the design of new PFPAE lubricants.

The application of infrared microscopy to characterize the interactions of fluid additives with metal surfaces was investigated. Several problems in the acquisition of reliable spectral data were noted. It is recommended that further tests be performed in conjunction with XPS experiments to provide a definitive assessment of the utility of IR spectroscopy in the study of chemisorbed additives.

MODELING OF CASTING SOLIDIFICATION

by

Hai-Lung Tsai

ABSTRACT

A general purpose finite element computer program, CAST3, for modeling casting solidification was evaluated from both the user's and the technical aspects. The CAST3 code was developed by the Universal Energy Systems, Inc. under the sponsorship of the Air Force. Although several commercial packages are available, it was found that CAST3 is the only software dedicated to the casting solidification modeling. As a result, CAST3 code has a superior capability in handling the casting-mold interfacial thermal resistance and the time stepping algorithm, which make the program computationally more efficient than any other available codes (to the knowledge of the author). An excellent start has been made by CAST3 in achieving the goal of developing an ideal casting design package for the Air Force. However, the present version of CAST3 is not yet completed for being able to simulate some casting problems. Therefore, recommendations are made for improving and expanding CAST3, so that the code can be used in the foundry industry as a powerful design tool for obtaining high quality casting parts.

**HARRY G. ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY
ABSTRACTS**

Cardio-Respiratory Measures of Workload During
Continuous Manual Performance

by

Richard W. Backs and Arthur M. Ryan

ABSTRACT

Twelve subjects (six female) participated in an experiment designed to separate those physiological variables that are sensitive to physical workload from those sensitive to cognitive workload. Cardiac (heart rate and variability), respiratory, and forearm muscle activity were measured while subjects performed a single-axis continuous manual tracking task. The cognitive demands of the task were increased by varying the tracking dynamics over three levels: pure velocity, a combination of velocity and acceleration, and pure acceleration. The physical demands of the task were varied by requiring subjects to track under either high or low amplitude sum-of-sines disturbance input. The experiment was conducted in three sessions over successive days. Subjects received a fixed amount of practice on Days 1 and 2. All data collected for analysis were obtained from a single trial of each of the six tracking order by disturbance gain conditions administered on Day 3.

Heart rate (and to a lesser extent, heart rate variability), respiration, and muscular activity were all sensitive to the decrease in tracking performance associated with increased workload. However, only the respiration measures dissociated under the physical and cognitive manipulations. Respiration rate increased with tracking order but not disturbance gain, while respiration amplitude increased with disturbance gain but not tracking order. Also, spectral power of respiratory activity dissociated from cardiovascular power for disturbance gain. RMS tracking error, heart rate, and forearm muscle activity increased as tracking order and disturbance gain increased. Further studies focusing on the dissociations of the respiratory measures themselves, and of the respiratory and cardiovascular measures, are indicated.

Heat Transfer Through Multiple Layers of Fabric

by

Larry W. Byrd

ABSTRACT

The United States Air Force has an interest in calculating the heat transfer through the uniform/suit of pilots during high speed ejection or exit through a burning fuel fire. This information is to be coupled with a current burn simulation program (BRNSIM) to determine thermal damage. A computer program was written to predict fabric temperatures for up to five layers of cloth exposed to a black body radiative heat source. The program was written in modular form so equations describing gas flow, water evaporation, pyrolysis, and variable thermal properties can be included. Radiation incident on the fabric was assumed to be either absorbed at the surface or directly transmitted with no other interaction with the cloth. This resulted in a considerable lag in the temperature rise of the interior of the fabric as compared to the surface. Time did not allow extensive testing of the program or comparison with experimental data. It is recommended that a more sophisticated radiation absorption model be used for the fabric. The Materials Laboratory should also be consulted to see if they have a program that can be modified to describe fabrics.

PILOT TASK FUNCTIONAL ANALYSIS AND DECOMPOSITION USING
STRUCTURED ANALYSIS AND IDEF MODELING METHODS FOR THE
PILOT'S ASSOCIATE PILOT-VEHICLE INTERFACE

by

John C. Duncan

ABSTRACT

The Pilot-Vehicle Interface (PVI) of the Pilot's Associate (PA) will provide the link between the fighter pilot and his aircraft. The PVI will provide dynamic controls and displays, furnish advisory data, and allow various levels and degrees of interaction between the pilot and the aircraft. The PVI will operate according to guidelines based on system status, mission plans and goals, mission status, task requirements, sensor data, and pilot actions. Design and implementation of the PVI requires systems analysis and requirements definition for the Pilot's Associate architecture. For this purpose, pilot mission and task requirements were analyzed and determined for a Tactical Fighter Air-Ground mission. An IDEF0 (Integrated Computer-Aided Manufacturing Technologies Definition Language #0) pilot focused model of the mission was created that provides a functional decomposition of pilot tasks and goals, corresponding mechanisms, constraints, and data requirements, and interrelationships between functions.

Effects of Time Delays in Networked Simulators

by

Martin T. Hagan

ABSTRACT

During the 1980's the Defense Advanced Research Projects Agency (DARPA), in partnership with the United States Army, sponsored a research project (SIMNET) to develop the technology to build a large-scale network of interactive combat simulators. Results from this research have been very promising, and there is growing interest within the Air Force community to network high-performance aircraft simulators. One of the key concerns of the Air Force will be the effects of inter-simulator time delay on the performance of these networks as training devices. Previous work on the effects of delays in single simulators provides guidance in analyzing this problem. A simplified formation flight task is modeled, and performance is analyzed as a function of inter-simulator time delay. Recommendations for future research are given.

Speaker Normalization and Vowel Recognition
using Neural Networks

by

Ashok K. Krishnamurthy

Edward L. Riegelsberger

ABSTRACT

A vowel recognition system was designed for classifying the ten American English vowels /aa/, /ae/, /ao/, /ay/, /eh/, /er/, /ey/, /iy/, /ow/, and /oy/. The vowels were excised from the speech corpus in the DARPA TIMIT database. The vowel classifier was based on a variant of the Kohonen Learning Vector Quantizer classifier, called the FSCL-LVQ classifier. A speaker-independent classifier using features from the output of an auditory model, and a speaker-dependent classifier using Line Spectrum Frequencies were implemented. Also, a speaker normalization method using the Multilayer Perceptron neural network was implemented. Preliminary experiments in mapping the spectral parameter vectors from one speaker to the spectral space of another speaker were also performed.

ERROR ANALYSIS OF THE AAMRL INERTIAL TESTING SYSTEM

BY

S. Alan Lephart

ABSTRACT

The accuracy of the Standard Automated Mass Properties Measuring System was examined in relation to objects of small weight (< 15 lbs) and small principal moments of inertia. Fifteen tests were conducted using a variety of objects having known masses, center of mass location, and principal moments of inertia.

Probable error curves based upon both mass and measured moments of inertia were developed. Error analysis was used to suggest lower limits of mass and principal moments of inertia considered to be acceptable for the equipment testing program at the Armstrong Aerospace Medical Research Laboratory.

Recommendations were made regarding the measurement of objects known to be below the limits established.

Simulation of Head/neck Response to -Gx Impact Acceleration

by

Amit L. Patra (Summer Faculty Research Fellow)

Christina Estep (Graduate Student Research Fellow)

ABSTRACT

The Articulated Total Body (ATB) model has been developed to predictively simulate gross human body dynamics resulting from external forces. This model allows the simulation of the head and neck response by specifying a 2-segment/2-joint system driven at the anatomical thoracic spine T1 position. The objective of this project was to validate the ATB modeling methodology for the -Gx impact response of the head/neck system. T1 -Gx acceleration data obtained from human volunteers at the Naval Biodynamics Laboratory (NBDL) was used to drive our simulations predicting head linear acceleration in the X and Z directions and angular acceleration about the Y axis. These responses when compared with corresponding NBDL human test data indicate an apparent T1 motion artifact which was confirmed through comparisons with the photographic records of NBDL subjects. After removal of the artifact from the T1 test data profile remarkable correlation with NBDL human tests was obtained. It was therefore concluded that this is a valid modeling methodology for -Gx impact response of the head/neck system.

**IMPROVING PILOT EFFICIENCY IN THE AGE OF THE GLASS COCKPIT:
DESIGNING INTELLIGENT SOFTWARE INTERFACES FOR THE MILITARY
AVIATION SETTING**

By Leonard Shyles

ABSTRACT

Today's fighter pilot must function in a cockpit environment featuring digital multi-function displays utilizing cathode-ray-tube (CRT) technologies which are growing in complexity. Pilots must therefore handle an increasing mental workload while maintaining trust and vigilance in the information they process during the performance of their mission. This study highlights significant advantages to devising display formats from a cognitive perspective and offers a formal, systematic and reliable method for bringing the needs of pilots into the design process during the early stages; it offers a method for determining what the pilot-machine partnership should be so that an optimal balance is achieved between those responsibilities a pilot can relinquish to machine intelligence and those functions a pilot should retain in order to optimize trust given the current capability of machine intelligent software as it is currently construed.

DECISION-MAKING UNDER SYSTEM FAILURE CONDITIONS

by

Bonnie J. Walker, Ph.D.
and
David R. Harper

ABSTRACT

The effects of system failure versus no system failure under restricted and unrestricted hypothesis-testing conditions on technically sophisticated subjects' problem-solving heuristics were assessed. Results indicated a strong bias to confirm among most subjects in all conditions. Engineers as a group were more likely to solve the task under restricted hypothesis-testing conditions than non-engineers. Furthermore, most subjects were unable to adjust their problem-solving styles under system failure conditions to cope with the possibility of unreliable data.

**HUMAN RESOURCES LABORATORY
ABSTRACTS**

**AN INTELLIGENT TUTORING SYSTEM TO FACILITATE INVENTION
STRATEGIES FOR BASIC WRITING STUDENTS**

by

Margaret W. Batschelet

ABSTRACT

Both the United States Air Force and the state of Texas have expressed concern over the basic skills of the contemporary student population. One approach to teaching basic skills is to use an Intelligent Tutoring System (ITS), a computer which simulates a tutorial dialogue. This report describes an ITS which would aid remedial writers in developing reflective, "invention" skills. The invention ITS uses a nodal network design in which the topmost layer of the network is divided into "content" and "rhetoric," nodes (based on a model of the writing process of experienced writers developed by Bereiter and Scardamalia). The next layer of nodes is based on Rose's discourse "schemata" (i.e., definition, classification, comparison, analysis, summary, and seriation) and the final layer uses a taxonomy of questions developed by Smith and Meyer. The ITS would ideally help the student to develop schemata and to move between rhetoric and content problem spaces in composing, thus moving towards a more mature writing process.

A COMPARATIVE ANALYSIS OF A 4-GROUP AND 6-GROUP

JOB CLASSIFICATION

by -

Pinyuen Chen

Laura T. Bernhofen

ABSTRACT

A random sample of Air Force enlistees were assigned both a MAGE classification and an A-F classification (Alley, Treat, and Black, 1988) using two procedures: discriminant analysis (SAS version 5, procedure DISCRIM) and the Expected Payoff Procedure (EPP). EPP is a regression and linear programming procedure developed at the Air Force Human Resources Laboratory (AFHRL) to assign jobs optimally by maximizing the expected payoff over a group of enlistees assigned to an array of jobs.

The comparative effectiveness of the MAGE and the A-F classifications were then evaluated. Using discriminant analysis, effectiveness was determined by comparing the classifications assigned by DISCRIM to the original classifications. A rate of classification (percentage of those who were correctly assigned) and a rate of misclassification (percentage of those who were misclassified) were calculated. The classification and misclassification rates for the MAGE and A-F classifications were then compared as one measure of effectiveness.

A second measure of effectiveness was considered using the EPP classification procedure. The maximum expected payoff was calculated for the MAGE and A-F systems as well as the minimum expected payoff and the expected payoffs for the original and a random classification. These payoffs were then analyzed to determine which system could be considered most effective.

Both measures indicate that the A-F aptitude clusters are more effective at classifying enlistees than the traditional MAGE aptitude areas.

Optimizing the Training and Acquisition
of Complex Spatial Skills

by

James R. Dykes, Ph.D.

ABSTRACT

Building on prior work with SPINNER as a complex spatial skills training platform, an animated tutorial was developed that described the goals and operations of the task, showed all possible stimuli in the task, and required accurate responses from the learner in both demonstration and directed performance modes. An experiment was designed to test the effects of motivation and voice synthesis on skill acquisition. A well standardized spatial task created by Shepard & Metzler (1971) was modified into two tests designed to measure general psychomotor ability and a specific spatial ability required for air traffic control. Combined with a measure of general mental ability, these measures can be used to validate the training platform and detect Aptitude-Training interactions and Aptitude-Motivation interactions.

DECISION PROCESSING IN DYNAMIC DECISION ENVIRONMENTS

by

Daniel J. Garland

ABSTRACT

Problematic judgement and decision making processes are often present during critical in-flight events in both civilian and military aviation. Statistics on aviation accidents indicate that 80-85% of aircraft incidents/accidents are attributable to "pilot error" namely errors in judgement and decision making. Consequently, an examination of the cognitive aspects of decision processing in aviation environments is needed. This research effort focused on an examination of the nature of optimality in human decision making during labor intensive, time intensive situations. More directly, the development of a laboratory-based research program to assess the sensitivity of decision strategies to variations in the structure of the task, and to gain insights into the cognitive processes that underlie decision processing in dynamic decision environments. Given this new research knowledge, prescriptive instructional design principles can be formulated, leading to more elegant solutions to the decision training problem than those represented by the current raw high-fidelity simulation approach.

The Use of CAD to develop ICAI

for the improvement of

Spatial Visualization Skills

by

Harold Goldstein

ABSTRACT

Orthographic Projection is used by virtually all Engineers at one time or another. The ability to perform this skill is related to ones spatial aptitude and is a predictor of success in engineering design.

This paper presents a review of literature dealing with issues that would arise in the development of an Orthographic Projection tutor. Research on spatial skills issues is presented and prior related CAI efforts are discussed. The use of Computer Aided Design (CAD) software as a shell for the tutor is recommended.

Automating the Administration of USAF Occupational Surveys

by

DeLayne R. Hudspeth

Paul Fayfich

ABSTRACT

Five objectives were defined with respect to automating the administration of the USAF occupational surveys: 1) to create a computerized version of an occupational survey; 2) to prepare a research design for comparing paper/pencil and computer-based administrations; 3) to collect data; 4) to analyze the data and describe the results; and 5) to provide recommendations for R&D based on our insights and experience. Test/re-test with each subject acting as their own control suggests that computer administration consistently garnered a higher rate of job task selection than paper. Considerable variance was found with respect to assessment of time ratings which may be a function of the instructions. Recommendations for future research include efforts to better understand the specific interface between man and computer.

Psychophysical Measurement of Spectral Attenuation in the Human In Vivo Ocular Media:

Method and Results

by

Gillray L. Kandel, Ph.D. and Ken Fleming, B.S.

ABSTRACT

An instrument is described that permits psychophysical spectrophotometry. It incorporates an indirect ophthalmoscope that allows, subject to the degree to which the spectral reflectance of the optic nerve head is known, the assessment of the spectral attenuation of human *in vivo* ocular media. With all measurements standardized to spectrally neutral BaSO₄, the brightness of the light reflected from the optic nerve head and sclera of four eyes (of male Caucasians, varying in age from 19 to 66 years) was measured. Measures of the relative reflectance of the human sclera made here agreed (within experimental error) with those reported for monkey sclera. Using the former to represent the reflectance of the optic nerve head, the spectral attenuation of the two older eyes was found to be ≈ 0.5 log units greater at 480 nm than at 700 nm, but significantly less in the deep violet. For the youngest eye, the attenuation was greatest (by the same amount) at 420 nm and also significantly less at 400 nm. While the hue of the light entering and exiting the eye remained substantially the same at all wavelengths, the exiting light at 400 nm for all eyes and at 420 nm for the oldest eye was perceived to be gray -- or greenish gray. This observation was unexpected, not previously reported and is tentatively ascribed by the authors to intraspectral fluorescence. Results bearing on the sensitivity and validity of the technique are also presented.

Benefit-Cost Evaluation of Simulator Based Multiship Training
Alternatives

by

William C. Moor

ABSTRACT

A general model that allows for the benefit-cost evaluation of multiship training simulation systems is presented that provides a decision assisting tool to Air Force managers. The usefulness of the model is demonstrated by means of an application which is based on actual data. The model allows for full sensitivity analysis and variation of organizational alternatives, benefit and cost parameters. A set of LOTUS 1-2-3 spreadsheets were developed which demonstrate the model and are interlinked in such a way that the effects of changes in the model or in the data used by the model may be easily seen.

Determinants of Staying and Leaving of Military Medical
Personnel From a US Air Force Hospital

by
James L. Price

ABSTRACT

This research sought to obtain data about the determinants of staying and leaving of military medical personnel from Wilford Hall Medical Center at Lackland Air Force Base, Texas. Data about the determinants were obtained by means of a questionnaire administered to military medical personnel in Wilford Hall.

Cognitive Representations of Teams

by

Joan R. Rentsch

ABSTRACT

In the Air Force, teams complete much of the work. Therefore, Air Force success depends on team performance. A recently developed line of research at HRL is investigating team performance and technology. The research reported here contributes to HRL's research. The reported research investigated a methodology for assessing team members' cognitive representations of teamwork. The ultimate goal of this research program is to develop a computerized team diagnostic, to prescribe team task and team environment interventions that will facilitate team performance. Stage 1 of this research program was started during the Summer Faculty Research Program (SFRP). Stage 1 has four objectives: (1) to develop a methodology for assessing cognitive representations, (2) to develop a strategy for categorizing teams, (3) to investigate cognitive representations of teamwork in different types of teams, (4) to investigate team environment and task conditions that influence cognitive representations of teamwork. The research conducted for the SFRP, described in this paper, addressed the first two objectives.

ABSTRACT

The American labor force is and will continue to change considerably. Between 1976-1980 the labor force growth averaged 2.8%, but the projected growth rate will drop to 1.1% by the year 2000. In relative numbers, the very old and the younger populations are beginning to decline, leaving a middle age group. It is projected that the youth population will be lowest and will "peak out" about 1995. Between 1986 and 2000, immigrant and minority groups will have the greatest increase in population and in the number of labor force entrants.

As the population increases, educational skills levels remain low. Better prepared students will be sought after by Corporate America and governmental and private industries/agencies. The **Air Force** will have to become competitive, while at the same time prepare for the lower performance of many of the recruits.

To prepare the new groups of recruits for the technical skills which will be needed, a new way of incorporating of basic skills/job related skills and survival skills development can be explored. Known as "fundamental skills" this approach includes skills necessary for communication (writing, speaking, reading) quantification skills (math), and skill's necessary to function in a diversified workplace.

Survival Analysis: A Training Decision Application

by

Stanley D. Stephenson

and

Julia A. Stephenson

ABSTRACT

The life of a task in an airman's inventory of tasks performed has not been investigated. Yet knowledge of how long a task remains (survives) in an individual's inventory is of interest, primarily for training purposes. Survival analysis, an analytical technique frequently used in the bio-medical field, could possibly be used to measure task survivability. However, survival analysis uses longitudinal data whereas in its occupational survey program the USAF captures vertical data; i.e., a snapshot is taken of the work force at one moment in time. Nonetheless, since survival analysis can incorporate both time and censored (incomplete) data, it could provide useful information about task survivability. By combining both occupational survey data and known attrition data, a task survival database was modeled and survival analysis functions generated. Results show both that survival analysis can be used to study task survivability and that this approach produces more accurate estimates of task life. Theoretical implications and further applications are discussed.

PREDICTING THE IMPACT OF AUTOMATION ON PERFORMANCE AND WORKLOAD
IN C² SYSTEMS

by

Pamela S. Tsang and Velma L. Velazquez

ABSTRACT

The research presented has three main objectives: (a) to utilize an computer-aided engineering (CAE) tool, AIRT, to predict the impact of increased system automation on the Air Force Tacitcal Air Control System Control and Reporting Center functions, (b) to evaluate the CAE tool itself, and (c) to develop a subjective workload instrument that will provide more precise prediction for multitask workload. Subjective and projective workload measures are discussed as promising supplements to performance measures in complex or highly automated environments where performance measures are prohibitively difficult to analyzed or not available.

**OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY
ABSTRACTS**

An Assay to Determine the Phytotoxic Effects of Jet Fuel:
Effects on Vesicular-Arbuscular Mycorrhizae

by

David W. Buckalew

ABSTRACT

A new protocol is presented for using plants as analytical tools to assess the impact of potentially hazardous chemicals in soil. Its methodology parallels that used in an earlier protocol as a range of JP-4 jet fuel concentrations in soil are utilized. In addition to measures of aboveground parameters (i.e., shoot length and shoot wet and dry weights), belowground measures of total root length and percent vesicular-arbuscular mycorrhizal colonization are recorded within a common test grass. A brief discussion of the role of mycorrhizal fungi in light of post-disturbance revegetation efforts is provided.

MATHEMATICAL MODELING AND DECISION-MAKING
FOR AIR FORCE CONTAMINANT MIGRATION PROBLEMS

by

Miguel A. Medina, Jr.

ABSTRACT

Mathematical modeling needs and capabilities within the Installation Restoration Program (IRP) and its information management system (IRPIMS) were reviewed: seven ground water models and one surface water quality model were identified within the computerized data base. These models do not have the capability to address many of the current contaminant transport prediction and decision-making needs of Air Force facilities. An advisory system approach is proposed, capable of performing risk analysis due to uncertainty in predictions and limited available data, within a user-friendly framework. A computerized database of parameters commonly used in groundwater contaminant transport models was assembled from published literature sources.

A visit to several field sites at Hill AFB, Utah provided great insight into the complexity of managing contamination and restoring groundwater quality.

AN ASSESSMENT OF HAZARDOUS WASTE MINIMIZATION EFFORTS
IN THE UNITED STATES AIR FORCE

by

Kirk A. Nordyke

ABSTRACT

Information and data were collected at the headquarters major command level (a total of eleven) to provide the United States Air Force with a current assessment of their hazardous waste minimization program. Data included quantities of hazardous waste generated and disposed, and costs of analysis and disposal. Two major commands, Air Force Logistics Command and Air Training Command, are well into the implementation and evaluation phases of their respective programs. The programs of the remaining major commands are less developed. The lack of a central office or director for hazardous waste minimization efforts places responsibility for a program with each major command. Technology transfer is difficult to maintain between major commands, and even within major commands. A central office would eliminate this problem. The current accounting system is difficult to access for specific information on costs and quantities and improvement would be of benefit. A strong effort Air Force-wide will be necessary to achieve the Department of Defense goal of 50% reduction in hazardous waste generation by 1992.

Beam Profile Characteristics
of the Shephard Cs-137 Gamma Irradiator
at the AF Occupational & Environmental Health Laboratory
Instrumentation Calibration Facility Brooks AFB

by

Lorin D. Weber

ABSTRACT

The beam uniformity profile for the Brooks AFB 130 Ci Cs-137 gamma ray source was determined at 200 cm, 264 cm, and 300 cm from the source using a J. L. Shephard & Associates Model 81-10 Beam Irradiator with an Exradin Shonka-Wycoff Model A-2 Ion Chamber and associated electronics. This will allow those using the facility to determine the optimum location for accurate irradiation of large numbers of Thermoluminescent Dosimeters (TLDs) as well as other items over the largest possible area available. The optimum distance from the source to the Panasonic TLD Element Correction Factor Jig was determined. This will allow all dosimeters exposed in the tray to be within acceptable limits of error, when compared with the exposure obtained at the beam center line. The gamma ray beam is uniform and symmetric when it emerges from the aperture. The irradiation platform used to position the TLDs, phantoms, and other targets is causing distortion of the lower half of the beam. Future modification to the facility should include a rotating device to uniformly irradiate the TLDs and other items. This method would approximate the actual irradiation geometry of a radiation worker better than the static method now used.

**SCHOOL OF AEROSPACE MEDICINE
ABSTRACTS**

COMPARISONS OF AIR AND LIQUID MICROENVIRONMENTAL COOLING
FOR INTERMITTENT HEAVY WORK IN MODERATE TEMPERATURES

by

Phillip A. Bishop

ABSTRACT

Personal microenvironmental cooling has been used to enhance safety and extend the work capacity of laborers wearing protective clothing. Previous studies of air and liquid cooling have used either very low work rates or high environmental temperatures. Emergency work tasks frequently require high work rates and occur in moderate ambient temperatures. The purpose of this research was to examine the efficacy of intermittent personal cooling during rest and to compare liquid and air cooling systems in subjects engaged in hard work. Fourteen subjects wearing chemical protective clothing performed treadmill walking at a metabolic rate of 430 W for 45 min followed by 15 min rest at a WBGT of 25°C. During rest subjects received either no cooling, air cooling or liquid cooling. Both cooling systems partially alleviated heat strain and increased work capacity, with the air system offering slightly more effective cooling.

IMAGE ANALYSIS OF RAW MACROPHAGE CELLS

by

Robert Vernon Blystone

ABSTRACT

A major portion of the summer research time was spent in learning how to culture RAW macrophage cells, to set up new image analysis hardware, and to implement software routines. It was determined that cells were the best candidates for experimentation if they were in log phase growth and seeded at between 50,000 and 100,000 cells/ml per 8-chamber culture slide. LPS treated RAW cells demonstrated cell division suppression early in culture and then rapidly dividing afterwards indicating a possible escape mechanism. LPS treated cells also stained more densely than controls indicating that the cell membrane may be affected by the LPS. The image analysis system was found to be able to detect RAW foci at an early stage of growth which suggests that this system might have applications in foci detection in chemical transformations of normal cells. With this developmental work completed, image analysis can now be brought to bear on the role of LPS induction of viral production of RAW mouse macrophage cells.

Perception and Attention in Three-Dimensional Visual Space

by

Bruno G. Breitmeyer

ABSTRACT

Perceptibility of crossed-disparity (near) and uncrossed-disparity (far) stereoscopic targets was determined as a function of their location in the upper left, upper right, lower left, and lower right quadrants of the visual field. Near targets were perceived better in the lower visual field; far targets, in the upper visual field. The effects of attention directed, via central arrow cues, to the left or right, upper or lower, and near or far fields also was investigated. Although left-right attention cues produced perceptibility benefits as expected, upper-lower cues did not, while near-far cues produced interference rather than beneficial effects. Since the lack of benefits in the latter two cue conditions may have been due to greater processing capacity required of central than of peripheral attention cues, a third experiment investigated effects of peripheral upper-lower field cues on target perceptibility. Attentional benefits on target perceptibility were found, with greater attentional benefits in the upper than lower visual field. These results point to an essential nonuniformity of crossed- and uncrossed disparity space and of attentional space along the upper and lower visual field axis.

PCR Analysis of Ureaplasma urealyticum and Mycoplasma hominis

by

Joseph M. Brogan
Bob Sabatini
Vito G. DelVecchio

ABSTRACT

Three sets of primers were analyzed for their ability to define various segments of the mycoplasma genome. Primers pUP18A and B were specific for Ureaplasma urealyticum. pMD7A and B defined a sequence found in Mycoplasma hominis; however, the exact specificity of these primers has not been determined. 5SA and B primers served as a generic probe for both bacteria. These primers were able to amplify as little as 200 pg of input DNA. They also efficiently yielded amplicons with clinical specimens providing the target segments.

The Effect of Absolute Humidity on Thermoregulation
by Rhesus Monkeys

by

R. Keith Dupre

ABSTRACT

Thermal balance of six juvenile female rhesus monkeys, Macaca mulatta, was examined under resting conditions at ambient temperatures of 25, 30, 35, and 40C and absolute humidities of 6, 22, and 40 mm Hg P_{H_2O} . Rhesus monkeys were capable of achieving thermal balance under all conditions except at 40C with 40 mm Hg absolute humidity where experiments were stopped after rectal temperature exceeded 40.5C. At ambient temperatures above 35C, monkeys increased evaporative heat loss through sweating. Absolute humidity had no direct effect on metabolic rate; slightly higher metabolic rates at high temperature/high humidity were likely due to a van't Hoff effect of higher rectal temperatures. The rise in body temperature under the conditions of high heat/high humidity was most attributable to a humidity-dependent decrease in evaporative heat loss.

Effects of Microwave Radiation on Yeast Cells

by

Reinhard Graetzer

ABSTRACT

Measurements have been carried out to determine cytotoxicity of microwave radiation on the eukaryotic microorganism yeast *Saccharomyces cerevisiae*. A glutathione-deficient mutant strain and its wild-type parent were exposed to microwave radiation of 2.450 GHz, to oxidative stress from H_2O_2 , and to the antioxidant 3-amino-L-tyrosine (3AT) in various combinations. Corresponding control measurements on non-irradiated cells were also carried out.

Irradiation by microwaves showed no apparent cytotoxic effect. Irradiation of cells under oxidative stress yielded survival curves that were not significantly different from curves obtained without irradiation. Cells treated with 3AT did show significant resistance to H_2O_2 . It was also observed that cells held in saline solution prior to exposure to peroxide became progressively more resistant. Cell samples were also irradiated and prepared for a molecular assay of possible microwave damage to nuclear DNA.

Determination and Analysis of Range Data Using Computer Vision

by

Paul M. Griffin

ABSTRACT

A PC-based computer vision system was developed for the determination of range data. The system used a structured laser light environment with a programmable spatial light modulator (PSLM) to solve correspondence unambiguously. A calibration package was also developed to determine the rotational and translational offsets between the camera plane and the PSLM plane. A methodology was developed to determine the necessary light resolution for the application of automated visual inspection. Finally, an algorithm for the determination of object pose from the range data using a superquadric-based object representation was developed.

Dioxin Half-Life Estimation In Veterans Of
Project Ranch Hand

by

Pushpa L. Gupta
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University of Maine
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August 28, 1990

ABSTRACT

In this project half-life of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in humans is estimated by modeling the distribution of within-subject half-lives. Two new models, conditional and unconditional, are proposed. The conditional model is based on the assumption that the dioxin level is decaying so that the first measurement is more than the second. The unconditional model has no such assumption. The distribution functions and probability density functions of the half-life are derived. These distributions are used to obtain the maximum likelihood estimators of the parameters and hence the confidence intervals of the median half-life are obtained. The methods developed are applied on the Ranch Hand data and the results are displayed in the form of a table and graphs. In addition the Michalek et. al. model (1989) is extended to incorporate any number of measurements. Some extensions of the unconditional model involving more than two measurements and covariates have been considered and consequences are examined.

A COMPARISON OF VARIOUS ESTIMATORS OF RELATIVE RISK IN EPIDEMIOLOGICAL STUDIES

BY.
Ramesh C. Gupta

ABSTRACT

The relative risk is an important parameter in certain epidemiological studies. It is given by the ratio of the rates of attack of a specified disease occurring in an exposed and a control group. This investigation deals with various methods of obtaining the confidence limits for relative risk. These methods are compared in terms of their lengths of the confidence intervals and their coverage probabilities.

A Bayes approach to the determination of confidence intervals is evaluated along with other non-Bayes methods. For the Bayes approach analytical expressions are given for the posterior distributions of the relative risk, and these distributions are utilized to construct Bayes confidence intervals. Simulation studies are presented comparing the Bayes and the non-Bayes confidence intervals of the relative risk in terms of their lengths and coverage probabilities. The behaviors of the coverage probabilities and the average widths of the 95% C.I. are studied graphically as a function of the relative risk.

Predisposition of Mammalian Cell Cultures Treated with Aflatoxin B1
to Potential Radiation Effects

by

Paul A. Lemke

and

Dora L. Brenner

ABSTRACT

Mouse fibroblast-derived cell cultures, NIH3T3 and NIHC3H, and a mouse macrophage-derived cell line, RAW 264.7, were treated with the potent carcinogenic compound, aflatoxin B1, at a concentration of 25 μ M. A 50 percent kill rate was consistently obtained with both of the fibroblast cell lines grown for 24 hours in the presence of microsome-activated aflatoxin whereas only a 30 percent kill rate was observed for the macrophage-derived cell line under the same conditions. Formation of foci among survivors of such treatment confirmed the expected mutagenicity/carcinogenicity of the aflatoxin for the 3T3 cells. In the one experiment that involved 3T3 cells, radiation exposure followed aflatoxin treatment for 10 min. to 4 hr. These preliminary results indicate that those cells treated with AB1 for short time periods and then exposed to RFR suffer more damage than those only treated with AB1 for the same time period. However, as the time of treatment with AB1 increases, subsequent exposure to RFR doesn't appear to have any significant effect.

The Effect of Hyperbaric Oxygenation on Denervation
Induced Muscle Atrophy

by

Arnold G Nelson

ABSTRACT

The right hindlimb of 36 adult male rabbits was denervated by crushing the sciatic nerve at mid thigh. Two days following the crush the animals were treated with one of four oxygenation treatments: 21% oxygen at 0 fsw, 100% oxygen at 0 fsw, 100% oxygen at 45 fsw, or 100% oxygen at 66 fsw. All 100% oxygen treatments lasted 90 min/day for 5 days/week. Following either 2 weeks or 8 weeks of treatment, the rabbits were euthanized and the soleus, plantaris, and anterior tibialis muscle were removed from both the right and left hindlimbs. Once removed, the muscles weighed and portions were then set aside for histochemical and biochemical analysis. The histochemical and biochemical analyses could not be completed under the time constraints of the Summer Faculty Research Program. Analysis of the muscle weights, however, revealed that hyperbaric oxygenation did not reduce muscle atrophy, as represented by muscle weight, incident to muscle denervation following either the 2 week or the 8 week treatment.

Bioeffects of Microwave Radiation on

Amino Acid Metabolism by RAW 264.7

Mouse Macrophage Cells

by

Donald K. Robinson

ABSTRACT

In this study, amino acid and ammonia uptake from culture media by RAW 264.7 mouse macrophage cells were used as a model system for studying the bioeffects of microwave radiation. In comparison to sham controls, microwave exposure (2450 MHz, 30 minutes) resulted in increased amino acid and ammonia uptake from the culture media after 24 hours post exposure. Microwave radiation also increases amino acid and ammonia uptake after 24 hours in cell cultures containing 3-amino-L-tryosine. The results indicate that microwave radiation increases the uptake of individual amino acids and ammonia from the culture media and that this model system might be useful for other studies involving the bioeffects of microwave radiation on cells and cell cultures.

Further studies employing a larger number of replicates are currently being performed as are studies involving changes in amino acid and ammonia concentrations for 24 hours and 48 hours post exposure.

**Neural Graft-Host Brain Interactions Visualized
with Voltage-Sensitive Probes**

by

David M. Senseman

ABSTRACT

Functional interactions between neural grafts and surrounding host regions were studied in 450 μ thick rat hippocampal slices using the voltage-sensitive probe, RH 155. A specialized computer-based data acquisition and graphic display system developed by the Principal Investigator at The University of Texas at San Antonio (UTSA) allowed evoked electrical activity in the *in vitro* slice preparation to be directly visualized and quantitatively analyzed. Our results support the general view that homologous grafts are more likely to form functional synaptic connections with surrounding neurons than non-homologous (ectopic) grafts. While non-homologous hippocampal grafts failed to establish neuronal connections with surrounding host cells, we found strong evidence that ectopically grafted cortical neurons were electrically active and in some cases had established an extensive intragraft neural plexus.

ABSTRACT

Richard Swope

This report considers the design of experiments which investigate the effects of gravitational field changes on ventricular-vascular hemodynamics. Uncertainty analysis is applied to the determination of arterial compliance, reflection coefficients for mismatched impedances, symmetric bifurcations and symmetric trifurcations, peripheral resistance, apparent phase velocity, and stroke volume. This technique is used to determine the sensitivity of result errors to uncertainties in the experimentally measured values of variables and parameters. It is found that arterial compliance is most sensitive to uncertainties in the measurement of stroke volume. The reflection coefficient for a mismatched characteristic impedance is most sensitive to measurement uncertainties of the distal and proximal vessel areas. For a symmetric bifurcation the proximal vessel wave velocity uncertainty is most important and the same is true for a symmetric trifurcation. Peripheral resistance accuracy is most dependent on mean aortic flow measurement uncertainties. Apparent phase velocity is most affected by pressure transducer spacing measurement errors and phase angle difference uncertainties. Stroke volume is by far most sensitive to the sum of the differences between the initial blood temperature and the end diastole temperatures.

Pulmonary Measurements in Hyperbaric and Non-Hyperbaric Exposures
Addendum to: The Reduction of Denervated Atrophy as a Consequence of
Hyperbaric Oxygen Treatment

by

John L. Szarek, Ph.D.

ABSTRACT

Hyperbaric oxygenation (HBO) is used as primary or adjunctive therapy in the treatment of several conditions. However, exposure to high concentrations of oxygen is associated with decreased pulmonary function and injury to lung tissues. The purpose of this study was to assess the potential for the development of oxygen toxicity in humans. Changes in pulmonary responsiveness to the bronchoconstrictor, histamine, were used to evaluate the effects of HBO in rabbits. To facilitate measurement of pulmonary responses, a plethysmograph was constructed at the Fabrication Branch at the School of Aerospace Medicine, Brooks AFB. After testing and calibrating the plethysmograph, pulmonary responses to aerosolized histamine were obtained in rabbits which comprised three exposure groups; those exposed to air at sea level (1 ATA), those exposed to 100% oxygen at 1 ATA, and those exposed to 100 % oxygen at 3 ATA. Pulmonary responses to histamine were obtained prior to oxidant exposure and after 3, 5, 8, 10, 15, 20, and 25 days of exposure. Responses to histamine in the air exposed group were essentially unchanged over this time period. Similarly, animals receiving HBO did not exhibit changes in histamine responsiveness when compared to preexposure responses. However, rabbits that were exposed to 100% oxygen at 1 ATA exhibited a marked increase in histamine responsiveness after 3 and 5 days of exposure. This increase in responsiveness was transient in nature as indicated by the return of histamine responses toward control after 8 days of hyperoxic exposure.

CHARACTERIZATION OF +Gz-INDUCED LOSS OF CONSCIOUSNESS IN RATS

by

Steven B. Waller

ABSTRACT

The effects of multiple +Gz force exposures to produce a +Gz-induced loss of consciousness (G-LOC) using a newly constructed small animal centrifuge were characterized in male, Sprague-Dawley rats. Each +Gz exposure cycle consisted of ten (10) "on" periods of +Gz forces of 15, 17.5 or 20 Gs alternated with ten "off" periods of +Gz forces of 0.5 G. Variables examined during the study include the intensity and duration of the "on" period, the duration of the "off" period, the vivarium lighting schedule, and the biochemical markers of cerebral energy utilization. In general, changes in the "on" or "off" period that resulted in reduced levels of energy substrates were associated with the onset of G-LOC. Enhanced resistance to G-LOC was observed in animals when tested late in their "lights-on" period, probably reflecting an enhanced basal level of cerebral excitability. These results, while preliminary, represent a good start on the characterization of the rodent G-LOC model using the small animal centrifuge.

**WILFORD HALL MEDICAL CENTER
ABSTRACTS**

Interrelationships of Tobacco, Caffeine, and Alcohol Use
Among Participants of an Air Force-Sponsored
Health Promotion Program

by

Janet B. Dizinno

ABSTRACT

Participants of a health promotion program at Wilford Hall USAF Medical Center were surveyed to assess predictors of change in health-related behaviors. Also, the participants were asked about their consumption of caffeine, nicotine, and alcohol so that hypothesized co-occurrence of usage could be investigated. The predictors of change study is on-going. The co-occurrence study provided some support for the proposed interrelationships among the three behaviors. Specifically, a significant correlation was found between number of cups of caffeinated coffee drunk and number of cigarettes smoked, total number of caffeinated beverages drunk and number of cigarettes smoked, number of glasses of beer drunk and number of cigarettes smoked, and number of cups of caffeinated coffee drunk and number of glasses of beer drunk. Sex differences were found in the consumption of all alcohol, beer alone, liquor alone, all caffeinated beverages, and all coffee.