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PROGRAM MANAGEMENT REPORT

RESEARCH & DEVELOPMENT LABORATORIES

5800 Uplander Way

Culver City, CA 90230-6608

Program Director, RDL  
Gary Moore

Program Manager, AFOSR  
Lt. Col. Claude Cavender

Program Manager, RDL  
Claude Baum

Program Administrator, RDL  
Gwendolyn Smith

Submitted to:

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Bolling Air Force Base

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## 1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty and graduate students, and for high school students, to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines, using laboratory facilities and equipment not often available at associates' institutions.

AFOSR also offers its research associates an opportunity, under its Research Initiation Program, to continue their AFOSR-sponsored research at their home institutions through the award of research grants of up to \$20,000.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members, with at least two years of teaching and/or research experience, working in accredited U.S. colleges, universities, or technical institutions.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or master's degree and enrolled fulltime at an accredited institution.

The High School Apprenticeship Program (HSAP) annually selects about 125 high school students located within commuting distance of participating Air Force laboratories.

The numbers of projected summer research participants in each of the three categories are usually increased through direct sponsorship of participating laboratories.

Disciplines include the following and related fields:

- Aeronautical Engineering
- Astronautical Engineering
- Behavioral Sciences
- Chemistry
- Civil Engineering
- Electrical Engineering
- Geophysics/Meteorology
- Life Sciences
- Materials Sciences
- Mathematics/Computer Science
- Mechanical Engineering
- Physics

AFSOR's Summer Research Program has well served its objectives of building critical links between Air Force research laboratories and the academic community; opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest; and strengthening the nation's efforts to sustain careers in science and engineering. The success of the Program can be gauged from its continued growth (shown in Table 1) and from the favorable responses the 1991 participants expressed in the questionnaires in Appendix B.

Administration of the Summer Research Program is contracted by AFOSR to civilian contractors. The contract was awarded to Research & Development Laboratories (RDL) in September 1990.

## 2. GROWTH OF SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the growth of the program.

Table 1. Growth of SRP

YEAR	NUMBER OF PARTICIPANTS			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444

Follow-on research opportunities have been created for a large number of SFRP participants and some exceptional graduate students. In the 1979-1983 period this was accomplished through an AFOSR Minigrant Program. AFOSR replaced the Minigrant Program with the Research Initiation Program (RIP) in 1983. The RIP provides follow-on research awards to home institutions of selected participants. Awards were made to approximately 50 researchers in 1983 for a maximum of \$12,000 each and a duration of one year or less. Cost-sharing by the schools contributes significantly to the value of the RIP. The amount of each RIP was increased to a maximum of \$20,000 in 1985. The growth of the RIP is shown in Table 2 and the funding and cost-sharing are shown in Table 3.

Table 2. Growth of RIP

YEAR	SFRP PARTICIPANTS	RIP APPLICANTS	RIP AWARDS
1983	101	-	50
1984	152	-	80
1985	154	120	82
1986	158	141	97
1987	159	124	83
1988	153	126	92
1989	168	134	96
1990	165	136	93
1991	170	155	N/A

Table 3. RIP Funding and Cost Sharing

YEAR	NUMBER OF RIPS	AFOSR FUNDING	COST SHARING
1985	82	\$1,551,091	\$ 782,812
1986	97	\$1,932,164	\$ 754,857
1987	83	\$1,646,379	\$ 721,398
1988	92	\$1,826,152	\$ 967,713
1989	96	\$1,900,187	\$1,100,081
1990	92	\$1,816,072	\$1,112,654

### 3. RECRUITING AND SELECTION

The Summer Research Program is conducted on a nationally advertised and competitive selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 12,000 40-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutes. Historically Black Colleges and Universities were included. Brochures also went to all participating USAF laboratories, special mailing lists supplied by AFOSR, and numerous individual requestors.

The 1991 SRP opportunity was also advertised in four journals: *Black Issues in Higher Education*, *Chemical & Engineering News*, *IEEE Spectrum* and *Physics Today*.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools.

The 1991 deadlines for applications and notification of selectees were as follows:

APPLICANTS	DEADLINE FOR APPLICATION	DEADLINE FOR NOTIFICATION
SFRP	2/01/91	3/01/91
GSRP	4/01/91	4/15/91
HSAP	3/15/91	4/15/91

Each applicant is given a first, second, and third choice of laboratory (including high school students with more than one laboratory at their nearby Air Force bases).

Laboratories make their selections from first, second, and third choices and prioritize their nominees. AFOSR determines the number it will fund at each laboratory, and approves laboratories' selections.

For faculty selections, a selection panel with representatives from all participating laboratories, AFOSR, and RDL met at Brooks AFB, Texas, on February 20-21, 1991, to make final decisions on offers.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment and alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after the scheduled deadlines.

In 1991, the number of total applicants and final participants were:

<b>PARTICIPANT TYPE</b>	<b>1991 APPLICANTS</b>	<b>1991 PARTICIPANTS</b>
SFRP	505	170
GSRP	251	142
HSAP	612	132
<b>Total</b>	<b>1,368</b>	<b>444</b>

#### 4. SITE VISITS

In June and July 1991, representatives of RDL and AFOSR visited each participating laboratory to provide briefings, answer questions, and resolve problems for laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants.

#### 5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCUs) VISITS

A project member from RDL visited a number of HBCUs to promote interest in the SRP among the faculty and graduate students. Orientations were provided at the following HBCUs in January 1991:

Atlanta Metropolitan College	Atlanta, GA
Clark Atlanta University	Atlanta, GA
Morehouse College	Atlanta, GA
Spelman College	Atlanta, GA
Alabama State University	Montgomery, AL
Tuskegee University	Tuskegee, AL
Fisk University	Nashville, TN

Table 4 records HBCU participation in this program.

Table 4. HBCU Participants in SRP

YEAR	HBCU SFRP		HBCU GSRP		HBCU RIP	
	Applicants	Participants	Applicants	Participants	Applicants	Participants
1985	76	23	15	11	10	7
1986	70	18	20	10	16	10
1987	82	32	32	10	23	7
1988	53	17	23	14	8	4
1989	39	15	13	4	9	4
1990	43	14	17	3	9	2
1991	42	13	8	5	7	N/A

#### 6. COMPENSATION FOR PARTICIPANTS

Compensation for 1991 participants included the following payments per 5-day work week:

- Faculty members \$690
- Graduate students with masters' degrees \$425
- Graduate students with bachelors' degrees \$365
- High school students (first year) \$200
- High school students (subsequent years) \$240

The program also offered an expense allowance (7 days per week) of \$47/day for faculty and \$34.50/day for graduate students. Transportation to the laboratory at the beginning of the program and back to their home destinations at the end was also reimbursed for these participants.

Faculty members were encouraged to visit their designated laboratories before the summer began. All costs of these orientation visits were reimbursed.

By the nature of their independent research, program participants were considered to be providing "nonpersonal services," i.e., services not under direct control of an employer. As such, participants were responsible for their own income taxes, FICA, and insurance and were exempt from paycheck withholding.

7. CONTENTS OF 1991 REPORT

The complete set of reports for the 1991 SRP includes the Program Management Report in this volume, augmented by twelve volumes of final research reports by the 1991 participants. The report volumes are shown in Table 5.

Table 5. Contents of 1991 SRP Report

<b>MANAGEMENT REPORT = VOLUME #1</b>			
<b>RESEARCHERS' FINAL REPORT VOLUMES</b>			
<b>LABORATORIES</b>	<b>SFRP REPORTS</b>	<b>GSRP REPORTS</b>	<b>HSAP REPORTS</b>
Armstrong, Wilford Hall	#2	#6	#10
Phillips, AFCEL	#3	#7	#11
Rome, Arnold, Seiler	#4	#8	#12
Wright	#5	#9	#13

8. LABORATORY DESIGNATIONS

During the summer of 1991 a number of participating Air Force Laboratories underwent organizational realignments and name changes, culminating in eight major laboratories. As shown in Table 5 above, the 1991 research reports are packaged according to the "new" laboratory designations. Because all data for the 1991 SRP were based on the prior laboratory designations, i.e., before the changes occurred, these prior designations are used in this management report. Table 6 provides the following correlations:

- a. The names of the eight major laboratories.
- b. The prior laboratory names and the order in which these laboratories are presented in the 1991 SRP Report.

**Table 6. USAF Laboratory Designations and Abbreviations**

TITLE	ABBREVIATION
<b>1. ARMSTRONG LABORATORY</b>	
Armstrong Aerospace Medical Research Laboratory	AAMRL
Human Resources Laboratory: Logistics & Human Factors Division	LHFD
Human Resources Laboratory: Manpower & Personnel Division	MPD
Human Resources Laboratory: Operations Training Division	OTD
Human Resources Laboratory: Training Systems Division	TSD
Occupational & Environmental Health Laboratory	OEHL
School of Aerospace Medicine	SAM
<b>2. WILFORD HALL USAF MEDICAL CENTER</b>	
Wilford Hall Medical Center	WHMC
<b>3. PHILLIPS LABORATORY</b>	
Astronautics Laboratory	ASTRO
Geophysics Laboratory	GEO
Weapons Laboratory	WL
<b>4. AF CIVIL ENGINEERING LABORATORY</b>	
Engineering & Services Center	ESC
<b>5. ROME LABORATORY</b>	
Rome Air Development Center -- Griffiss AFB	RADC
Rome Air Development Center -- Hanscom AFB	RADCH
<b>6. ARNOLD ENGINEERING DEVELOPMENT CENTER</b>	
Arnold Engineering Development Center	AEDC
<b>7. FRANK J. SEILER RESEARCH LABORATORY</b>	
Frank J. Seiler Research Laboratory	FJSRL
<b>8. WRIGHT LABORATORY</b>	
Aero Propulsion & Power Laboratory	PROP
Armament Laboratory	ATL
Avionics Laboratory	AVION
Electronic Technology Laboratory	ETL
Flight Dynamics Laboratory	FDL
Materials Laboratory	MAT

## APPENDIX A. PROGRAM STATISTICS

The participants in AFOSR's 1991 Summer Research Program represent a broad cross-section of research associates. The combination of 170 SFRP and 142 GSRP (312 in all) include representatives from 50 states, 62 technical specialties, and 145 universities and colleges, including 13 Historically Black Colleges and Universities (HBCUs).

<b>NUMBER OF PARTICIPANTS</b>	
SFRP	170
GSRP	142
HSAP	132
<b>Total</b>	<b>444</b>

<b>DEGREES REPRESENTED</b>		
	<b>SFRP</b>	<b>GSRP</b>
Bachelors	0	106
Masters	6	35
Doctoral	164	1
<b>Total</b>	<b>170</b>	<b>142</b>

<b>ACADEMIC TITLES--SFRP</b>	
Assistant professor	62
Associate professor	56
Professor	45
Instructor	3
Chairman	1
Visiting professor	1
Visiting scholar	1
Resident engineer	1
<b>Total</b>	<b>170</b>

Table A-1. Source of Learning About SRP by 1991 Participants

SOURCE	SFRP		GSRP	
	No.	Pct.	No.	Pct.
Applied/participated in prior years	55	27%	24	16%
Brochure mailed to institutions	76	37	28	19
Colleague familiar with SRP	23	11	19	13
Contact with Air Force laboratory scientist	33	16	14	10
Journal advertisement	13	6	4	3
Faculty request	NA	NA	45	31
Other	5	3	12	8
<b>Total</b>	<b>205</b>	<b>100%</b>	<b>146</b>	<b>100%</b>

Percentages are approximate as participants indicated more than one source. The biggest source of program information for SFRP participants was the annual brochure. The biggest source for GSRP was faculty requests.

The 13 SFRPs who cited journals mentioned IEEE Spectrum (5), Physics Today (4), and Chemical & Engineering News (4). The four GSRPs cited IEEE Spectrum (2) and Physics Today (2). The advertisement in Black Issues in Higher Education was not cited.

Table A-2. Total Applicants vs. Participants by Laboratory Choice--SFRP

Laboratory	First Choice			Second Choice		Third Choice		Total Participants
	Apply	Participate		Apply	Participate	Apply	Participate	
AAMRL	24	8	33%	17	1	17		9
LHFD	5	2	40%	7		8		2
MPD	10	3	30%	12		7	1	4
OTD	6	2	33%	11		10	1	3
TSD	13	4	31%	9		6		4
OEHL	16	2	13%	9		15	1	3
SAM	37	14	38%	27	1	20		15
WHMC	13	1	8%	11		11		1
ASTRO	29	10	34%	20	1	15	1	12
GEO	21	9	43%	6	1	7	1	11
WL	28	9	32%	22	1	10		10
ESC	44	9	20%	19		16		9
RADC	53	11	21%	24	3	15		14
RADCH	18	3	17%	18	3	5		6
AEDC	19	7	37%	20	1	9		8
FJSRL	16	4	25%	12	1	20		5
PROP	28	9	32%	14	1	9	1	11
ATL	23	7	30%	28	2	24		9
AVION	15	7	47%	23	3	15		10
ETL	14	2	14%	10		5		2
FDL	34	10	29%	28	1	8		11
MAT	39	10	26%	20	1	20		11
Total	505	143	28%	367	21 6%	272	6 2%	170 34%

Table A-2 shows that of the 505 SFRP applicants, 143 (or 28%) were accepted to their first choice of laboratory. Of those applicants indicating a second and third choice, 21 or 6% were accepted to their second choice, and 6 or 2% to their third choice.

Table A-3. Total Applicants vs. Participants by Laboratory Choice--GSRP

Laboratory	First Choice			Second Choice		Third Choice		Total Participants
	Apply	Participate		Apply	Participate	Apply	Participate	
AAMRL	19	7	37%	6		1		7
LHFD	4	1	25%	2	1	4		2
MPD	5	2	40%	4	1	3	1	4
OTD	6	2	33%	3		3		2
TSD	7	2	29%	7		1		2
OEHL	3	3	100%	1		1		3
SAM	25	10	40%	7	2	8		12
WHMC	8	2	25%	2		3		2
ASTRO	13	6	46%	3		5	2	8
GEO	13	5	38%	5	1	2		6
WL	15	10	67%	4	1	4	1	12
ESC	10	2	20%	3		2		2
RADC	15	8	53%	7		5		8
RADCH	5	3	60%	2	1	0		4
AEDC	30	18	60%	4	1	5	1	20
FJSRL	12	9	75%	2		4		9
PROP	9	5	56%	1		1		5
ATL	11	9	82%	11		2		9
AVION	6	4	67%	2		3	1	5
ETL	2	1	50%	5		4		1
FDL	17	9	53%	6		5		9
MAT	16	10	63%	6		4		10
Total	251	128	51%	93	8 9%	70	6 9%	142 56%

Table A-3 shows that of the 251 GSRP applicants, 128 or (51%) were accepted by their laboratory of first choice. This percentage is higher than that for SFRP applicants (28%) for two reasons: the lower number of GSRP applicants made the percentage of overall GSRP acceptance higher (56% to 34% for faculty); and the large numbers of GSRP (45) who indicated that their professor urged them to participate at a particular laboratory were typically accepted by that laboratory if their professor was accepted.

Table A-4. 1991 Participants Who Participated in Prior Years

Laboratory	SFRP		GSRP		Combined Total	
	1991	Prior	1991	Prior	1991	Prior
AAMRL	9	4	7	1	16	5
LHFD	2		2		4	
MPD	4	1	4		8	1
OTD	3		2		5	
TSD	4	2	2		6	2
OEHL	3	1	3		6	1
SAM	15	6	12		27	6
WHMC	1	1	2	1	3	2
ASTRO	12	2	8	2	20	4
GEO	11	3	6	1	17	4
WL	10	1	12	1	22	2
ESC	9	3	2		11	3
RADC	14	4	8		22	4
RADCH	6		4		10	
AEDC	8	4	20	6	28	10
FJSRL	5	1	9	3	14	4
PROP	11	4	5			4
ATL	9	4	9	2	18	6
AVION	10	7	5		15	7
ETL	2		1		3	
FDL	11	5	9	2	20	7
MAT	11	3	10		21	3
Total	170	56 (33%)	142	19 (13%)	312	75 (24%)

Table A-5. Disciplines Represented (62)

DISCIPLINE	SFRP	GSRP	TOTAL
Aeronautical Engineering	4		4
Aerospace Engineering	3	16	19
Aerospace Mechanics		2	2
Astronomy		1	1
Astrophysics		2	2
Biochemistry		1	1
Bioengineering	1		1
Biological Psychology	1		1
Biology	1	4	5
Biomedical Engineering		1	1
Business Administration		1	1
Ceramic Science & Engineering		2	2
Chemical Engineering	3	1	4
Chemistry	9	8	17
Civil Engineering	3	1	4
Cognitive Psychology	1		1
Communications		1	1
Composites	1		1
Computer Science	6	3	9
Educational Psychology	1		1
Educational Technology	1		1
Electrical Engineering	26	22	48
Electro-optics		1	1
Electrophysics	1		1
Engineering Mechanics	4	2	6
Environmental Engineering	1	1	2
Experimental Psychology	3	4	7
Geography	1	1	2
Geophysics	1		1
Industrial Engineering	2	2	4
Industrial Psychology		1	1
Information Transfer	1		1
Instructional Design		1	1
Management Science		1	1
Marine Biology		1	1
Materials Science & Engineering	4	3	7
Mathematics	16	4	20
Mechanical Engineering	19	17	36
Mechanics	1		1
Metallurgy	1	1	2
Meteorology	1		1
Microbiology	1	1	2
Muscle Physiology	1		1
Neuroscience		1	1
Numerical Analysis	1		1

Table A-5. Disciplines Represented (Cont.)

DISCIPLINE	SFRP	GSRP	TOTAL
Nutrition	1		1
Ocean Engineering		1	1
Operations Research	1		1
Optical Science		1	1
Organic Chemistry	3		3
Physical Chemistry	5		5
Physical Sciences	1		1
Physics	26	15	41
Physiology	4	3	7
Political Science		1	1
Polymer Science		1	1
Psychology	4	8	12
Sociology	1		1
Structural Engineering	1	1	2
Structures	1	1	2
Technology	1	1	2
Zoology	1		1
<b>Total</b>	<b>170</b>	<b>142</b>	<b>312</b>

Table A-6. Colleges and Universities Represented

(\* = Historically Black Colleges and Universities)

INSTITUTION	SFRP	GSRP	TOTAL
Alabama, University of	1	3	4
Alfred University	1		1
Arizona State University		1	1
Arizona, University of	2	2	4
Arkansas Tech University	1		1
Auburn University	2	3	5
Averett College	1		1
Baylor University	1	1	2
Bob Jones University	2		2
Boston University		3	3
Brigham Young University	2	2	4
California State Polytechnic University	1	1	2
California State University - Chico	1		1
California State University - Fresno	1		1
California State University - Northridge	1		1
California, University of (Berkeley)	1		1
California, University of (Irvine)	1		1
Cameron University	1		1
Capital University	1		1
Carnegie-Mellon University	1	2	3
Case Western Reserve University	2	2	4
Central Florida, University of	1	1	2
Cincinnati, University of	5	2	7
Clark Atlanta University*		1	1
Clarkson University	2	1	3
Clemson University	2		2
Colorado State University		1	1
Colorado, University of	1	2	3
Dayton, University of	1	2	3
Drury College	1		1
Duke University	1	1	2
East Carolina University	1		1
Eastern Illinois University	1		1
Embry-Riddle Aeronautical University	1		1
Emory University		1	1
Florida State University		1	1
Florida, University of	2	5	7
Georgia Institute of Technology	2	3	5
Georgia, University of	1		1
Grand Canyon University	1		1
Hampton University*	1		1
Harvard University		1	1
Hawaii, University of	1		1

Table A-6. Colleges and Universities Represented (Cont.)

INSTITUTION	SFRP	GSRP	TOTAL
Highland Park Community College*	1		1
Houston, University of	1		1
Idaho State University	1	1	2
Illinois, University of (Chicago)		1	1
Illinois, University of (Urbana - Champaign)	1	1	2
Indiana University	1	1	2
Indiana University/Purdue University	1		1
Iowa State University		1	1
Iowa, University of		1	1
Jackson State University*		1	1
Johns Hopkins University		1	1
Kansas State University	2	2	4
Kansas, University of	2	1	3
Kent State University	2	1	3
Kentucky State University*	1		1
Kentucky, University of	1	4	5
LeMoyne-Owen College*	1		1
Louisiana State University	2	1	3
Maryland, University of	1		1
Massachusetts Maritime Academy	1		1
Meharry Medical College*		2	2
Memphis State University	2		2
Mercer University	1	1	2
Miami University	1		1
Miami, University of	2	2	4
Michigan Technological University	2	1	3
Minnesota, University of (Duluth)	3	1	4
Minnesota, University of (Minneapolis)	1		1
Mississippi State University	2		2
Mississippi, University of	1	1	2
Missouri-Rolla, University of	3	1	4
Missouri, University of	1		1
Mobile College	1		1
Montana, University of	1		1
Morehouse College*	2		2
Nevada, University of (Las Vegas)	2		2
Nevada, University of (Reno)	1		1
New Mexico, University of	2	4	6
New Orleans, University of	1	2	3
New York, City College of	4	1	5
Norfolk State University*	1		1
North Carolina State University	4		4
North Carolina, University of (Chapel Hill)		1	1
North Carolina, University of (Charlotte)	2		2
North Dakota State University	1		1

Table A-6. Colleges and Universities Represented (Cont.)

INSTITUTION	SFRP	GSRP	TOTAL
North Texas State University	1		1
Northeastern University	1		1
Northwestern University	1	1	2
Notre Dame University		1	1
Ohio State University	2	2	4
Ohio University	1		1
Oklahoma State University	3	2	5
Oregon Institute of Technology	1		1
Pennsylvania State University	2	2	4
Pittsburgh, University of	2		2
Polytechnic University	1	1	2
Puerto Rico, University of*	1		1
Purdue University	3		3
Rice University		1	1
Rochester Institute of Technology	1		1
Rochester, University of	1		1
Salem State University	1		1
Scranton University	1		1
Southern Connecticut State Universtiy	1		1
Southern California, University of		1	1
South Florida, University of	1	1	2
Stanford University		1	1
Stevens Institute of Technology	1		1
SUNY Institute of Technology	1		1
SUNY at Buffalo	1	5	6
SUNY at Utica	1		1
Syracuse University	4	3	7
Tennessee State University*	1		1
Tennessee Technological University		1	1
Tennessee, University of		1	1
Texas A&M University		2	2
Texas College of Osteopathy		1	1
Texas Space Institute		5	5
Texas Tech University	1		1
Texas, University of (Arlington)	1		1
Texas, University of (Austin)		2	2
Texas, University of (Permian Basin)	1	1	2
Texas, University of (San Antonio)	3	2	5
Texas Womans University	1		1
Transylvania University	1		1
Trinity University	3	4	7
Tuskegee University*		1	1
Utah State University		3	3
Utah, University of	1		1
Valparaiso University	1		1

Table A-6. Colleges and Universities Represented (Cont.)

INSTITUTION	SFRP	GSRP	TOTAL
Vanderbilt University	2	5	7
Virginia Polytechnic Institute	2	7	9
Washington State University		2	2
Western Canada, University of	1		1
Western Illinois University	1		1
Wichita State University		1	1
Wilkes University	1	1	2
Wittenberg University	1	1	2
Worcester Polytechnic Institute	1	2	3
Wright State University		2	2
Wyoming, University of	1	1	2
Xavier University of Louisiana*	4		4
<b>Total Participants</b>	<b>170</b>	<b>142</b>	<b>312</b>
<b>Total Institutions:</b>	<b>116</b>	<b>79</b>	<b>145</b>
<b>Total HBCUs:</b>	<b>9</b>	<b>5</b>	<b>13</b>

Table A-7. States Represented by 1991 Participants (SFRP/GSRP)

(Total = 52)

STATE	SFRP		GSRP		Total	
	Applied	Selected	Applied	Selected	Applied	Selected
Alabama	14	4	10	6	24	10
Alaska	1	0	0	0	1	0
Arizona	11	4	5	3	16	7
Arkansas	1	1	0	0	1	1
California	18	6	10	3	28	9
Colorado	6	1	9	4	15	5
Connecticut	11	1	0	0	1	1
Delaware	2	0	1	0	3	0
District of Columbia	0	0	1	0	1	0
Florida	22	7	17	10	39	17
Georgia	18	6	8	4	26	10
Hawaii	1	1	0	0	1	1
Idaho	3	1	1	0	4	1
Illinois	13	5	6	2	19	7
Indiana	25	6	2	1	27	7
Iowa	2	0	4	3	6	3
Kansas	6	4	6	3	12	7
Kentucky	9	4	7	5	16	9
Louisiana	21	7	4	4	25	11
Maine	1	0	0	0	1	0
Maryland	10	1	1	1	11	2
Massachusetts	11	4	12	6	23	10
Michigan	13	3	0	0	13	3
Minnesota	4	4	2	2	6	6
Mississippi	14	3	3	1	17	4
Missouri	21	5	2	1	23	6
Montana	2	1	0	0	2	1

Table A-7. States Represented by 1991 Participants (SFRP/GSRP) (Cont.)

STATE	SFRP		GSRP		Total	
	Applied	Selected	Applied	Selected	Applied	Selected
Nebraska	2	0	0	0	2	0
Nevada	3	3	0	0	3	0
New Hampshire	1	0	2	0	3	0
New Jersey	16	3	4	1	20	4
New Mexico	6	2	6	4	12	6
New York	35	12	23	13	58	25
North Carolina	11	8	4	3	15	11
North Dakota	3	1	0	0	3	1
Ohio	34	15	21	12	55	27
Oklahoma	10	4	3	2	13	6
Oregon	7	1	1	0	8	1
Pennsylvania	20	7	12	7	32	14
Puerto Rico	2	1	0	0	2	1
Rhode Island	2	0	1	0	3	0
South Carolina	16	4	2	2	18	6
South Dakota	1	0	0	0	1	0
Tennessee	18	4	17	8	35	12
Texas	35	15	25	17	60	32
Utah	5	3	4	4	9	7
Vermont	2	0		0	2	0
Virginia	11	5	7	6	18	11
Washington	2	1	6	3	8	4
West Virginia	6	0	0	0	6	0
Wisconsin	3	0	1	0	4	0
Wyoming	3	1	1	4	2	2
Canada	1	1	0	0	1	1
Total	505	170	251	142	756	312

Table A-8. High School Participants (HSAP) by Laboratory

LABORATORY	1991	1990	1989	1988
AAMRL	6	7	8	9
OEHL	3	3	3	1
SAM	20	13	7	5
ASTRO	8	12	10	14
GEO	6	7	8	9
WL	10	10	0	0
ESC	10	15	7	11
RADC	14	15	15	11
AEDC	13	6	0	0
PROP	7	7	7	4
ATL	16	16	16	16
AVION	7	6	10	9
ETL	4	5	0	0
FDL	8	9	12	12
MAT	0	1	0	0
Total	132	132	103	101

Table A-9. 1991 HSAP by State

STATE	APPLIED	SELECTED
Alabama	1	1
California	44	9
Connecticut	1	0
Delaware	1	1
Florida	64	23
Georgia	1	0
Illinois	2	1
Kentucky	1	1
Massachusetts	27	7
Maryland	1	1
New Hampshire	1	0
New Mexico	46	10
New York	69	13
Ohio	127	30
Pennsylvania	1	1
Tennessee	49	12
Texas	176	22
Total	612	132

## APPENDIX B. QUESTIONNAIRE RESPONSES -- RDL EVALUATIONS

### I. OVERVIEW

Questionnaires were completed and returned to RDL by four groups at the end of the SRP. The number of respondents in each group is shown below.

<u>Questionnaire Group</u>	<u>Responses</u>
USAF Laboratory Focal Points	= 58
SFRP	= 144
GSRP	= 126
HSAP	= 124

All groups indicated near-unanimous enthusiasm for the SRP experience. Of the 444 participants all but four rated the program highly.

A number of participants cited the rigid ten-week time period and insufficient financial compensation as shortcomings. For 1992 AFOSR is providing a more flexible 8-12 week schedule as well as increases in salary and expense allowance for SFRP and GSRP participants.

To provide a comprehensive analysis of SFRP and GSRP responses, these two groups are presented together where feasible.

## II. 1991 USAF LABORATORY FOCAL POINT QUESTIONNAIRE RESPONSES

### 1. How do you rate the communication concerning program administration?

Excellent	-	6
Good	-	25
Average	-	23
Poor	-	4

### 2. Did you have sufficient time to evaluate the applications?

Yes	-	51
No	-	6

Comments from respondents stating No: Need extra week. Three days instead of one. One week instead of one day (2 responses). Five days instead of two (2 responses).

### 3. Was your allotted number of faculty associates satisfactory?

Yes	-	45
No	-	6

Respondents stating No wanted more: 2 instead of 1 (3 responses); the other 3 wanted 3 instead of 1, 6 instead of 2, and 12 instead of 4.

### 4. How many would you want for the 1992 summer?

Wanted 0	-	1
Wanted 2	-	12
Wanted 3	-	14
Wanted 4 or more	-	4

### 5. How important was the SFRP orientation visit to you?

Essential	-	28
Convenient	-	11
Not worth expense	-	1
Unfamiliar with such visits	-	10

The last ("unfamiliar") group worked mostly with graduate or high schools students only.

### 6. Is the ten-week work period a sufficient length of time?

Yes	-	38
No	-	16

If No, what do you feel is a sufficient length of time?

12 weeks	-	7
13 weeks	-	2
16 weeks	-	6
3-6 months	-	3

## II. 1991 USAF LABORATORY FOCAL POINT QUESTIONNAIRE RESPONSES (Cont)

7. Did your laboratory establish means to access the associate's academic knowledge, other than the research assignment?

Yes - 25  
No - 23

If yes, please explain

Seminars and lectures - 17  
Personal discussions - 4  
Collaborative projects and publications - 3

8. How would you improve this program?

Flexible and extended time span - 15  
More prior involvement between associate and focal point - 3  
Improve payment procedures for participants - 3  
Send brochures to all lab focal points in advance - 2  
Provide a laboratory-furnished on-site program administrator - 2  
Clearer up-front explanations on administrative and voucher procedures - 4  
Improve RDL communications - 2  
Earlier acceptance of grad students - 2  
Order routine supplies through RDL - 1  
Higher payments to faculty - 1

9. Other Comments

9.1 Program Duration and Selection Date

By ten weeks he [the faculty associate] was just getting started on his work so he was not able to contribute to the program.

Lose a couple of weeks getting started.

By the time the faculty associates are attuned to the laboratory, it's time for them to leave.

## II. 1991 USAF LABORATORY FOCAL POINT QUESTIONNAIRE RESPONSES (Cont)

### 9.1 Program Duration and Selection Date (cont)

Move selection date ahead. Not enough time from selection to arrival to acquire necessary supplies and equipment.

Even though we order supplies a few months in advance, when the faculty arrives they have no supplies to work with and have insufficient time to do research.

### 9.2 Information and Communications

Provide a Summer Faculty summary document for sponsors/participants.

Would like to see a summary of all research conducted to see what other labs are doing (2).

Excellent response from RDL. Thank you.

Laboratory orientation by RDL very effective.

My professor's acceptance letter misrouted him to the wrong Rome laboratory site. This is poor administration.

Housing arrangements are always a problem. I could benefit from knowing where people stayed and how they evaluated housing.

### 9.3 Positive Endorsements - Examples

I like it and the students seem to benefit.

Excellent program. Our student/faculty interactions have produced outstanding results.

Program should be expanded.

Good program.

I have enjoyed working with the summer faculty members.

Do it again next year!

### 9.4 Miscellaneous

Require initial written statement of objectives, halfway progress report, and final report at end (not end of September).

Prefer to have faculty members only.

An outright contract on a mutually agreeable topic performed on campus will be more efficient and cost-effective.

Some travel money to and from cooperating laboratories should be available to associates.

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES

The SFRP/GSRP questionnaire responses are divided into the following sections:

- A. Multiple Choice
- B. Narrative Responses
- C. Specific Issues by Laboratory
- E. Weekly Cost for Lodging

A comparison of SFRP and GSRP responses in the same tables shows that faculty had a somewhat richer experience and rated the program accordingly higher than graduate students. For example, in Table A, Multiple Choice, item no. 9 shows that 60% of SFRP gave seminars contrasted with 36% of GSRP. Turning to the rating factors in item no. 18, the overall assessment of the SRP is also slightly higher for SFRP. Nevertheless, despite some difficulties experienced by participants, item no. 7 shows that 94% of SFRP and 95% of GSRP would reapply next year. (Respondents who would not reapply typically cited other pre-arranged travel or unavailability for 1992.)

Comments that did not vary significantly among participants at different laboratories are all included in section B, Narrative Responses, and are not repeated for each laboratory.

Comments that addressed problems at specific laboratories are in section C, Specific Issues by Laboratory. These comments deal primarily with housing, other local issues, and particular issues in the laboratory itself. Although these comments focus on problem areas, section D should not be interpreted as a negative reflection since the positive comments for all laboratories are integrated in section B.

Section D is an analysis of responses to the question, "How much did you pay for your room or apartment per week?" These responses are organized by location, e.g., all laboratories at Wright-Patterson AFB are grouped together. The results show significant differences in rent among locations and between faculty and graduate students.

**III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)**

<b>A. MULTIPLE CHOICE</b>		<b>SFRP</b>		<b>GSRP</b>	
1.	Did laboratory research closely match your field?	Yes No	135 (95%) 7	105 (88%) 14	
2.	Did you have reasonable influence on topic?	Yes No	131 (94%) 9	102 (84%) 20	
3.	Was the work challenging?	Yes No	141 (99%) 1	115 (95%) 6	
4.	Would you classify the effort as research?	Yes No	136 (96%) 6	114 (93%) 9	
5.	Satisfied with working relationships with lab scientists?	Yes No	135 (97%) 4	116 (95%) 6	
6.	Adequate facilities/equipment?	Yes No	132 (93%) 10	103 (85%) 18	
7.	Would you reapply next year?	Yes No	130 (94%) 9	115 (95%) 6	
8.	Did you travel while at lab?	Yes No	57 (40%) 85	35 (30%) 80	
9.	Were you asked to give a seminar?	Yes No	85 (60%) 56	43 (36%) 77	
10.	Participate in technical meetings?	Yes No	98 (74%) 35	81 (65%) 43	
11.	Participate in other lab activities?	Yes No	74 (52%) 67	46 (38%) 75	
12.	Will you continue related research?	Yes No	135 (96%) 6	108 (91%) 11	
13.	Were brochures satisfactory?	Yes No	128 (90%) 14	98 (86%) 16	
14.	More than normal domestic problems?	Yes No	20 (14%) 120	21 (20%) 85	
15.	How important was the orientation visit?	Essential Convenient Not worth expense	93 (75%) 29 (23%) 3 (2%)	N/A	
16.	Were grad students working with you?	Yes No	42 (32%) 90	N/A	
17.	Would you bring grad students next year?	Yes No	103 (77%) 30	N/A	

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### A. MULTIPLE CHOICE (Cont)

18. Grade the following items  
(5 = highest; 1 = lowest):

RATING FACTOR	SFRP						GSRP					
	5	4	3	2	1	Avg	5	4	3	2	1	Avg
Technically challenging	73	51	14	0	3	4.4	47	54	14	4	1	4.2
Professional association	84	42	12	2	1	4.5	79	25	11	3	1	4.5
Future research opportunities	90	39	9	1	2	4.5	62	36	18	3	1	4.3
Enhance academic qualifications	56	53	25	4	3	4.1	62	34	19	4	1	4.3
Enhance research qualifications	66	56	14	3	2	4.3	73	34	11	1	1	4.5
Overall assessment of SRP	87	49	3	0	2	4.6	63	47	7	2	1	4.4
Number of participants rating the program "all 5s"	31						22					

19. Rank the following:    3 = more than adequate  
                                      2 = adequate  
                                      1 = less than adequate:

RATING FACTOR	SFRP				GSRP			
	3	2	1	Avg	3	2	1	Avg
Travel reimbursement	10 8%	95 77%	19 15%	1.9	20 20%	76 76%	4 4%	2.4
Regular pay	5 4%	83 58%	54 38%	1.6	20 17%	83 70%	15 13%	2.0
Expense allowance	12 9%	105 80%	15 11%	2.0	21 19%	78 70%	13 11%	2.1

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES

##### 1. Participation in Laboratory Activities

RESPONSES	SFRP	GSRP
Meetings and Seminars	25	15
Social Functions	14	9
Related R&D Efforts	12	7
Informal Discussions	10	3
Tours	5	4

##### 2. Improvements in Brochures and Administrative Data

RESPONSES	SFRP	GSRP
Clarify "independent contractor" tax status	4	13
Clarify payment process and reimbursed expenses	0	3
Include local housing information	4	4
Improve payment forms	2	0
Provide comprehensive "final report" guidance	2	1
Send materials to all lab focal points	1	0
Include local hospital/doctor information	1	0
More overall clarity and detail	3	5
Clarify security clearance process	0	1
Define RDL/labs mutual responsibilities	0	2

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 3. Program Strengths

RESPONSES	SFRP	GSRP
Interaction with outstanding lab scientists	59	29
Facilities and equipment	19	17
Valuable future working relationships	13	14
Collaborative efforts	14	2
Professional research environment	8	25
Government laboratory setting	11	16
Research opportunities outside academia	14	12
Contribution to problems of USAF/national interest	25	2
Practical, real-world research projects	12	10
Freedom to perform independent research	10	10
New insights and perspectives	11	6
Practical utilization of research	7	3
New skills learning	8	12
State-of-the-art research	7	3
Career enhancement	3	6
Opportunity for funded follow-on research	22	0
Association with other faculty and students	5	0
Great opportunity for grad student	1	12
Helped with thesis or own research	2	7
Ability to use learning in teaching	6	0
Library resources	6	3
RDL program management	9	1
Good materials and administration	6	1
Refreshing, energizing process	5	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 4. Program Weaknesses

RESPONSES	SFRP	GSRP
Program duration too short	23	24
Insufficient time to get equipment/supplies	4	2
Lack of clerical/research support	5	0
Late acceptance of grad students	1	2
Lack of interaction with focal points	1	6
Inadequate salary	17	3
Inadequate expense allowance	3	6
Inadequate per diem for orientation trip	1	0
Unable to find furnished apartment for 10-week period	9	6
Not finding family housing	8	1
Payment intervals too infrequent	3	11
Taxes not withheld	1	2
Reimbursements late or incorrect	4	5
Weak RDL communication/information	7	6
Minigrant (RIP) funding too low	3	0
Limiting final reports to 20 pages	2	0
Lengthy security clearance process	3	6
No provisions for conference travel	2	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 5. Recommendations for Improvements

###### 5.1 Pre-Summer Activities

RESPONSES	SFRP	GSRP
Improve pre-coordination among lab, RDL, and researchers	4	3
Assure the lab focal point and equipment are ready for researchers	2	3
Provide upfront instructions on goals, tasks, expectations	1	4
Initiate pre-summer contact with focal point	0	5
Fund orientation visit for grad students	1	5
Pre-coordinate housing	8	9
Provide advance housing information for area	4	2
Expand orientation visit to 3 full days at lab	2	0

###### 5.2 Duration of Research

RESPONSES	SFRP	GSRP
Extend research period	3	11
More flexible schedule permitting breaks for conferences, home visits	22	7
Increase time to 2 to 3 years of intermittent work	4	0
Provide minigrants for 2 to 3 years	3	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 5. Recommendations for Improvements (cont)

##### 5.3 Compensation

RESPONSES	SFRP	GSRP
Increase salaries	4	5
Match professorial salaries based on status and experience	12	0
Provide each associate a sum (\$500) for supplies	5	0
Grant mileage allowance for commuters within 50 miles from lab	3	0
Provide more funds for RIPs	3	0
Increase daily allowance	2	4
Include full-time rental car for researchers using air travel	3	0
Provide benefits and relocation costs	1	0

##### 5.4 Payment Policies and Procedures

RESPONSES	SFRP	GSRP
Provide advances on travel pay and first weeks' compensation	4	9
Change participant tax status from independent consultant	2	5
Withhold income tax and FICA	3	6
Provide faster payment turnaround	3	6
Eliminate vouchers; pay by week	1	7
Pay participants on-site	1	2
Issue final payment on receipt of abstract rather than full final report	1	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 5. Recommendations for Improvements (cont)

##### 5.5 Personnel Support and Interactions

RESPONSES	SFRP	GSRP
Include talented undergraduates in SRP	5	0
Provide clerical/research support	5	0
Enable each faculty member to bring one or several trained students	3	0
Provide coordination with other SRP participants at same lab	5	5
Provide organized student activities	0	2
Accept students who will enter graduate school in the fall	2	0

##### 5.6 Administrative/Other

RESPONSES	SFRP	GSRP
Expedite security clearances	2	2
Arrange lab mail stop for all participants	0	2
Expedite administrative paperwork	0	2
Notify accepted graduate students earlier	3	2
Provide information on other local lab programs	2	0
Make final report more flexible, especially 20-page limitation	2	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### B. NARRATIVE RESPONSES (cont)

##### 6. Positive Comments - Examples

###### 1. Faculty

My thanks to AFOSR and to RDL.  
I'm able to bring what I learn back to the classroom.  
Contributed something useful to the Air Force and benefited substantially.  
An excellent program that fully met its objectives.  
Both visiting and resident scientists benefitted tremendously.  
Very productive and enjoyable summer.  
The program is extraordinarily well directed and administered.  
Enhances cooperation between USAF and academia.  
Exceeded my expectations in every respect.  
The program is run very skillfully.  
I thoroughly enjoyed the program and intend to apply next year.  
Absolutely the strongest research experience available to faculty members.  
A great program; I enjoyed the change of pace.  
A worthwhile experience which contributed to my professional development.  
I enjoyed this experience tremendously.

###### 2. Graduate Students

Great learning experience. No need for program improvements.  
Experience gained and contacts with AF were invaluable.  
Great research opportunity with positive professional associations.  
Program was terrific.  
Wonderful learning experience.  
Students are treated better than at universities.  
The program provided a tremendous learning opportunity.  
Invaluable research experience.  
Perfect opportunity to do research not otherwise possible.  
The experience could not have been better.  
The program was excellent. There were no weak points.  
I had never been in such a research-intensive atmosphere.  
It's a fantastic learning experience.  
Excellent. I learned so much.

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### C. SPECIFIC ISSUES BY LABORATORY

1. *Armstrong, Wright-Patterson AFB (AAMRL)*

DESCRIPTION	SFRP	GSRP
Lab unprepared for researchers	0	1
Delays due to equipment conflicts	0	1
Unrealistic scheduling of computer support	1	0

2. *HRL: Logistics & HF, Wright-Patterson AFB (LHFD)*

DESCRIPTION	SFRP	GSRP
Programming language not well documented	0	1

3. *HRL: Manpower, Brooks AFB (MPD)*

None

4. *HRL: Operations Training, Williams AFB (OTD)*

DESCRIPTION	SFRP	GSRP
Equipment not satisfactory (no detail)	0	1

5. *HRL: Training Systems, Brooks AFB (TSD)*

None

6. *OcciEnvironmental Health, Brooks AFB (OEHL)*

DESCRIPTION	SFRP	GSRP
Pre-Coordinate housing	1	0
Limited lab facility space	0	1
Instruments not operational at outset	1	0

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### C. SPECIFIC ISSUES BY LABORATORY (cont)

##### 7. *Aerospace Medicine, Brooks AFB (SAM)*

DESCRIPTION	SFRP	GSRP
Equipment hard to obtain	1	2
Equipment months late	0	1
Lab scientist hesitant to work with students	0	1
Better preparation for arrival of researcher	0	1
No protocol, no subjects, no results	1	0

##### 8. *Wilford Hall, Lackland AFB (WHMC)*

None

##### 9. *Astronautics, Edwards AFB (ASTRO)*

DESCRIPTION	SFRP	GSRP
Housing a problem, motel \$260/week	2	1
Pre-arrange housing at VOQ	0	1
Limited computer workstations	1	0
Focal point unaware of role	1	0
Lab contacts were managerial, not researchers	1	0
Interlibrary loans from Phillips take 6 weeks	1	0

##### 10. *Geophysics, Hanscom AFB (GEO)*

DESCRIPTION	SFRP	GSRP
Driving in Boston difficult	0	1
Need upgrades in computers and network equipment	0	3
Need to allocate equipment before researcher arrival	0	1

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### C. SPECIFIC ISSUES BY LABORATORY (cont)

##### 11. *Weapons, Kirtland AFB (WL)*

DESCRIPTION	SFRP	GSRP
Housing difficult and inadequate	1	0
Hard to obtain equipment	0	1
Computer disc too small; upgrade OS	0	1
Not physically close to focal point	1	0

##### 12. *Engineering & Services, Tyndall AFB (ESC)*

DESCRIPTION	SFRP	GSRP
Need support in obtaining housing	2	0
Bad phone services at VOQ	0	1
Uncertainty of VOQ availability	2	0
Delays in purchasing jeopardized research	2	0
Facilities leak, need repair	1	0

##### 13. *Rome-Griffiss AFB, Griffiss AFB (RADC)*

DESCRIPTION	SFRP	GSRP
Impossible to find family housing	3	1
Expelled from VOQ housing	1	0
Some scientists unfriendly	0	1
Hard to order equipment	0	1
More Sparcstations and Mac IIs	0	1
Work rooms too large and noisy	0	1
Lab people busy with own work	0	1
Work area still in development	1	0

III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

C. SPECIFIC ISSUES BY LABORATORY (cont)

14. *Rome-Hanscom, Hanscom AFB (RADCH)*

DESCRIPTION	SFRP	GSRP
Need a car in Boston	0	1
Could not take family due to housing cost	0	1
Need check cashing facility	1	0

15. *Arnold, Arnold AFB (AEDC)*

DESCRIPTION	SFRP	GSRP
Temporary housing very limited	0	3
VCQ not available	1	0
No check cashing facility	1	0
Lack of local organization for participants	0	1
Research facilities not ready	0	1
More interaction with focal point	1	2
Focal point was an AF contractor employee with little time available	0	1
Lack of communication due to security	0	1
Insufficient access to PCs	1	1
Update library holdings	1	1
No phone, PC or equipment	1	0

16. *FJ Seiler, USAF Academy (FJSRL)*

DESCRIPTION	SFRP	GSRP
Conflicts over computer resources	0	2
Access to CRAY computers unrealized	1	0

III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

C. SPECIFIC ISSUES BY LABORATORY (cont)

17. *Aero Propulsion, Wright-Patterson AFB (PROP)*

DESCRIPTION	SFRP	GSRP
Wright-State dorm housing unacceptable	0	2
Pre-coordinate housing with local hotels	0	1
Computing facilities need improvement	1	1

18. *Armament, Eglin AFB (ATL)*

DESCRIPTION	SFRP	GSRP
VOQ reservations not honored	0	3
Difficult temporary housing	0	4
Mail at VOQ lost	0	2
No housing on base for first 4 weeks	0	1
Hard to find housing allowing pets	1	0
Had to rent unfurnished housing and move furniture	0	1
Insufficient interaction with lab focal point	0	1
Classified work limits availability of staff	1	0
Purchasing supplies during 10 weeks a problem	1	0
Lab overemphasis on short-term results	1	0

19. *Avionics, Wright-Patterson AFB (AVION)*

DESCRIPTION	SFRP	GSRP
Housing needs improvement	0	1
Provide ID badges during orientation visit	1	0
Could use more modern computers	0	1

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### C. SPECIFIC ISSUES BY LABORATORY (cont)

20. *Electronic Technology, Wright-Patterson AFB (ETL)*

None

21. *Flight Dynamics, Wright-Patterson AFB (FDL)*

DESCRIPTION	SFRP	GSRP
Difficulty of 10-week housing	1	0
Could not cash out-of-state checks	0	1
Closer relationship to focal point	0	1

22. *Materials, Wright-Patterson AFB (MAT)*

DESCRIPTION	SFRP	GSRP
Family housing difficult	1	0
Check cashing difficult	1	0
Parts should have been ordered in advance	0	1

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### D. WEEKLY COST FOR LODGING (ROOM, APARTMENT, MOTEL)

(See Notes at End)

Laboratory	Location	SFRP				GSRP			
		No.	High	Low	Avg	No.	High	Low	Avg
Armstrong	W-P AFB, Dayton, OH	9	\$247	\$75	\$128	6	\$254	\$75	\$124
Avionics	"	7	181	70	118	4	150	25	75
Electronic Technology	"	2	150	125	138	1	75	75	75
Flight Dynamics	"	9	479	80	160	4	100	65	81
HRL: Logistics/HF	"	2	250	105	178	1	80	80	80
Materials	"	8	250	94	180	5	87	50	71
Aero Propulsion	"	6	238	70	126	5	140	60	90
Weapons	"	6	173	85	124	7	150	65	100
Number and Weighted Average		49	-	-	\$140	33			\$ 92
Geophysics	Hanscom AFB Boston, MA	5	\$250	\$ 46	\$147	5	\$200	\$ 50	\$119
Rome-Hanscom	"	6	300	67	159	2	100	75	87
Number and Weighted Average		11			\$154	7			\$110
HRL: Manpower	Brooks AFB San Antonio, TX	2	\$100	\$ 74	\$ 87	3	\$ 88	\$ 75	\$ 84
HRL: Training System	"	2	139	115	127	1	90	90	90
HRL: Occ/Env Health	"	3	250	150	193	3	90	56	74
Aerospace Medicine	"	9	210	60	115	9	127	60	79
Wilford Hall	Lackland AFB San Antonio, TX	1	100	100	100	1	100	100	100
Number and Weighted Average		17			\$120	17			\$ 80
Arnold	Arnold AFB Tullahoma, TN	6	\$150	\$ 69	\$129	12	\$150	\$ 30	\$ 90
Astronautics	Edwards AFB Lancaster, CA	9	\$300	\$ 88	\$141	4	\$260	\$125	\$219

### III. 1991 SFRP & GSRP QUESTIONNAIRE RESPONSES (Cont)

#### D. WEEKLY COST FOR LODGING (ROOM, APARTMENT, MOTEL) (cont)

(See Notes at End)

Laboratory	Location	SFRP				GSRP			
		No.	High	Low	Avg	No.	High	Low	Avg
Armament	Eglin AFB Ft. Walton Bch, FL	7	\$275	\$ 56	\$135	7	\$189	\$ 50	\$ 98
Engineering Services	Tyndall AFB Panama City, FL	9	\$187	\$ 65	\$129	2	\$125	\$ 42	\$ 83
Frank J. Seiler	AF Academy Colo Springs, CO	5	\$130	\$ 84	\$112	7	\$100	\$ 50	\$ 90
HRL: Operations Training	Williams AFB Phoenix, AZ	1	\$200	\$200	\$200	2	\$160	\$150	\$155
Rome-Griffiss	Griffiss AFB Rome, NY	6	\$300	\$ 75	\$159	6	\$140	\$ 50	\$ 85
Total Respondents and Weighted Average		120			\$137	97			\$ 97

#### Notes to Table D

For each laboratory, the table shows the number of respondents by SFRP and GSRP, and the high, low, and average of weekly lodging costs. From other information provided, very low weekly rates typically represent housing on base; very high rates are usually hotels. These data by laboratory are aggregated by location, with a weighted average cost for all responding participants at the particular location. An average cost for all SFRP and GSRP respondents is shown in the last row. The data do not distinguish between one-person versus family occupancy. Faculty participants utilized family housing more than graduate students. The average weekly housing costs per location are:

Location	Average Weekly Rent	
	SFRP	GSRP
Williams AFB, Phoenix, AZ	\$200	\$155
Griffiss AFB, Rome, NY	159	85
Hanscom AFB, Boston, MA	154	110
Edwards AFB, Lancaster, CA	141	219(!)
W-P AFB, Dayton, OH	140	92
Eglin AFB, Ft. Walton Beach, FL	135	98
Arnold AFB, Tullahoma, TN	129	90
Tyndall AFB, Panama City, FL	129	83
Brooks/Lackland AFBs, San Antonio, TX	120	80
AF Academy, Colorado Springs, CO	112	90
<b>Total Respondents</b>	<b>\$137</b>	<b>\$ 97</b>

#### IV. 1991 HSAP QUESTIONNAIRE RESPONSES

1. Did Laboratory research match field of interest?

Yes - 91  
No - 33

2. Did you influence research topic?

Yes - 84  
No - 40

3. Was work challenging?

Yes - 112  
No - 12

4. Would you classify work as research?

Yes - 89  
No - 35

5. Satisfied with working relationships?

Yes - 123  
No - 1

6. Facilities/equipment adequate?

Yes - 116  
No - 8

7. Would you apply again next year?

Yes - 115  
No - 9

8. Present an oral report?

Yes - 51  
No - 73

9. Attend technical meetings?

Yes - 25  
No - 87

10. Participate in other lab activities?

Yes - 87  
No - 34

#### IV. 1991 HSAP QUESTIONNAIRE RESPONSES (Cont)

11. Were brochures satisfactory?

Yes - 114  
No - 10

12. Grade the following: 5 = highest; 1 = lowest

CRITERION	RATING					
	5	4	3	2	1	Avg
Technically challenging	51 41%	52 42%	13 10%	5 5%	3 2%	4.2 100%
Increase science and math interest	44 35%	48 39%	23 19%	6 5%	3 2%	4.2 100%
Amount of Pay	40 32%	46 37%	24 19%	8 7%	6 5%	3.9 100%
Enhance academic qualifications	81 65%	26 21%	13 11%	4 3%	0	4.5 100%
Enhance research qualifications	63 51%	33 27%	17 14%	6 5%	5 3%	4.2 100%
Overall program assessment	55 44%	50 41%	16 13%	3 2%	0	4.3 100%

13. **Program Strengths**

Hands-on computer/equipment exposure	43
Work with scientists on real problems	42
Improve work skills	35
Increase interest in future research	30
Cooperation with co-workers	18
Great mentors	9
Challenging work	8
Flexibility/relaxed environment	6
Compensation	6
Able to impact results	4
Good administration	3

#### IV. 1991 HSAP QUESTIONNAIRE RESPONSES (Cont)

##### 14. Program Weaknesses

Mentors ill-prepared, let students drift	25
Payment processing	20
Time span too short	18
No hands-on lab experience	12
Taxes and FICA not withheld	11
Low pay	10
Poor communication with RDL	10
No contact with other apprentices	9
Lack of structure or topic	8
Inability to select research topic	6
Work not matched to interests	6
Boring, repetitive work	6
Facilities/equipment broken or limited	5
Expectations, objectives unclear	4
High, nonreimbursed local transportation costs	3

##### 15. Recommendations for Improvement

Allow choice of projects	16
Increase time period	14
Provide meetings of all apprentices	12
Inform mentors of roles at outset	12
Improve introductory materials from RDL	12
Withhold taxes and FICA	9
Increase compensation	8
Open program to undergraduates	9
Match work to student interests	6
Expedite paychecks	6
Provide mileage allowance to and from lab	5
Improve instructions for final report	3
Encourage students to give briefings	1
Allow classified reports	1

##### 16. Positive Comments - Examples

I learned more in two months than ever before.  
Thanks, RDL, for a great experience.  
Wonderful idea, especially if undergraduates were included.  
This program helped me start my major in computers.  
The absolutely best learning facility I've ever been involved in.  
The program enabled me to narrow down my engineering field.  
Educated me on the many jobs available in the armed services.  
I know more now after 8 weeks than I learned in class in one year.  
The money and experience will take me far in college.  
My mentors, branch chiefs, and co-workers were absolutely wonderful.  
I have found new respect for our government.

## APPENDIX C. LIST OF PARTICIPANTS

### C-1. SFRP

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Raj Acharya Asst Professor Dept of Electrical Engineering SUNY at Buffalo Buffalo, NY 14260	DEGREE: PhD SPECIALTY: Electrical Engineering LAB ASSIGNMENT: AVION
Christopher M. Adams Asst Professor Dept of Chemistry Oklahoma State University Stillwater, OK 74078	DEGREE: PhD SPECIALTY: Organic Chemistry LAB ASSIGNMENT: FJSRL
Murty A. Akundi Chairman Dept of Physics/Engineering Xavier University New Orleans, LA 70125	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: AEDC
Richard A. Anderson Professor Dept of Physics University of Missouri-Rolla Rolla, MO 65401	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: WL
Charlotte G. Andrist Adjunct Professor Dept of Psychology Case Western Reserve University Cleveland, OH 44106	DEGREE: PhD SPECIALTY: Cognitive Psychology LAB ASSIGNMENT: MPD
John K. Antonio Asst Professor Dept of Electrical Engineering Purdue University West Lafayette, IN 47907	DEGREE: PhD SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADC
Vijay K. Arora Professor Dept of Engineering Wilkes University Wilkes-Barre, PA 18766	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: ETL
Addagatla J. G. Sabu Asst Professor Dept of Industrial & Mgt Syst University of South Florida Tampa, FL 33620	DEGREE: PhD SPECIALTY: Operations Research LAB ASSIGNMENT: LHFD
Suzanne C. Baker Asst Professor Dept of Psychology Mercer University Macon, GA 31207	DEGREE: PhD SPECIALTY: Biological Psychology LAB ASSIGNMENT: SAM
William P. Ball Asst Professor Dept of Civ & Env Engineering Duke University Durham, NC 27706	DEGREE: PhD SPECIALTY: Environmental Engineering LAB ASSIGNMENT: ESC

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

David W. Barnett  
Asst Professor  
Dept of Kinesiology  
University Texas Permian Basin  
Odessa, TX 79762

DEGREE: PhD  
SPECIALTY: Physical Sciences  
LAB ASSIGNMENT: SAM

Stanley Bashkin  
Professor  
Dept of Physics  
University of Arizona  
Tucson, AZ 85721

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: OEHL

Frank P. Battles  
Professor  
Dept of Basic Sciences  
Massachusetts Maritime Academy  
Buzzards Bay, MA 02532

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: GEO

Abdul A. Bhatti  
Asst Professor  
Dept of Electrical Engineering  
Memphis State University  
Memphis, TN 38152

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADC

Verne L. Biddle  
Professor  
Dept of Chemistry  
Bob Jones University  
Greenville, SC 29614

DEGREE: PhD  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: OEHL

Ronald J. Bieniek  
Assoc Professor  
Dept of Physics  
University of Missouri-Rolla  
Rolla, MO 65401

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: GEO

Daniel J. Biezad  
Professor  
Dept of Aerospace Engineering  
California Polytechnic State University  
San Luis Obispo, CA 93407

DEGREE: PhD  
SPECIALTY: Aeronautical Engineering  
LAB ASSIGNMENT: FDL

Robert V. Blystone  
Professor  
Dept of Biology  
Trinity University  
San Antonio, TX 78212

DEGREE: PhD  
SPECIALTY: Zoology  
LAB ASSIGNMENT: SAM

James K. Boger  
Asst Professor  
Dept of Laser Opt/Eng Tech  
Oregon Institute of Technology  
Klamath Falls, OR 97601-8801

DEGREE: MS  
SPECIALTY: Physics  
LAB ASSIGNMENT: WL

Gary S. Buckley  
Assoc Professor  
Dept of Physical Science  
Cameron University  
Lawton, OK 73505

DEGREE: PhD  
SPECIALTY: Physical Chemistry  
LAB ASSIGNMENT: FJSRL

Soyoung S. Cha  
Assoc Professor  
Dept of Mechanical Engineering  
University of Illinois  
Chicago, IL 60680

DEGREE: PhD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: FDL

**NAME/ADDRESS**

**DEGREE, SPECIALTY, LAB ASSIGNMENT**

Satish D.V. Chandra  
 Assoc Professor  
 Dept of Electrical Engineering  
 Kansas State University  
 Manhattan, KS 66506

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: AVION

Do Ren Chang  
 Professor  
 Dept of Chemistry & Physics  
 Averett College  
 Danville, AL 24541

DEGREE: PhD  
 SPECIALTY: Chemistry  
 LAB ASSIGNMENT: FJSRL

Ing-Ray Chen  
 Asst Professor  
 Dept of Computer Science  
 University of Mississippi  
 University, MS 38677

DEGREE: PhD  
 SPECIALTY: Computer Science  
 LAB ASSIGNMENT: AVION

Eugene R. Chenette  
 Professor  
 Eglin Graduate Center  
 University of Florida  
 Eglin AFB, FL 32542

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: ATL

David B. Choate  
 Assoc Professor  
 Dept of Mathematics  
 Transylvania University  
 Lexington, KY 40508

DEGREE: PhD  
 SPECIALTY: Mathematics  
 LAB ASSIGNMENT: AVION

Joe G. Chow  
 Asst Professor  
 Dept of Mechanical Engineering  
 Clarkson University  
 Potsdam, NY 13676

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: FDL

Douglas A. Christensen  
 Professor  
 Dept of Electrical Engineering  
 University of Utah  
 Salt Lake City, UT 84112

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: WL

Gerald P. Chubb  
 Asst Professor  
 Dept of Aviation  
 Ohio State University  
 Columbus, OH 43235

DEGREE: PhD  
 SPECIALTY: Industrial Engineering  
 LAB ASSIGNMENT: SAM

Mingking K. Chyu  
 Assoc Professor  
 Dept of Mechanical Engineering  
 Carnegie-Mellon University  
 Pittsburgh, PA 15213-3890

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: PROP

Robert W. Courter  
 Assoc Professor  
 Dept of Mechanical Engineering  
 Louisiana State University  
 Baton Rouge, LA 70803

DEGREE: PhD  
 SPECIALTY: Aerospace Engineering  
 LAB ASSIGNMENT: ATL

Mary Lynne Crittenden  
 Science Specialist/Instructor  
 Dept of Science  
 Highland Park Community College  
 Highland Park, MI 48203

DEGREE: MS  
 SPECIALTY: Physiology  
 LAB ASSIGNMENT: AAMRL

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

**Shashikala T. Das**  
Asst Professor  
Trumbull Campus  
Kent State University  
Warren, OH 44484

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: MAT

**Marat Davidovitz**  
Asst Professor  
Dept of Electrical Engineering  
University of Minnesota  
Minneapolis, MN 55455

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADCH

**Pradip P. Dey**  
Assoc Professor  
Dept of Computer Science  
Hampton University  
Hampton, VA 23668

DEGREE: PhD  
SPECIALTY: Computer Science  
LAB ASSIGNMENT: RADCH

**Suhrit Kumar Dey**  
Professor  
Mathematics Department  
Eastern Illinois University  
Charleston, IL 61920

DEGREE: PhD  
SPECIALTY: Aeronautical Engineering  
LAB ASSIGNMENT: FDL

**Arthur W. Draut**  
Assoc Professor  
Computer Sci/Electrical Engrng  
Embry Riddle Aeronautical University  
Prescott, AZ 86301

DEGREE: PhD  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: OTD

**Joseph H. Dreisbach**  
Professor  
Dept of Chemistry  
University of Scranton  
Scranton, PA 18510-4626

DEGREE: PhD  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: ESC

**Walter Drost-Hansen**  
Professor  
Department of Chemistry  
University of Miami  
Coral Gables, FL 33124

DEGREE: PhD  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: UHMC

**John C. Duncan**  
Instructor  
Dept of Technology  
Kent State University  
Kent, OH 44242

DEGREE: MS  
SPECIALTY: Technology  
LAB ASSIGNMENT: AAMRL

**Lawrence P. Dunleavy**  
Asst Professor  
Dept of Electrical Engineering  
University of South Florida  
Tampa, FL 33620

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADCH

**James R. Dykes Jr.**  
Assoc Professor  
Div of Behavior & Cultural Sci  
University of Texas  
San Antonio, TX 78285-0652

DEGREE: PhD  
SPECIALTY: Experimental Psychology  
LAB ASSIGNMENT: TSD

**David M. Elliott**  
Assoc Professor  
Dept of Engineering  
Arkansas Tech University  
Russellville, AR 72801

DEGREE: PhD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: ASTRO

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Gene H. Evans  
 Assoc Professor  
 Dept of Home Economics  
 Valparaiso University  
 Valparaiso, IN 46383

DEGREE: PhD  
 SPECIALTY: Nutrition  
 LAB ASSIGNMENT: SAM

Joseph B. Evans  
 Asst Professor  
 Dept of Elec & Computer Eng  
 University of Kansas  
 Lawrence, KS 66045-2228

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: RADCH

Juanita M. Firestone  
 Asst Professor  
 Dept of Social & Policy Sci  
 University of Texas  
 San Antonio, TX 78285

DEGREE: PhD  
 SPECIALTY: Sociology  
 LAB ASSIGNMENT: TSD

George T. Flowers  
 Asst Professor  
 Dept of Mechanical Engineering  
 Auburn University  
 Auburn Univ, AL 36849-5341

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: FDL

Albert V. Fratini  
 Professor  
 Dept of Chemistry  
 University of Dayton  
 Dayton, OH 45469-2357

DEGREE: PhD  
 SPECIALTY: Chemistry  
 LAB ASSIGNMENT: MAT

John M. Gahl  
 Asst Professor  
 Dept of Electrical Engineering  
 University of New Mexico  
 Albuquerque, NM 87131

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: WL

Rex E. Gantenbein  
 Asst Professor  
 Dept of Computer Science  
 University of Wyoming  
 Laramie, WY 82070

DEGREE: PhD  
 SPECIALTY: Computer Science  
 LAB ASSIGNMENT: RADC

Ephraim Garcia  
 Asst Professor  
 Dept of Mech & Aero Engineer  
 SUNY at Buffalo  
 Buffalo, NY 14240

DEGREE: PhD  
 SPECIALTY: Aerospace Engineering  
 LAB ASSIGNMENT: ASTRO

Thomas K. Gearhart  
 Assoc Professor  
 Dept of Math & Computer Sci  
 Capital University  
 Columbus, OH 43209

DEGREE: PhD  
 SPECIALTY: Mathematics  
 LAB ASSIGNMENT: AVION

Stanley D. Gedzelman  
 Professor  
 Dept of Earth & Planetary Sci  
 City College of New York  
 New York, NY 10031

DEGREE: PhD  
 SPECIALTY: Meteorology  
 LAB ASSIGNMENT: GEO

Larry E. Gerdom  
 Asst Professor  
 Dept of Physical Science  
 Mobile College  
 Mobile, AL 36613

DEGREE: PhD  
 SPECIALTY: Chemistry  
 LAB ASSIGNMENT: ESC

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Fred J. German Assoc Professor Dept of Electrical Engineering Auburn University Auburn Univ, AL 36849	DEGREE: Phd SPECIALTY: Electrical Engineering LAB ASSIGNMENT: SAM
Walter H. Gerstle Asst Professor Dept of Civil Engineering University of New Mexico Albuquerque, NM 87131	DEGREE: Phd SPECIALTY: Structural Engineering LAB ASSIGNMENT: WL
Hany A. Ghoneim Assoc Professor Dept of Mechanical Engineering Rochester Institute of Technology Rochester, NY 14623	DEGREE: Phd SPECIALTY: Mechanics LAB ASSIGNMENT: ASTRO
Vincent P. Giannamore Asst Professor Dept of Chemistry Xavier University of Louisiana New Orleans, LA 70125	DEGREE: Phd SPECIALTY: Organic Chemistry LAB ASSIGNMENT: ASTRO
Ashok K. Goel Asst Professor Dept of Electrical Engineering Michigan Tech University Houghton, MI 49931	DEGREE: Phd SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADC
Richard D. Gould Asst Professor Dept of Mech & Aero Engineer North Carolina State University Raleigh, NC 27695-7910	DEGREE: Phd SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP
Rakesh Govind Professor Dept of Chemical Engineering University of Cincinnati Cincinnati, OH 45221	DEGREE: Phd SPECIALTY: Chemical Engineering LAB ASSIGNMENT: MAT
Marek Grabowski Assoc Professor Dept of Physics University of Colorado Colorado Springs, CO 80933-1750	DEGREE: Phd SPECIALTY: Physics LAB ASSIGNMENT: FJSRL
Bobby L. Green Asst Professor Dept of Technology Texas Tech University Lubbock, TX 79409-3107	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: ESC
William M. Grissom Instructor Dept of Physics Morehouse College Atlanta, GA 30314	DEGREE: MS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: ASTRO
Manjriker Gunaratne Asst Professor School of Engineering & Tech Tennessee State University Nashville, TN 37209-1561	DEGREE: Phd SPECIALTY: Mathematics LAB ASSIGNMENT: FDL

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Ernest L. Hall Professor Dept of Mech Ind & Nuc Eng University of Cincinnati Cincinnati, OH 45221	DEGREE: PhD SPECIALTY: Electrical Engineering LAB ASSIGNMENT: LHFD
Kirk L. Hamilton Asst Professor Department of Biology Xavier University of Louisiana New Orleans, LA 70125	DEGREE: PhD SPECIALTY: Physiology LAB ASSIGNMENT: SAM
William L. Hamilton Assoc Professor Dept of Geography Salem State University Salem, MA 01970	DEGREE: PhD SPECIALTY: Geography LAB ASSIGNMENT: GEO
Thomas E. Hancock Asst Professor Dept of Educational Psychology Grand Canyon University Phoenix, AZ 85017	DEGREE: PhD SPECIALTY: Educational Psychology LAB ASSIGNMENT: OTD
Harold M. Harris Assoc Professor Dept of Chemistry University of Missouri St. Louis, MO 63141	DEGREE: PhD SPECIALTY: Physical Chemistry LAB ASSIGNMENT: PROP
John M. Harris Assoc Professor Dept of Math & Computer Sci LeMoine-Owen College Memphis, TN 38126	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: TSD
George Harley Hartung Professor Dept of Physiology University of Hawaii Honolulu, HI 96822	DEGREE: PhD SPECIALTY: Physiology LAB ASSIGNMENT: SAM
Paul O'Dell Hedman Professor Dept of Chemical Engineering Brigham Young University Provo, UT 84602	DEGREE: PhD SPECIALTY: Chemical Engineering LAB ASSIGNMENT: PROP
Stephen D. Heister Asst Professor Dept of Aero & Astro Eng Purdue University West Lafayette, IN 47907	DEGREE: PhD SPECIALTY: Aeronautical Engineering LAB ASSIGNMENT: ASTRO
Richard A. Hengst Assoc Professor Dept of Biology Purdue University Westville, TN 46391	DEGREE: PhD SPECIALTY: Physiology LAB ASSIGNMENT: SAM
Richard W. Hoffman Professor Dept of Physics Case Western Reserve University Cleveland, OH 44106	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: ASTRO

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Iris A. Howard  
Asst Professor  
Dept of Physics  
University of Texas Arlington  
Arlington, TX 76019

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: ASTRO

Manuel A. Huerta  
Professor  
Dept of Physics  
University of Miami  
Coral Gables, FL 33124

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: ATL

David Hui  
Assoc Professor  
Dept of Mechanical Engineering  
University of New Orleans  
New Orleans, LA 70148

DEGREE: PhD  
SPECIALTY: Aeronautical Engineering  
LAB ASSIGNMENT: FDL

Ashok Iyer  
Assoc Professor  
Dept of Electrical Engineering  
University of Nevada  
Las Vegas, NV 89154

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: ASTRO

Laurence J. Jacobs  
Asst Professor  
Dept of Science and Math  
Georgia Institute of Technology  
Atlanta, GA 30332

DEGREE: PhD  
SPECIALTY: Engineering Mechanics  
LAB ASSIGNMENT: AEDC

Jerald A. Kabell  
Assoc Professor  
Dept of Computer Science  
Michigan Technological University  
Houghton, MI 49931

DEGREE: PhD  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: WL

Arkady Kheifets  
Asst Professor  
Dept of Mathematics  
North Carolina State University  
Raleigh, NC 27695-8205

DEGREE: PhD  
SPECIALTY: Theoretical Physics  
LAB ASSIGNMENT: GEO

Michael M. Khonsari  
Assoc Professor  
Dept of Mechanical Engineering  
University of Pittsburgh  
Pittsburgh, PA 15261

DEGREE: PhD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: PROP

Charles J. Kibert  
Assoc Professor  
Dept of Mechanical Engineering  
University of Florida  
Gainesville, FL 32611

DEGREE: PhD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: AAMRL

Douglas G. Klarup  
Asst Professor  
Dept of Chemistry  
University of Montana  
Missoula, MT 59812

DEGREE: PhD  
SPECIALTY: Physical Chemistry  
LAB ASSIGNMENT: ESC

Arthur J. Koblasz  
Assoc Professor  
Dept of Engineering Science  
Georgia Institute of Technology  
Atlanta, GA 30332

DEGREE: PhD  
SPECIALTY: Bioengineering  
LAB ASSIGNMENT: SAM

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Philipp G. Kornreich  
Professor  
Dept of Electrical Engineering  
Syracuse University  
Syracuse, NY 13244

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADC

Spencer S. Kuo  
Professor  
Dept of Electrical Engineering  
Polytechnic University  
Teaneck, NJ 11735

DEGREE: PhD  
SPECIALTY: Electrophysics  
LAB ASSIGNMENT: GEO

Peter W. Langhoff  
Professor  
Dept of Chemistry  
Indiana University  
Bloomington, IN 47405

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: ASTRO

Byung-Lip Lee  
Assoc Professor  
Dept of Eng Sci & Mechanics  
Pennsylvania State University  
University Park, PA 16802

DEGREE: PhD  
SPECIALTY: Materials Science  
LAB ASSIGNMENT: FDL

Jay Kyoan Lee  
Asst Professor  
Dept of Elec & Computer Eng  
Syracuse University  
Syracuse, NY 13244-1240

DEGREE: PhD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADC

Tzesan D. Lee  
Assoc Professor  
Argonne National Laboratory  
Western Illinois University  
Argonne, IL 60439

DEGREE: PhD  
SPECIALTY: Numerical Analysis  
LAB ASSIGNMENT: AAMRL

Wallace Brooks Leigh  
Asst Professor  
Dept of Electrical Engineering  
Alfred University  
Alfred, NY 14802

DEGREE: PhD  
SPECIALTY: Materials Science  
LAB ASSIGNMENT: RADC

Elizabeth D. Liddy  
Asst Professor  
School of Information Studies  
Syracuse University  
Syracuse, NY 13244-4100

DEGREE: PhD  
SPECIALTY: Information Transfer  
LAB ASSIGNMENT: RADC

Cheng Liu  
Professor  
Dept of Engineering Technology  
University of North Carolina-Charlotte  
Charlotte, NC 28223

DEGREE: MS  
SPECIALTY: Chemical Engineering  
LAB ASSIGNMENT: ESC

Paul K. Maciejewski  
Asst Professor  
Dept of Mechanical Engineering  
University of Pittsburgh  
Pittsburg, PA 15261

DEGREE: PhD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: PROP

Antonio A. Magliaro  
Assoc Professor  
Dept of Mathematics  
South Connecticut State University  
New Haven, CT 06515

DEGREE: PhD  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: ATL

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Robert G. Main Professor Dept of Communication Design California State University Chico, CA 95929-0504	DEGREE: PhD SPECIALTY: Educational Technology LAB ASSIGNMENT: MPD
Gilbert J. Mains Professor Dept of Chemistry Oklahoma State University Stillwater, OK 74078	DEGREE: PhD SPECIALTY: Physical Chemistry LAB ASSIGNMENT: FJSRL
Robert C. Mania Jr. Asst Professor Dept of Mathematics & Science Kentucky State University Frankfort, KY 40601	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: OEHL
Arvind S. Marathay Professor Dept of Optical Sciences University of Arizona Tucson, AZ 85721	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: GEO
S. Douglas Marcum Assoc Professor Dept of Physics Miami University Oxford, OH 45056	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: PROP
Charlesworth R. Martin Assoc Professor Dept of Electrical Engineering Norfolk State University Norfolk, VA 23504	DEGREE: PhD SPECIALTY: Civil Engineering LAB ASSIGNMENT: ATL
Michael D. Matthews Assoc Professor Dept of Behavioral Science Drury College Springfield, MO 65802	DEGREE: PhD SPECIALTY: Psychology LAB ASSIGNMENT: MPD
Vernon C. Matzen Assoc Professor Dept of Civil Engineering North Carolina State University Raleigh, NC 27695-7908	DEGREE: PhD SPECIALTY: Structures LAB ASSIGNMENT: FDL
Steven M. McKay Asst Professor Dept of Applied Mathematics University of Houston Houston, TX 77002	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: AEDC
Richard E. Miers Assoc Professor Dept of Physics Indiana University-Purdue University Fort Wayne, IN 46805	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: AVION
Warren J. Moberly Asst Professor Dept of Materials & Science Stevens Institute of Technology Hoboken, NJ 07030	DEGREE: PhD SPECIALTY: Materials Science LAB ASSIGNMENT: MAT

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Carlyle E. Moore  
Assoc Professor  
Physics Department  
Morehouse College  
Atlanta, GA 30030

DEGREE: PHD  
SPECIALTY: Physics  
LAB ASSIGNMENT: AEDC

Benjamin E. Mulligan  
Professor  
Dept of Psychology  
University of Georgia  
Athens, GA 30602

DEGREE: PHD  
SPECIALTY: Psychology  
LAB ASSIGNMENT: OTD

Edgar G. Munday  
Asst Professor  
Dept of Mechanical Engineering  
University of North Carolina-Charlotte  
Charlotte, NC 28223

DEGREE: PHD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: AAMRL

Arnold G. Nelson  
Asst Professor  
Dept of Kinesiology  
Louisiana State University  
Baton Rouge, LA 70810

DEGREE: PHD  
SPECIALTY: Muscle Physiology  
LAB ASSIGNMENT: SAM

Byron P. Newberry  
Asst Professor  
Dept of Aerospace Engineering  
University of Cincinnati  
Cincinnati, OH 45221-0070

DEGREE: PHD  
SPECIALTY: Engineering Mechanics  
LAB ASSIGNMENT: MAT

Michael Sanford Nilan  
Assoc Professor  
School of Information Studies  
Syracuse University  
Syracuse, NY 13244-4100

DEGREE: PHD  
SPECIALTY: Computer Science  
LAB ASSIGNMENT: RADC

Olin Perry Norton  
Research Engineer  
Diag Instru & Analysis Lab  
Mississippi State University  
Mississippi, MS 39762

DEGREE: PHD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: AEDC

Joseph H. Nurre  
Asst Professor  
Dept of Electrical Engineering  
Ohio University  
Athens, Oh 45701

DEGREE: PHD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: MAT

Paul David Orkwis  
Asst Professor  
Dept of Aerospace Engineering  
University of Cincinnati  
Cincinnati, OH 45221-0070

DEGREE: PHD  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: ATL

Ronnie E. Owens  
Asst Professor  
Dept of Elec & Computer Eng  
Clemson University  
Clemson, SC 29634-0915

DEGREE: PHD  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADCH

Amit L. Patra  
Assoc Professor  
Dept of General Engineering  
University of Puerto Rico  
Mayaguez, PR 00709

DEGREE: PHD  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: AAMRL

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Jim Harold Patton  
 Assoc Professor  
 Dept of Psychology  
 Baylor University  
 Waco, TX 76798-7334

DEGREE: PhD  
 SPECIALTY: Experimental Psychology  
 LAB ASSIGNMENT: MPD

Richard Alan Peters II  
 Asst Professor  
 Dept of Electrical Engineering  
 Vanderbilt University  
 Nashville, TN 37235

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: AEDC

Gerald W Pitts  
 Professor  
 Dept of Computer Science  
 Trinity University  
 San Antonio, TX 78212

DEGREE: PhD  
 SPECIALTY: Computer Science  
 LAB ASSIGNMENT: TSD

Steven K. Pollack  
 Asst Professor  
 Dept of Materials Sci and Eng  
 University of Cincinnati  
 Cincinnati, OH 45221-0012

DEGREE: PhD  
 SPECIALTY: Organic Chemistry  
 LAB ASSIGNMENT: MAT

Glenn E. Prescott  
 Assoc Professor  
 Dept of Electrical Engineering  
 University of Kansas  
 Lawrence, KS 66045

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: AVION

Keith F. Priestley  
 Professor  
 Dept of Geological Science  
 University of Nevada  
 Reno, NV 89557

DEGREE: PhD  
 SPECIALTY: Geophysics  
 LAB ASSIGNMENT: GEO

Salahuddin Gazi  
 Assoc Professor  
 Dept of Elec Eng Technology  
 SUNY Institute of Technology  
 Utica, NY 13509

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: RADC

Carey M. Rappaport  
 Asst Professor  
 Dept of Elec/Comp Engineering  
 Northeastern University  
 Boston, MA 02115

DEGREE: PhD  
 SPECIALTY: Mathematics  
 LAB ASSIGNMENT: RADCH

Jerry L. Rawson  
 Asst Professor  
 Dept of Electrical Engineering  
 North Dakota State University  
 Fargo, ND 58105

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: FDL

Joseph J. Rencis  
 Assoc Professor  
 Dept of Mechanical Engineering  
 Worcester Polytechnic Institute  
 Worcester, MA 01609

DEGREE: PhD  
 SPECIALTY: Engineering Mechanics  
 LAB ASSIGNMENT: GEO

Gary E. Riccio  
 Asst Professor  
 Dept of Kinesiology  
 University of Illinois at Urbana-Champaign  
 Urbana, IL 61801

DEGREE: PhD  
 SPECIALTY: Psychology  
 LAB ASSIGNMENT: AAMRL

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Donald Kermie Robinson  
 Assoc Professor  
 Dept of Chemistry  
 Xavier University  
 New Orleans, LA 70125

DEGREE: PhD  
 SPECIALTY: Chemistry  
 LAB ASSIGNMENT: SAM

Christopher A. Rotz  
 Assoc Professor  
 Dept of Mfg Eng & Technology  
 Brigham Young University  
 Provo, UT 84602

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: ASTRO

Martin Schwartz  
 Professor  
 Dept of Chemistry  
 University of North Texas  
 Denton, TX 76203

DEGREE: PhD  
 SPECIALTY: Chemistry  
 LAB ASSIGNMENT: MAT

David M. Senseman  
 Assoc Professor  
 Division of Life Sciences  
 University of Texas  
 San Antonio, TX 78250

DEGREE: PhD  
 SPECIALTY: Biology  
 LAB ASSIGNMENT: SAM

Edward J. Seykora  
 Professor  
 Dept of Physics  
 East Carolina University  
 Greenville, NC 27858-4353

DEGREE: PhD  
 SPECIALTY: Physics  
 LAB ASSIGNMENT: GEO

Jeff S. Shama  
 Asst Professor  
 Dept of Electrical Engineering  
 University of Minnesota  
 Minneapolis, MN 55455

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: ATL

Brian J. Shelburne  
 Assoc Professor  
 Dept of Math & Computer Sci  
 Wittenberg University  
 Springfield, OH 45501

DEGREE: PhD  
 SPECIALTY: Mathematics  
 LAB ASSIGNMENT: AVION

Tie-Mo Shih  
 Assoc Professor  
 Dept of Mechanical Engineering  
 University of Maryland  
 College Park, MD 20742

DEGREE: PhD  
 SPECIALTY: Mechanical Engineering  
 LAB ASSIGNMENT: PROP

Jon H. Shively  
 Professor  
 School of Eng & Computer Sci  
 California State University-Northridge  
 Northridge, CA 91330

DEGREE: PhD  
 SPECIALTY: Metallurgy  
 LAB ASSIGNMENT: WL

Sahjendra N. Singh  
 Professor  
 Dept of Elec Eng & Comp Eng  
 University of Nevada  
 Las Vegas, NV 89154

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: ASTRO

Dean L. Smith  
 Assoc Professor  
 Dept of Electrical Engineering  
 Memphis State University  
 Memphis, TN 38152

DEGREE: PhD  
 SPECIALTY: Electrical Engineering  
 LAB ASSIGNMENT: AEDC

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Gerald A. Smith Professor Dept of Physics Pennsylvania State University University Park, PA 16802	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: WL
Wayne D. Smith Assoc Professor Dept of Computer Science Mississippi State University Mississippi State, MS 39762	DEGREE: PhD SPECIALTY: Computer Science LAB ASSIGNMENT: RADC
Benjamin R. Stephens Assoc Professor Dept of Psychology Clemson University Clemson, SC 29634-1511	DEGREE: PhD SPECIALTY: Psychology LAB ASSIGNMENT: AAMRL
David J. Stevens Asst Professor Dept of Civil Engineering Clarkson University Potsdam, NY 13676	DEGREE: PhD SPECIALTY: Civil Engineering LAB ASSIGNMENT: WL
Thomas A. Sudkamp Visiting Scholar Computer Science Division University of California Berkeley, CA 94720	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: AVION
Richard D. Swope Professor Dept of Engineering Science Trinity University San Antonio, TX 78212	DEGREE: PhD SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: SAM
Michael Sydor Professor Dept of Physics University of Minnesota-Duluth Duluth, MN 55812	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: MAT
Kaveh A. Tagavi Assoc Professor Dept of Engineering University of Kentucky Lexington, KY 40506-0046	DEGREE: PhD SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP
Richard S. Tankin Professor Dept of Mechanical Engineering Northwestern University Evanston, IL 60208	DEGREE: PhD SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP
Michael D. Taylor Assoc Professor Dept of Mathematics University of Central Florida Orlando, FL 32816	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: RADC
Teresa A. Taylor Asst Professor Dept of Civil Engineering Virginia Polytechnic Institute Blacksburg, VA 24061	DEGREE: PhD SPECIALTY: Civil Engineering LAB ASSIGNMENT: ESC

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Kenneth J. Teegarden Professor Dept of Optics University of Rochester Rochester, NY 14627	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: RADC
Jeffrey D. Tew Asst Professor Dept of Industrial Engineering Virginia Polytechnic Institute Blacksburg, VA 24061-0118	DEGREE: PhD SPECIALTY: Industrial Engineering LAB ASSIGNMENT: RADC
Richard H. Tipping Professor Dept of Physics University of Alabama Tuscaloosa, AL 35487	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: GEO
Ram C. Tripathi Professor Dept of Math/Comp Sci & Stat University of Texas San Antonio, TX 78285-0664	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: SAM
Steven A. Tregdon Assoc Professor Dept of Math & Statistics University of Minnesota Duluth, MN 55812	DEGREE: PhD SPECIALTY: Mathematics LAB ASSIGNMENT: ATL
John J. Uhlark Professor Dept of Psychology Kansas State University Manhattan, Ks 66506-5302	DEGREE: PhD SPECIALTY: Experimental Psychology LAB ASSIGNMENT: AAMRL
Brian S. Vogt Professor Dept of Chemistry Bob Jones University Greenville, SC 29614	DEGREE: PhD SPECIALTY: Chemistry LAB ASSIGNMENT: ESC
Fred V. Wells Assoc Professor Dept of Chemistry Idaho State University Pocatello, ID 83209	DEGREE: PhD SPECIALTY: Physical Chemistry LAB ASSIGNMENT: PROP
Philip D. Whitefield Assoc Professor Dept of Chemistry University of Missouri Rolla, MO 65401	DEGREE: PhD SPECIALTY: Physics LAB ASSIGNMENT: WL
D. Mitchell Wilkes Asst Professor Dept of Electrical Engineering Vanderbilt University Nashville, TN 37235	DEGREE: PhD SPECIALTY: Electrical Engineering LAB ASSIGNMENT: AEDIC
Jonathan B. Wolfrum Asst Professor Dept of Mechanical Engineering University of California-Irvine Irvine, CA 92717	DEGREE: PhD SPECIALTY: Materials Science LAB ASSIGNMENT: MAT

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

James S. Wolper  
Visiting Professor  
Dept of Mathematics  
University of Western Canada  
London, Ont, CA N6A 5B7

DEGREE: PhD  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: AVION

In-Soon You  
Assoc Professor  
Dept of Biology  
California State University-Fresno  
Fresno, CA 93710

DEGREE: PhD  
SPECIALTY: Microbiology  
LAB ASSIGNMENT: ESC

Fuh-Gwo Yuan  
Asst Professor  
Dept of Mechanical & Aero Eng  
North Carolina State University  
Raleigh, NC 27694-7910

DEGREE: PhD  
SPECIALTY: Composites  
LAB ASSIGNMENT: MAT

Raymond Zanoni  
Asst Professor  
Dept of Electrical Engineering  
Oklahoma State University  
Stillwater, OK 74078

DEGREE: PhD  
SPECIALTY: Physics  
LAB ASSIGNMENT: ETL

Lawrence D. Zavodney  
Asst Professor  
Dept of Mechanical Engineering  
Ohio State University  
Columbus, OH 43210

DEGREE: PhD  
SPECIALTY: Engineering Mechanics  
LAB ASSIGNMENT: FDL

Wayne J. Zimmermann  
Assoc Professor  
Dept of Mathematics  
Texas Woman's University  
Denton, TX 76204

DEGREE: PhD  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: ATL

## APPENDIX C. LIST OF PARTICIPANTS (CONT)

### C-2. GSRP

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
James E. Abbey Georgia Institute of Tech Dept of Civil Engineering Atlanta, GA 30332	DEGREE: BS SPECIALTY: Engineering Mechanics LAB ASSIGNMENT: AEDC
Ben A. Abbott Vanderbilt University Dept of Electrical Engineering Nashville, TN 37212	DEGREE: MS SPECIALTY: Computer Engineering LAB ASSIGNMENT: AEDC
George B. Aboutanos Vanderbilt University Dept of Electrical Engineering Nashville, TN 37235	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: AEDC
Gregory A. Addington University of Colorado Dept of Aerospace Engineering Science Boulder, CO 80309	DEGREE: BS SPECIALTY: Fluid Dynamics LAB ASSIGNMENT: FJSRL
Stephen T. Ameling Kent State University School of Technology Kent, OH 44242	DEGREE: BS SPECIALTY: Technology LAB ASSIGNMENT: AAMRL
James M. Argento SUNY at Buffalo Dept of Mechanical & Aerospace Engineering Williamsville, NY 14221	DEGREE: BS SPECIALTY: Structural Dynamics LAB ASSIGNMENT: ASTRO
W. B. Ball Vanderbilt University Dept of Electrical Engineering Nashville, TN 37212	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: AEDC
Theodore A. Bapty Vanderbilt University Dept of Electrical Engineering Nashville, TN 37212	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: AEDC
Wenoy L. Barkman University of Kentucky Dept of Mathematics Lexington, KY 40506	DEGREE: MS SPECIALTY: Operations Research LAB ASSIGNMENT: AVION
Clinton D. Benefield University of Tennessee Dept of Physics Tullahoma, TN 37388-8897	DEGREE: BA SPECIALTY: Physics LAB ASSIGNMENT: AEDC
David J. Bizzak Carnegie Mellon University Dept of Mechanical Engineering Pittsburgh, PA 15213	DEGREE: MS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Eusong Blacketer Wright State University Dept of Psychology Dayton, OH 45435	DEGREE: BA SPECIALTY: Psychology LAB ASSIGNMENT: LHFD
George C. Boynton University of Miami Dept of Physics Coral Gables, FL 33124	DEGREE: MS SPECIALTY: Physics LAB ASSIGNMENT: ATL
Mary D. Brady Baylor University Dept of Psychology Waco, TX 76798	DEGREE: BS SPECIALTY: Psychology LAB ASSIGNMENT: MPD
Peter W. Brown Ohio State University Dept of Material Science & Engineering Columbus, OH 43210	DEGREE: BS SPECIALTY: Metallurgical Engineering LAB ASSIGNMENT: MAT
Becky L. Buckley University of Texas Dept of Science San Antonio, TX 78285-0662	DEGREE: BS SPECIALTY: Neuroscience LAB ASSIGNMENT: SAM
Robert L. Caldwell, Jr. University of Texas Dept of Social & Policy Sciences Helotes, TX 78023	DEGREE: BA SPECIALTY: Political Science LAB ASSIGNMENT: TSD
Cristina A. Cardoso Jackson State University Dept of Biology Jackson, MS 39217	DEGREE: BS SPECIALTY: Biology LAB ASSIGNMENT: OEHL
Robert A. Carlin SUNY at Buffalo Dept of Mechanical & Aerospace Engineering Buffalo, NY 14260	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: ASTRO
Richard C. Castillo University of New Mexico Dept of Engineering Belen, NM 87002	DEGREE: BS SPECIALTY: Structural Engineering LAB ASSIGNMENT: WL
Kuang Z. Cheng University of Southern Calif Dept of Electrical Engineering Los Angeles, CA 90089	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADCH
Christopher J. Coliamb Trinity University Dept of Biology San Antonio, TX 78212	DEGREE: BS SPECIALTY: Marine Biology LAB ASSIGNMENT: SAM
Craig G. Crandall Texas Coll of Osteopathic Med Dept of Physiology Fort Worth, TX 76106	DEGREE: MS SPECIALTY: Physiology LAB ASSIGNMENT: SAM
John F. Crawford, Jr. University of New Mexico Dept of Electrical Engineering Albuquerque, NM 87131	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: WL

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Jeffrey D. Curtis  
SUNY at Buffalo  
Dept of Mechanical & Aerospace Engineering  
Buffalo, NY 14214

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: FJSRL

Marco D. D'Amore  
SUNY at Buffalo  
Dept of Mechanical & Aerospace Engineering  
Buffalo, NY 14260

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: ASTRO

Robert E. Davies  
Utah State University  
Dept of Physics  
Logan, UT 84322-4415

DEGREE: BS  
SPECIALTY: Space Physics  
LAB ASSIGNMENT: WL

Guy A. DeRose  
Case Western Reserve Univ  
Dept of Physics  
Cleveland, OH 44106

DEGREE: MS  
SPECIALTY: Physics  
LAB ASSIGNMENT: ASTRO

John V. Dempsey, Jr.  
University of Tennessee  
Dept of Aerospace Engineering  
Tullahoma, TN 37388-8897

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: AEDC

Michael P. W. Donnelly  
Washington State University  
Dept of Psychology  
Pullman, WA 99163

DEGREE: BA  
SPECIALTY: Experimental Psychology  
LAB ASSIGNMENT: SAM

Nathan A. Dowden  
Colorado State University  
Dept of Civil Engineering  
Fort Collins, CO 80524

DEGREE: BS  
SPECIALTY: Geotechnical Engineering  
LAB ASSIGNMENT: WL

David E. Drake  
Wright State University  
Dept of Chemistry  
Dayton, OH 45435

DEGREE: BS  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: MAT

Itiel E. Dror  
Harvard University  
Dept of Psychology  
Cambridge, MA 02138

DEGREE: MA  
SPECIALTY: Psychology  
LAB ASSIGNMENT: OTD

Thomas W. Drueding  
Boston University  
College of Engineering  
Allston, MA 02134

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: GEO

James R. Engholm  
University of Minnesota  
Dept of Physics  
Duluth, MN 55812

DEGREE: BS  
SPECIALTY: Physics  
LAB ASSIGNMENT: MAT

Kimberly A. Engle  
Pennsylvania State University  
Dept of Astronomy & Astrophysics  
University Park, PA 16802

DEGREE: BS  
SPECIALTY: Astronomy  
LAB ASSIGNMENT: GEO

Dillard D. Ensley  
Auburn University  
Dept of Electrical Engineering  
Auburn, AL 36849-5201

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: AVION

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Paul S. Erdman University of Iowa Dept of Physics Iowa City, IA 52242	DEGREE: MS SPECIALTY: Physics LAB ASSIGNMENT: ASTRO
Christina E. Estep Virginia Polytechnic Institute Dept of Engineering Mechanics Blacksburg, VA 24060	DEGREE: BS SPECIALTY: Biomedical Engineering LAB ASSIGNMENT: AAMRL
Dion D. Farrell Meharry Medical College Dept of Biology Nashville, TN 37208	DEGREE: BS SPECIALTY: Biology LAB ASSIGNMENT: OEHL
Laurence M. Flath University of Arizona Optical Sciences Center Tucson, AZ 85721	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: ATL
Scott P. Francis University of Kansas Dept of Electrical Engineering Lawrence, KS 66045	DEGREE: MS SPECIALTY: Communications LAB ASSIGNMENT: AVION
Shawn J. Gaffney University of Notre Dame Dept of Electrical Engineering Notre Dame, IN 46617	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: WL
Mark J. Gavora Florida State University Dept of Educational Research Tallahassee, FL 32313	DEGREE: BA SPECIALTY: Psychology LAB ASSIGNMENT: TSD
Griffin K. Gothard Auburn University Dept of Electrical Engineering Auburn, AL 36849	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: SAM
Lawrence R. Gottlob Arizona State University Dept of Psychology Tempe, AZ 85287	DEGREE: BS SPECIALTY: Experimental Psychology LAB ASSIGNMENT: OTD
Randy L. Gove University of Alabama Dept of Physics Huntsville, AL 35899	DEGREE: BS SPECIALTY: Physics LAB ASSIGNMENT: ATL
Michael C. Governale Utah State University Dept of Physics Logan, UT 84322-4415	DEGREE: BS SPECIALTY: Physics LAB ASSIGNMENT: WL
Tami A. Hamernik SUNY at Buffalo Dept of Mechanical & Aerospace Engineering Buffalo, NY 14214	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: FJSRL
Steven W. Hancock Utah State University Dept of Instructional Technology Logan, UT 84322-2830	DEGREE: BA SPECIALTY: Instructional Design LAB ASSIGNMENT: MPD

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Steven L. Hatfield  
University of Kentucky  
Dept of Materials Science Engineering  
Lexington, KY 40504

DEGREE: BS  
SPECIALTY: Materials Science & Eng  
LAB ASSIGNMENT: ATL

Dollena S. Hawkins  
Tennessee Technology Univ  
Dept of Mathematics  
Cookeville, TN 38501

DEGREE: BS  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: AEDC

Christopher M. Hearon  
Louisiana State University  
Dept of Kinesiology  
Baton Rouge, LA 70803

DEGREE: MS  
SPECIALTY: Exercise Physiology  
LAB ASSIGNMENT: SAM

Amie L. Hedley-Goode  
Texas A&M University  
Dept of Psychology  
College Station, TX 77843-4235

DEGREE: MS  
SPECIALTY: Psychology  
LAB ASSIGNMENT: MPD

David J. Hess  
University of Texas  
Dept of Psychology  
Austin, TX 78712

DEGREE: BA  
SPECIALTY: Psychology  
LAB ASSIGNMENT: MPD

Charles R. Hewitt, Jr.  
Georgia Inst of Technology  
Dept of Mechanical Engineering  
Atlanta, GA 30332-0405

DEGREE: MS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: AEDC

Pat K. Hippo  
Pennsylvania State University  
Dept of Engineering Science & Mechanics  
University Park, PA 16802

DEGREE: BS  
SPECIALTY: Ceramic Science & Eng  
LAB ASSIGNMENT: FDL

Benjamin W. Hoe  
Polytechnic University  
Dept of Electrical Engineering  
Brooklyn, NY 11201

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADC

Stephen D. Howard  
University of Tennessee  
Dept of Mechanical & Aerospace Engineering  
Tullahoma, TN 37388-8897

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: AEDC

Dora Y. Hsieh  
Trinity University  
Dept of Engineering Science  
San Antonio, TX 78212

DEGREE: BS  
SPECIALTY: Engineering Science  
LAB ASSIGNMENT: SAM

Christopher P. Hussell  
University of Florida  
Dept of Electrical Engineering  
Gainesville, FL 32611

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: ATL

Kurt M. Joseph  
Kansas State University  
Dept of Psychology  
Manhattan, KS 66506

DEGREE: BS  
SPECIALTY: Industrial Psychology  
LAB ASSIGNMENT: AAMRL

Emily G. Joy  
Mercer University  
Dept of Mechanical & Aerospace Engineering  
Macon, GA 31207

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: AEDC

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Karl E. Kauffmann Carnegie-Mellon University Dept of Chemistry Pittsburgh, PA 15213	DEGREE: BS SPECIALTY: Chemistry LAB ASSIGNMENT: FJSRL
Timothy S. Keen University of Florida School of Building Construction Gainesville, FL 32611	DEGREE: BS SPECIALTY: Business Administration LAB ASSIGNMENT: AAMRL
Yolanda J. Kime Syracuse University Dept of Physics Syracuse, NY 13244-1130	DEGREE: MS SPECIALTY: Physics LAB ASSIGNMENT: RADC
John D. Klinge University of Colorado Dept of Aerospace Engineering Boulder, CO 80309	DEGREE: BS SPECIALTY: Physics LAB ASSIGNMENT: FJSRL
James K. Koga University of Texas Institute for Fusion Studies Austin, TX 78712	DEGREE: MA SPECIALTY: Plasma Physics LAB ASSIGNMENT: WL
Thomas A. Kuchar Boston University Dept of Astronomy Boston, MA 02215	DEGREE: MA SPECIALTY: Astrophysics LAB ASSIGNMENT: GEO
John T. Lair University of New Orleans Dept of Engineering Bridge City, LA 70096	DEGREE: BS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: FDL
Steven M. Lardizabal University of South Florida Dept of Electrical Engineering Tampa, FL 33620	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADCH
Matthew M. Leipnitz Michigan Technological Univ Dept of Electrical Engineering Houghton, MI 49931	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADC
Jules W. Lindau Virginia Polytechnic Institute Dept of Mechanical Engineering Blacksburg, VA 24061	DEGREE: MS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: AEDC
Patricia M. Liu Stanford University Dept of Material Science & Engineering Stanford, CA 94305	DEGREE: BS SPECIALTY: Science & Engineering LAB ASSIGNMENT: ASTRO
Darron D. Lockett Clark Atlanta University Dept of Physics East Point, GA 30344	DEGREE: BA SPECIALTY: Physics LAB ASSIGNMENT: AVION
Beth L. Losiewicz University of Texas Dept of Experimental Psychology Austin, TX 78712	DEGREE: MS SPECIALTY: Experimental Psychology LAB ASSIGNMENT: RADC

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Julie A. Lovato  
Washington State University  
Dept of Mechanical & Material Engineering  
Pullman, WA 99164-2920

DEGREE: MS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: FJSRL

Thomas A. Lusby  
Johns Hopkins University  
Dept of Materials Science & Engineering  
Baltimore, MD 21218

DEGREE: BS  
SPECIALTY: Physics  
LAB ASSIGNMENT: RADCH

Annette M. Marsh  
University of Florida  
Dept of Materials Science & Engineering  
Gainesville, FL 32611-3501

DEGREE: BS  
SPECIALTY: Materials Science & Eng  
LAB ASSIGNMENT: ATL

Bryan T. Martin  
University of Kentucky  
Dept of Mechanical Engineering  
Lexington, KY 40517

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: PROP

Rodney C. Mason  
Tuskegee University  
Dept of Chemistry  
Tuskegee, AL 36088

DEGREE: BS  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: ASTRO

Jessica L. Mayes  
University of Kentucky  
Dept of Materials Science & Engineering  
Lexington, KY 40503-4203

DEGREE: BS  
SPECIALTY: Materials Science  
LAB ASSIGNMENT: ATL

John E. McCord  
Emory University  
Dept of Chemistry  
Atlanta, GA 30322

DEGREE: MS  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: WL

Richard R. McNeer  
University of Miami  
Dept of Chemistry  
Coral Gables, FL 33124

DEGREE: BS  
SPECIALTY: Biochemistry  
LAB ASSIGNMENT: WHMC

Sarah E. Miller  
Trinity University  
Dept of Biology  
San Antonio, TX 78212

DEGREE: MS  
SPECIALTY: Physiology  
LAB ASSIGNMENT: SAM

John A. Mitchell  
Virginia Polytechnic Institute  
Dept of Engineering Science & Mechanics  
Blacksburg, VA 24060

DEGREE: BS  
SPECIALTY: Ocean Engineering  
LAB ASSIGNMENT: FDL

Douglas C. Moore  
University of Cincinnati  
Dept of Electrical Computer Engineering  
Cincinnati, OH 45221

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: MAT

Michael S. Moore  
Vanderbilt University  
Dept of Electrical Engineering  
Nashville, TN 37235

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: AEDC

Russell A. Morris  
Virginia Polytechnic Institute  
Dept of Engineering Mechanics  
Blacksburg, VA 24060

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: FDL

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

David W. Moss  
Wilkes University  
Dept of Physics  
Wilkes-Barre, PA 18766

DEGREE: BS  
SPECIALTY: Physics  
LAB ASSIGNMENT: ETL

Mary E. Napier  
Northwestern University  
Dept of Chemistry  
Evanston, IL 60208

DEGREE: MS  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: MAT

Kyle L. Nash  
University of Alabama  
Dept of Aerospace Engineering  
Northport, AL 35476

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: AEDC

Dennis D. Olcott  
Brigham Young University  
Dept of Mechanical Engineering  
Provo, UT 84604

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: ASTRO

Kara L. Olen  
Virginia Polytechnic Institute  
Dept of Civil Engineering  
Blacksburg, VA 24060

DEGREE: BS  
SPECIALTY: Civil Engineering  
LAB ASSIGNMENT: ESC

Juan B. Ordonez  
University of Florida  
Dept of Aerospace Engineering  
Gainesville, FL 32608

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: ATL

Maureen K. Parrish  
Wichita State University  
Dept of Chemistry  
Wichita, KS 67208-1595

DEGREE: BS  
SPECIALTY: Chemistry  
LAB ASSIGNMENT: FJSRL

James F. Peters  
Kansas State University  
Dept of Computing & Information Science  
Manhattan, KS 66506

DEGREE: MS  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: RADC

Scott M. Peterson  
University of New Mexico  
Dept of Electrical Engineering  
Albuquerque, NM 87112

DEGREE: BS  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: WL

Bryant L. Poole  
University of Mississippi  
Dept of Computer Science  
University, MS 38677

DEGREE: MS  
SPECIALTY: Computer Science  
LAB ASSIGNMENT: AVION

Mark A. Preischel  
University of Cincinnati  
Dept of Aerospace Engineering  
Cincinnati, OH 45219

DEGREE: BS  
SPECIALTY: Aerospace Engineering  
LAB ASSIGNMENT: MAT

Joanne H. Promislow  
University of North Carolina  
Dept of Applied Science  
Chapel Hill, NC 27514

DEGREE: BS  
SPECIALTY: Polymer Science  
LAB ASSIGNMENT: MAT

Jennifer G. Reid  
University of Dayton  
Dept of Chemical & Materials Engineering  
Dayton, OH 45409

DEGREE: BS  
SPECIALTY: Chemical Engineering  
LAB ASSIGNMENT: MAT

## NAME/ADDRESS

## DEGREE, SPECIALTY, LAB ASSIGNMENT

Dean Richardson  
University of Arizona  
Optical Science Center  
Tucson, AZ 85712

DEGREE: PhD  
SPECIALTY: Optical Science  
LAB ASSIGNMENT: RADC

Robyn C. Robinson  
Meharry Medical College  
Dept of Pharmacology  
Nashville, TN 37208

DEGREE: BA  
SPECIALTY: Biology  
LAB ASSIGNMENT: WHMC

Blair M. Rollin  
University of Tennessee  
Dept of Mathematics  
Tullahoma, TN 37386

DEGREE: BS  
SPECIALTY: Mathematics  
LAB ASSIGNMENT: AEDC

Tod D. Romo  
Trinity University  
Dept of Biology  
San Antonio, TX 78212

DEGREE: BS  
SPECIALTY: Biology  
LAB ASSIGNMENT: SAM

Anna L. Rowe-Hallbert  
Rice University  
Dept of Psychology  
Houston, TX 77251

DEGREE: MS  
SPECIALTY: Experimental Psychology  
LAB ASSIGNMENT: SAM

Steven M. Ruesegger  
Case-Western Reserve Univ  
Dept of Electrical Engineering  
Cleveland, OH 44106

DEGREE: BS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: MAT

David M. Russell  
Clarkson University  
Dept of Mech & Aeronautical Engineering  
Potsdam, NY 13699-5725

DEGREE: MS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: FDL

Christopher Scarpino  
Worcester Polytechnic Inst  
Dept of Mechanical Engineering  
Worcester, MA 01609

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: GEO

Thomas D. Scattergood  
Virginia Polytechnic Institute  
Dept of Mechanical Engineering  
Blacksburg, VA 24061-0238

DEGREE: BS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: PROP

Daniel E. Schatt  
University of Tennessee  
Dept of Aerospace Engineering  
Tullahoma, TN 37388

DEGREE: BS  
SPECIALTY: Aerospace Mechanics  
LAB ASSIGNMENT: AEDC

Jeffrey H. Schmidt  
University of Dayton  
Dept of Psychology  
Dayton, OH

DEGREE: BA  
SPECIALTY: Psychology  
LAB ASSIGNMENT: AAMRL

Jacqueline C. Schnepf  
University of South Florida  
Dept of Industrial Engineering  
Tampa, FL 33617

DEGREE: BS  
SPECIALTY: Industrial Engineering  
LAB ASSIGNMENT: LHFD

Joseph A. Schudt  
Ohio State University  
Dept of Engineering Mechanics  
Columbus, OH 43210

DEGREE: MS  
SPECIALTY: Mechanical Engineering  
LAB ASSIGNMENT: FDL

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
John M. Sebghati University of Tennessee Dept of Aerospace Engineering Tullahoma, TN 37388	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: AEDC
Martin Sensiper University of Central Florida Dept of Elect Eng & Computer Science Orlando, FL 32826	DEGREE: BS SPECIALTY: Electro-Optics LAB ASSIGNMENT: ATL
Russell F. Shipman University of Wyoming Dept of Physics & Astronomy Laramie, WY 82071	DEGREE: BA SPECIALTY: Physics LAB ASSIGNMENT: GEO
Waleed W. Smari Syracuse University Dept of Electrical & Computer Engineering Syracuse, NY 13244	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADC
Karen D. Somers University of Texas Dept of Environmental Management San Antonio, TX 78212	DEGREE: BS SPECIALTY: Chemistry LAB ASSIGNMENT: OEHL
Sofia B. Sotelo/Ruiz University of Texas Dept of Behavioral Sciences Odessa, TX 79762-8301	DEGREE: BA SPECIALTY: Psychology LAB ASSIGNMENT: SAM
Anne M. Stephenson University of Dayton Dept of Aerospace Engineering Dayton, OH 45420	DEGREE: BS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: FDL
Vincent W. Stone University of Florida Dept of Building Construction Gainesville, FL 32604	DEGREE: BS SPECIALTY: Marketing LAB ASSIGNMENT: AAMRL
Dennis J. Strickland, Jr. Auburn University Dept of Aerospace Engineering Auburn, AL 36849-5338	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: FJSRL
Aziz Tadayon University of New Orleans Dept of Mechanical Engineering New Orleans, LA 70148	DEGREE: BS SPECIALTY: Engineering LAB ASSIGNMENT: FDL
Andrew J. Thom Iowa State University Dept of Material Science & Engineering Ames, IA 50010	DEGREE: BS SPECIALTY: Ceramic Engineering LAB ASSIGNMENT: MAT
Timothy J. Urekeu Worcester Polytechnic Inst Dept of Mechanical Engineering Worcester, MA 01609	DEGREE: MS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: GEO
Cortney G. Vargo Virginia Polytechnic Inst Dept of Industrial/System Engineering Blacksburg, VA 24060	DEGREE: BS SPECIALTY: Industrial Engineering LAB ASSIGNMENT: AAMRL

NAME/ADDRESS	DEGREE, SPECIALTY, LAB ASSIGNMENT
Marilu Vasquez University of Texas Dept of Microbiology San Antonio, TX 78232	DEGREE: BS SPECIALTY: Microbiology LAB ASSIGNMENT: SAM
Keith W. Ver Steeg Oklahoma State University Dept of Physics Stillwater, OK 74078	DEGREE: MS SPECIALTY: Physics LAB ASSIGNMENT: WL
Paul H. Vitt University of Missouri-Rolla Dept of Aerospace Engineering Rolla, MO 65401	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: AEDC
Phuong T. Vu Calif State Polytechnic Univ Dept of Aerospace Engineering San Luis Obispo, CA 93405	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: FDL
David L. Warren Brigham Young University Dept of Chemical Engineering Provo, UT 84602	DEGREE: BS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP
Michael A. Weaver Georgia Inst of Technology School of Aerospace Engineering Atlanta, GA 30332	DEGREE: MS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: AEDC
Paul H. Wheeler Idaho State University College of Engineering Pocatello, ID 83209	DEGREE: BS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: WL
Charles T. Widener Syracuse University Dept of Electrical Engineering Syracuse, NY 13210	DEGREE: MS SPECIALTY: Electrical Engineering LAB ASSIGNMENT: RADC
William G. Wilk University of Alabama Dept of Aerospace Engineering Tuscaloosa, AL 35486-4094	DEGREE: BS SPECIALTY: Aerospace Engineering LAB ASSIGNMENT: AEDC
Carla S. Williams University of New Mexico Dept of Electrical & Computer Engineering Albuquerque, NM 87131	DEGREE: MA SPECIALTY: Computer Science LAB ASSIGNMENT: WL
Mark R. Williams Texas A&M University Dept of Mechanical Engineering College Station, TX 77840	DEGREE: BS SPECIALTY: Mechanical Engineering LAB ASSIGNMENT: PROP
Marty K. Wilson Oklahoma State University Dept of Chemistry Stillwater, OK 74078	DEGREE: BS SPECIALTY: Chemistry LAB ASSIGNMENT: FJSRL
Dirk F. Young Duke University Dept of Civil & Environ Engineering Durham, NC 27706	DEGREE: MS SPECIALTY: Environmental Engineering LAB ASSIGNMENT: ESC

**NAME/ADDRESS**

Yonghuan Zhou  
Boston University  
Dept of Elect, Comp & Systems Engineering  
Boston, MA 02215

**DEGREE, SPECIALTY, LAB ASSIGNMENT**

DEGREE: MS  
SPECIALTY: Electrical Engineering  
LAB ASSIGNMENT: RADCH

**APPENDIX C. LIST OF PARTICIPANTS (CONT)****C-3. HSAP**

<b>NAME/HIGH SCHOOL ADDRESS</b>	<b>GRADE, LAB ASSIGNMENT</b>
D. Joseph Abbis Rome Free Academy Rome, NY 13440	GRADE: 12 LAB ASSIGNMENT: RADC
Lori L. Anderson Centerville High School Centerville, OH 45459	GRADE: 11 LAB ASSIGNMENT: AVION
Eric A. Apfel Choctawhatchee High School Ft Walton Bch, FL 32547	GRADE: 11 LAB ASSIGNMENT: ATL
Jean C. Ay Fairborn High School Fairborn, OH 45324	GRADE: 12 LAB ASSIGNMENT: FDL
Kenneth R. Barnes Shelbyville Central High School Shelbyville, TN 37160	GRADE: 12 LAB ASSIGNMENT: AEDC
Matthew J. Bauder Sauquoit Valley Central High School Sauquoit, NY 13456	GRADE: 10 LAB ASSIGNMENT: RADC
Barbara M. Bean East Central High School San Antonio, TX 78263	GRADE: 11 LAB ASSIGNMENT: SAM
Matthew E. Becker Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: FDL
Kevin W. Belew Coffee County Central High School Manchester, TN 37355	GRADE: 12 LAB ASSIGNMENT: AEDC
Whitney A. Brandt East Central High School San Antonio, TX 78263	GRADE: 11 LAB ASSIGNMENT: SAM
Jennifer L. Brewer Port St. Joe High School Port St. Joe, FL 32456	GRADE: 11 LAB ASSIGNMENT: ESC
Lee D. Bunch Tecumseh High School New Carlisle, OH 45344	GRADE: 11 LAB ASSIGNMENT: PROP
Mark J. Buxton West Carrollton High School W. Carrollton, OH 45449	GRADE: 11 LAB ASSIGNMENT: ETL
Eduardo Carrillo Louis W. Fox Acad. & Tech. High School San Antonio, TX 78205	GRADE: 12 LAB ASSIGNMENT: SAM
John R. Cerda Sam Houston High School San Antonio, TX 78220	GRADE: 11 LAB ASSIGNMENT: SAM

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Tina M. Chilcoat West Carrollton High School W. Carrollton, OH 45449	GRADE: 12 LAB ASSIGNMENT: PROP
Helen H. Chou Centerville High School Centerville, OH 45429	GRADE: 11 LAB ASSIGNMENT: ETL
Caroline C. Chuang Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: AAMRL
Mark L. Coleman Tullahoma High School Tullahoma, TN 37388	GRADE: 12 LAB ASSIGNMENT: AEDC
Mara L. Collins Valley High School Albuquerque, NM 87107	GRADE: 12 LAB ASSIGNMENT: WL
Jeffrey Shawn Cropp Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: PROP
Nirmala V. Daramarajah A. C. Mosley High School Lynn Haven, FL 32444	GRADE: 12 LAB ASSIGNMENT: ESC
Kathryn D. Deibler Choctawhatchee High School Ft Walton Bch, FL 32548	GRADE: 12 LAB ASSIGNMENT: ATL
Lesha Denega Niceville High School Niceville, FL 32578	GRADE: 11 LAB ASSIGNMENT: ATL
Philip C. Dorsch Bay High School Panama City, FL 32405	GRADE: 10 LAB ASSIGNMENT: ESC
Rebekah A. Drezek Tom C. Clark High School San Antonio, TX 78249	GRADE: 11 LAB ASSIGNMENT: SAM
Eric D. Eidson Eldorado High School Albuquerque, NM 87111	GRADE: 10 LAB ASSIGNMENT: WL
Eric Engberg Albuquerque Academy Albuquerque, NM 87122	GRADE: 11 LAB ASSIGNMENT: WL
Brian K. Eplett Niceville High School Niceville, FL 32578	GRADE: 12 LAB ASSIGNMENT: ATL
Mark R. Eslinger Judson High School Converse, TX 78148	GRADE: 10 LAB ASSIGNMENT: SAM
Matthew D. Felder Judson High School Converse, TX 78109	GRADE: 12 LAB ASSIGNMENT: SAM
Joshua D. Finch Tecumseh High School New Carlisle, OH 45344	GRADE: 10 LAB ASSIGNMENT: AAMRL

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Matthew B. Firstenburg Albuquerque High School Albuquerque, NM 87102	GRADE: 11 LAB ASSIGNMENT: WL
Tom J. Fraites, Jr. Niceville High School Niceville, FL 32578	GRADE: 11 LAB ASSIGNMENT: ATL
Jessica B. Gardner Desert High School Edwards, CA 93523	GRADE: 12 LAB ASSIGNMENT: ASTRO
Andrew J. Gerrard Holland Patent High School Holland Patent, NH 13354	GRADE: 11 LAB ASSIGNMENT: RADC
Genetta K. Gibson Tullahoma High School Tullahoma, TN 37388	GRADE: 11 LAB ASSIGNMENT: AEDC
Todd C. Gleason Rome Free Academy Rome, NY 13440	GRADE: 11 LAB ASSIGNMENT: RADC
Shari D. Goldenberg Northmont High School Clayton, OH 45315	GRADE: 12 LAB ASSIGNMENT: FDL
Julie A. Gopell Westmoreland Central High School Westmoreland, NY 13490	GRADE: 12 LAB ASSIGNMENT: RADC
Brian M. Gose Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: AAMRL
Daniel R. Grayson Choctawhatchee High School Ft Walton Bch, FL	GRADE: 11 LAB ASSIGNMENT: ATL
Barbara C. Grazier Dayton Christian High School Dayton, OH 45405	GRADE: 12 LAB ASSIGNMENT: AAMRL
Matthew A. Grider Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: PROP
Julie R. Grinde Douglas MacArthur High School San Antonio, TX 78217	GRADE: 12 LAB ASSIGNMENT: SAM
Russell A. Grubbs Sandia Preparatory School Albuquerque, NM 87113	GRADE: 11 LAB ASSIGNMENT: WL
Mark P. Hansell Centerville High School Centerville, OH 45459	GRADE: 12 LAB ASSIGNMENT: PROP
Richard C. Hartzler A.C. Mosley High School Lynn Haven, FL 32444	GRADE: 11 LAB ASSIGNMENT: ESC
Kenneth H. Harwell Tullahoma High School Tullahoma, TN 37388	GRADE: 11 LAB ASSIGNMENT: AEDC

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Jacquelynn L. Hearne Palmdale High School Palmdale, CA 93550	GRADE: 12 LAB ASSIGNMENT: ASTRO
Rosalie D. Hemeyer Health Careers High School San Antonio, TX 78229	GRADE: 11 LAB ASSIGNMENT: OEHL
Marsha G. Henke Alamo Heights High School San Antonio, TX 78209	GRADE: 10 LAB ASSIGNMENT: OEHL
Christina Ho Centerville High School Centerville, OH 45459	GRADE: 12 LAB ASSIGNMENT: FDL
Derek Holland Niceville High School Niceville, FL 32578	GRADE: LAB ASSIGNMENT: ATL
Heather B. Hopwood Tullahoma High School Tullahoma, TN 37388	GRADE: 10 LAB ASSIGNMENT: AEDC
Robert C. Horrocks, Jr. Tecumseh High School New Carlisle, OH 45344	GRADE: 12 LAB ASSIGNMENT: FDL
Daniel Houghton Choctawhatchee High School Ft Walton Bch, FL 32457	GRADE: 11 LAB ASSIGNMENT: ATL
Deanna L. Jende Northmont High School Clayton, OH 45315	GRADE: 12 LAB ASSIGNMENT: AAMRL
Kevin L. Johnson Shelbyville Central High School Shelbyville, TN 37160	GRADE: 12 LAB ASSIGNMENT: AEDC
Thor M. Johnson A.C. Mosley High School Lynn Haven, FL 32405	GRADE: 11 LAB ASSIGNMENT: ESC
Brad L. Karmiol Albuquerque Academy Albuquerque, NM 87109	GRADE: 10 LAB ASSIGNMENT: WL
Kathryn L. Kawazoe New Braunfels High School New Braunfels, TX 78130	GRADE: 10 LAB ASSIGNMENT: SAM
Jennifer M. Kim Beavercreek High School Beavercreek, OH 45385	GRADE: 11 LAB ASSIGNMENT: AAMRL
Jason A. Kitchen Niceville High School Niceville, FL 32578	GRADE: 11 LAB ASSIGNMENT: ATL
Kris in E. Klatt Madison High School San Antonio, TX 78247	GRADE: 11 LAB ASSIGNMENT: SAM
Barry J. Koestler Beavercreek High School Beavercreek, OH 45385	GRADE: 11 LAB ASSIGNMENT: AVION

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Jason D. Kowalczyk Whitesboro High School Marcy, NY 13403	GRADE: 11 LAB ASSIGNMENT: RADC
Frank A. Lasley Winchester High School Winchester, MA 01890	GRADE: 11 LAB ASSIGNMENT: GEO
Allen L. Lefkovitz Dayton Christian High School Dayton, OH 45404	GRADE: 11 LAB ASSIGNMENT: AVION
Jason C. Lenio Venon-Verona-Sherrill High School Verona, NY 13478	GRADE: 12 LAB ASSIGNMENT: RADC
Lisa G. Lewis Tullahoma High School Tullahoma, TN 37388	GRADE: 12 LAB ASSIGNMENT: AEDC
Meredith A. Lewis Centerville High School Centerville, OH 45459	GRADE: 12 LAB ASSIGNMENT: AVION
Jeremy B. Liebowitz North Middlesex Regional High School Townsend, MA 01469	GRADE: 12 LAB ASSIGNMENT: GEO
Jerome A. Lindsay John Marshall High School San Antonio, TX 78240	GRADE: 10 LAB ASSIGNMENT: SAM
Natasha A. Lindsay Rutherford High School Springfield, FL 32401	GRADE: 11 LAB ASSIGNMENT: ESC
Sonya M. Longbotham Robert E. Lee High School San Antonio, TX 78213	GRADE: 11 LAB ASSIGNMENT: SAM
Kerim Martinez Eldorado High School Albuquerque, NM 87111	GRADE: 11 LAB ASSIGNMENT: WL
Daran Mason Crestview High School Crestview, FL 32536	GRADE: 11 LAB ASSIGNMENT: ATL
Galen A. McKinley Newton South High School Newton, MA 02159	GRADE: 12 LAB ASSIGNMENT: GEO
Sean A. Menge Adirondack High School Boonville, NY 13309	GRADE: 10 LAB ASSIGNMENT: RADC
Debra M. Meyer Quartz Hill High School Lancaster, CA 93536	GRADE: 12 LAB ASSIGNMENT: ASTRO
Virginia A. Miksch Incarnate Word High School San Antonio, TX 78223	GRADE: 10 LAB ASSIGNMENT: SAM
Brent A. Miller Bay High School Panama City, FL 32401	GRADE: 10 LAB ASSIGNMENT: ESC

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Diane M. Monaghan Paraclete High School Lancaster, CA 93536	GRADE: 11 LAB ASSIGNMENT: ASTRO
Cathie A. Moore West Carrollton High School W. Carrollton, OH 45449	GRADE: 12 LAB ASSIGNMENT: FDL
John-Paul Motley Shelbyville Central High School Shelbyville, TN 37160	GRADE: 12 LAB ASSIGNMENT: AEDC
Christopher L. Moylan Notre Dame High School Utica, NY 13502	GRADE: 10 LAB ASSIGNMENT: RADC
Christopher W. O'Dell Beavercreek High School Beavercreek, OH 45378	GRADE: 12 LAB ASSIGNMENT: PROP
Lori R. Olenick Dillard McCollum High School San Antonio, TX 78221	GRADE: 12 LAB ASSIGNMENT: SAM
Steven M. Olkowski Desert High School Edwards AFB, CA 93523	GRADE: 12 LAB ASSIGNMENT: ASTRO
Joseph V. Padilla Paraclete High School Lancaster, CA 93536	GRADE: 12 LAB ASSIGNMENT: ASTRO
Alan M. Page Beavercreek High School Beavercreek, OH 45385	GRADE: 12 LAB ASSIGNMENT: ETL
Eugene M. Paige Yellow Springs High School Yellow Springs, OH 45387	GRADE: 12 LAB ASSIGNMENT: FDL
Debra A. Panek Rome Catholic High School Rome, NY 13440	GRADE: 12 LAB ASSIGNMENT: RADC
John S. Paschkewitz Bedford High School Bedford, MA 01730	GRADE: 12 LAB ASSIGNMENT: GEO
Jason A. Phillips Chaffey High School Ontario, CA 91762	GRADE: 11 LAB ASSIGNMENT: ASTRO
Jennifer L. Pollock New Lebanon-Dixie High School New Lebanon, OH 45345	GRADE: 12 LAB ASSIGNMENT: PROP
Thatcher J. Pospiech Rome Free Academy Rome, NY 13440	GRADE: 12 LAB ASSIGNMENT: RADC
Eric J. Powers Beavercreek High School Beavercreek, OH 45385	GRADE: 10 LAB ASSIGNMENT: AVION
Nathan C. Pritchard Judson High School Converse, TX 78109	GRADE: 10 LAB ASSIGNMENT: OEHL

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
Jonathan M. Protz A.C. Mosley High School Lynn Haven, FL 32444	GRADE: 11 LAB ASSIGNMENT: ESC
Julie A. Reece Tullahoma High School Tullahoma, TN 37388	GRADE: 12 LAB ASSIGNMENT: AEDC
Tracy R. Reed Tehachapi High School Tehachapi, CA 93561	GRADE: 10 LAB ASSIGNMENT: ASTRO
Michael I. Richie Meadowdale High School Dayton, OH 45416	GRADE: 11 LAB ASSIGNMENT: FDL
Christine D. Riendeau Choctawhatchee High School Ft Walton Bch, FL 32547	GRADE: 12 LAB ASSIGNMENT: ATL
Jason M. Riordan Onshony Central High School Onshony, NY 13424	GRADE: 11 LAB ASSIGNMENT: RADC
Brian D. Rizzoli Sandia Preparatory School Albuquerque, NM 87110	GRADE: 11 LAB ASSIGNMENT: WL
Jeffrey M. Roth Lincoln-Sudbury High School Sudbury, MA 01776	GRADE: 11 LAB ASSIGNMENT: GEO
Eugene C. Salerno Oneida High School Oneida, NY 13421	GRADE: 11 LAB ASSIGNMENT: RADC
Carol A. Salinas Incarnate Word High School San Antonio, TX 78242	GRADE: 10 LAB ASSIGNMENT: SAM
Paul A. Salinas William Howard Taft High School San Antonio, TX 78253	GRADE: 10 LAB ASSIGNMENT: SAM
Jonathan R. Sanders Franklin County High School Winchester, TN 37398	GRADE: 12 LAB ASSIGNMENT: AEDC
Jason M. Scott Franklin County High School Winchester, TN 37398	GRADE: 12 LAB ASSIGNMENT: AEDC
Dennis W. Scott, Jr. Niceville High School Niceville, FL 32578	GRADE: 11 LAB ASSIGNMENT: ATL
Joseph C. Senus Rome Free Academy Rome, NY 13440	GRADE: 10 LAB ASSIGNMENT: PADC
Patrick W. Sharkey Churchill High School San Antonio, TX 78216	GRADE: 10 LAB ASSIGNMENT: SAM
Paul D. Shocklee James Madison High School San Antonio, TX 78247	GRADE: 12 LAB ASSIGNMENT: SAM

NAME/HIGH SCHOOL ADDRESS	GRADE, LAB ASSIGNMENT
David C. Summey A.C. Mosley High School Lynn Haven, FL 32444	GRADE: 11 LAB ASSIGNMENT: ESC
Paul K. Swietek Bedford High School Bedford, MA 01730	GRADE: 11 LAB ASSIGNMENT: GEO
Amy L. Thomas A.C. Mosley High School Lynn Haven, FL 32444	GRADE: 11 LAB ASSIGNMENT: ESC
Karen E. Thomas Meadowdale High School Dayton, OH 45416	GRADE: 11 LAB ASSIGNMENT: AVION
Jennifer M. Trent Tullahoma High School Tullahoma, TN 37388	GRADE: 12 LAB ASSIGNMENT: AEDC
Troy A. Urquhart Ft. Walton Beach High School Ft. Walton Bch, FL 32548	GRADE: 12 LAB ASSIGNMENT: ATL
Greg VanWiggeren Ft. Walton Beach High School Ft. Walton Bch, FL 32548	GRADE: 12 LAB ASSIGNMENT: ATL
Dawn M. Vernooy West Mesa High School Albuquerque, NM 87120	GRADE: 11 LAB ASSIGNMENT: WL
Brandon S. Wadsworth Tom C. Clark High School San Antonio, TX 78249	GRADE: 11 LAB ASSIGNMENT: SAM
Evan L. Werkema Sandia Preparatory School Albuquerque, NM 87113	GRADE: 12 LAB ASSIGNMENT: WL
Eric P. White Crestview High School Crestview, FL 32536	GRADE: 12 LAB ASSIGNMENT: ATL
Leisha E. Wood Incarnate Word High School San Antonio, TX 78284	GRADE: 11 LAB ASSIGNMENT: SAM
Christine S. Yoon West Carrollton High School W. Carrollton, OH 45449	GRADE: 12 LAB ASSIGNMENT: AVION
Eugene J. Youngblood Crestview High School Crestview, FL 32536	GRADE: 11 LAB ASSIGNMENT: ATL
Suzette M. Yu Beavercreek High School Beavercreek, OH 45432	GRADE: 12 LAB ASSIGNMENT: ETL

# FINAL REPORT ABSTRACTS

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## APPENDIX D. SFRP REPORT ABSTRACTS

### D-1. ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY (AAMRL)

Body Composition In Rodents and Humans for P-Pbk Modeling

Mary L. Crittenden PhD Candidate Faculty

#### Abstract

The purpose of this research was to search the literature extensively to better define and characterize the body weights and compartments of the F-344, and Sprague-Dawley Rats, B6C3F1 Mice, Hartley and Hairless Guinea Pigs and the Human by sex, and age. The results were to be generated in a form suitable for use in the Physiologically Based Pharmacokinetic Models. The literature was searched from 1979 to the present for values. Data from laboratory necropsy studies of controls were surveyed. Data from a current request to a vendor were surveyed. Human values were ascertained from medical literature and from information on organ transplantation. Information was successfully obtained on the F-344 and Sprague-Dawley Rats, the B6C3F1 Mice, and Humans with limited success on the Hartley Guinea Pig and no success on the Hairless Guinea Pig.

DESIGN OF A THREAT SITE/EMITTER LAYDOWN DATABASE  
AND THREAT EMITTER PARAMETERS DATABASE  
FOR THE ADVANCED DEFENSIVE MISSION PLANNING SYSTEM  
AND B1-B ENGINEERING RESEARCH SIMULATOR

John C. Duncan  
Instructor  
Aerospace Engineering Technology  
Kent State University

ABSTRACT

The primary goal of the Advanced Defensive Mission Planning System (ADMPS) is to allow rapid Mission Generation - integrating terrain information, routes, and threats - by a non-expert Mission Planner. The ADMPS should provide a realistic and accurate model of threat/site laydown using current doctrine, strategy and practices. At the same time, each threat model should simulate realistic threat emitter characteristics and operation. Together, the digitized terrain database, threat site laydown and emitter simulation should provide a realistic simulated electronic warfare environment that can be used in various Defensive System simulations. Once fully implemented, the ADMPS will be able to easily and quickly provide total mission scenarios - including training and EWO missions - for use in studies in various aircraft simulations.

**A PROPOSED METHODOLOGY FOR COMBUSTION TOXICOLOGY  
TESTING OF HALON REPLACEMENT AGENTS**

**CHARLES J. KIBERT, Ph.D., P.E.  
Associate Professor  
University of Florida**

**ABSTRACT**

An international consensus to remove Chlorofluorocarbon (CFC) compounds from production and U.S. national policy to implement the resulting protocols has motivated the U.S. Air Force to embark on a program to find a suitable replacement for Halon 1211, currently used to extinguish flight line fires. This research addressed the feasibility of conducting a combustion toxicology (CT) program to assess the toxic products of the combustion interaction of JP-8 and the Group 1 or so-called "Near Term" candidate replacement agents for Halon 1211: HCFCs 123, 124, and 142b. A laboratory scale experiment benchmarked on large scale testing of a 150 ft<sup>2</sup> pool fire was developed on the basis of Froude scaling of the full scale fire to a 15 x 15 cm pan fire. A prototype apparatus was developed and investigation into the use of animal behavior methods as an indicator of human incapacitation was conducted. The result is a new method which may potentially be utilized for future toxicity studies of the combustion interaction of current and future U.S. Air Force fuels with various fire extinguishants.

STATISTICAL UNCERTAINTY OF PBPK MODEL PREDICTIONS FOR  
METHYLENE CHLORIDE

Tze-San Lee<sup>1</sup>, R.L. Carpenter<sup>2</sup>, and C.D. Flemming<sup>1</sup>

<sup>1</sup>Dept. of Mathematics, Western Illinois University, Macomb, IL  
61455      <sup>2</sup>Naval Medical Research Institute/Toxicology  
Detachment, Wright-Patterson AFB, OH 45433      <sup>3</sup>MANTECH  
Environmental, Inc., Dayton OH 45432

**Abstract.** A Monte Carlo study on the reliability of the Physiologically Based Pharmacokinetic (PBPK) model for methylene chloride was conducted. It is noticed that the prediction errors for some of the model output variables could be three times greater than the parameter errors. Also, some of the model output variables were highly correlated. therefore, it is not profitable to just use a particular output as a dose surrogate in the risk assessment of chemical carcinogenesis for methylene chloride. Two recommendations were proposed as a result of the present study.

A One-Degree-of-Freedom Master-Slave Device Based on  
a Shape Memory Alloy Actuator

Edgar G. Munday  
Department of Mechanical Engineering  
and Engineering Science  
University of North Carolina at Charlotte  
Charlotte, NC 28223

Abstract

A one-degree-of-freedom master-slave device was built using shape memory alloy (SMA) wires for actuation. A bang-bang control scheme was used for both the position control of the slave and the force control of the master. A prototype was built to demonstrate stability and other aspects of the design concept.

Air cooling of the SMA wires proved inadequate, causing the slave to lag behind the master when the slave wires were being returned to extended length. An experiment was performed to determine the cooling time constants for the SMA wire in air, water, and a 50/50 mixture of water and glycerol.

It was necessary to limit the driving voltage of the SMA wires of both master and slave to prevent over-heating. Unfortunately, the voltage limitation does not allow minimum contraction time. Therefore, a test was performed to examine the feasibility of an infrared phototransistor for temperature detection.

Simulation of Head/Neck Response to +Gz Impact Acceleration due to  
Additional Head Mass

by

Amit Lal Patra (Summer Faculty Research Fellow)

University of Puerto Rico at Mayaguez

Christina Estep (Graduate Student Research Fellow)

Virginia Polytechnic and State University

ABSTRACT

This work was to extend research initiated at the Armstrong Laboratory (AL) to investigate the effects of added head mass on the dynamics of the neck and head during +Gz impact acceleration. The original effort was conducted to provide an analytical modeling foundation for a better understanding of the dynamic response of the head/neck system when encumbered with additional masses such as helmet, night vision goggles, mask or other performance enhancing or protective equipment. The summer effort include a literature search and the validating of a modelling methodology for +Gz impact response. The emphasis was on modelling experimental data obtained from tests on human volunteers for head acceleration and neck flexion. The work predicted loading at the occipital condyle interface, and performed extensive model parametric studies to explore the changes in acceleration, flexion and neck loading due to variations in the amount and placement of mass on the head.

## COORDINATION OF POSTURAL CONTROL AND VEHICULAR CONTROL

Gary E. Riccio, Ph.D.

### Abstract

The objective of this report is to reveal some of the factors that affect the perception of self motion during changes in the velocity vector. The report focuses on multimodal perception of self motion in the context of the forces implicit in curved trajectories. It is argued that theories and experiments on the perception of self motion must consider the multiplicity of perceptual systems that are sensitive to forces and motions. It is recommended that the relation between displayed roll-orientation and heading should be experimentally manipulated so that changes in orientation can be investigated in relation to changes in the direction and magnitude of centripetal acceleration. The extent to which such events can be perceived as self motion is determined by the sensitivity of the nonvisual perceptual systems to the presence or absence of variations in constraints on postural control. The relation between orientation and centripetal acceleration determines which nonvisual systems should be most sensitive to the attendant constraints. The introduction of novel dependent and independent variables in an otherwise familiar flight-simulation paradigm is recommended in order to reveal the role of postural control in the multimodal perception of self motion.

## THE MISSING FUNDAMENTAL ILLUSION

Benjamin R. Stephens, Ph.D.

Summary. The detectability, apparent contrast, and appearance of sine, square, and missing fundamental waveforms were measured using standard psychophysical techniques. The results suggest non-trivial modifications to models of low spatial frequency pattern vision. However, stimulus artifacts require replication of the results before publication.

RAPID COMMUNICATION (RAPCOM) DISPLAY FORMATS FOR  
INTEGRATION AND FOCUSED ATTENTION TASKS

John Uhlarik  
Department of Psychology  
Kansas State University  
Manhattan, KS 66506-5302

ABSTRACT

RAPCOM (rapid communication) displays have been shown to have useful potential human-computer interactions involving high information transfer rates (cf., Matin and Boff, 1988). An experiment was conducted to evaluate the relative effectiveness of various spatial and temporal display formats for presenting information pertaining to the likelihood of aircraft stall using the simulated dynamics of a light aircraft. Specific spatial and temporal characteristics of the display formats were based on the proximity compatibility principle (PCP) which attempts to integrate findings regarding the benefits and limitations of displaying multiple sources of information in similar or "proximal" ways (Wickens and Andre, 1990; Carswell and Wickens, 1990).

The effectiveness of these display formats were compared for judgments which required the integration of three display parameters (airspeed, bank, and flap angle) to determine stall probability with those requiring focused attention necessitating the recall of the specific value of one of the parameters. Overall, the RAPCOM display format was generally associated with the best performance, but the findings were not consistent with design guidelines suggested by the PCP.

## D- 2. HUMAN RESOURCES LABORATORY: LOGISTICS & HUMAN FACTORS DIVISION (LHFD)

### MODELING COMPOSITE WINGS: AN OBJECT ORIENTED SIMULATION APPROACH USING MODSIM II

A.J.G. Babu and Jacqueline C. Schnepf

In this report, we describe a discrete event simulation model of an United States Air Force base-level aircraft maintenance organization serving a composite wing of aircraft. A composite wing is a mix of multiple types of aircraft under one commander in one general location. In contrast, a traditional wing, which we will call monolithic, contains many aircraft of the same type. For a composite wing consisting of F-16, F-15, and KC-135 aircraft, a prototype simulation model is constructed using a modular object-oriented design and the MODSIM II programming language. An arriving aircraft goes through flight line check and maintenance, obtains service at a selection of intermediary shops and finally gets reconfigured to take off. In reality, there would be more than twenty such intermediary shops. However, a simplified model is conceived for ease of prototyping. It consists of airframe repair shop, electrical shop, and environmental control shop in addition to flight line and reconfiguration shop. The prototype provides an understanding of the nature and scope of the problem as well as modularity and flexibility of the object oriented simulation approach. While demonstrating the modeling feasibility, it makes a case for the development of a complete model. A full scale model would help assess the maintenance resource requirements versus the sorties per aircraft. It can also be used to compare the cost and contributions of maintaining composite versus monolithic wings. The report concludes with suggestions for future directions of research.

## **ACQUISITION MANAGEMENT OF HAZARDOUS MATERIALS -- A DESIGN ADVISOR**

**Dr. Ernest L. Hall  
Dept of Mechanical, Industrial and Nuclear Engineering  
University of Cincinnati  
Cincinnati, OH 45221**

### **Abstract**

**A design advisor concept is presented to show how and where the several databases which are available relating to hazardous materials could be used to anticipate and hopefully avoid being surprised by hazardous materials issues on future systems. A review of the very complicated problem facing the designer of minimizing hazards for humans and the environment is presented which shows that different databases would be of interest at the various design stages. The design advisor would involve accessing about 100 different databases which could provide partial information on hazardous materials identification and alternative evaluation. A strategy and software tool concept for identification of hazardous materials is presented. The significance of such a software tool would lie in the ability of the designer to obtain appropriate information in a timely manner.**

### **D-3. HUMAN RESOURCES LABORATORY: MANPOWER & PERSONNEL DIVISION (MPD)**

**What's in a rule?:**

**A structural model of inductive reasoning**

**Charlotte G. Andrist  
Department of Education  
Notre Dame College  
Cleveland, Ohio 44121**

#### **Abstract**

The purpose of the current research was to systematically identify structural components of inductive reasoning tasks which were sensitive to individual differences in performance. Structural components were defined as basic patterns of attribute predictability within and between individual stimuli in a classic 3x3 matrix task of inductive reasoning, the Raven's Advanced Progressive Matrices (APM; Raven, 1962). The relationship between structure and both individual differences in performance and item difficulty was tested. Two pilot studies were conducted. The first study tested how well structural parameters predicted item difficulty on the APM and contrasted that work with predictions from a more traditional rule based model. In the second study an experimental matrix test was constructed based on structural parameters identified in the first study. The strength of using structural principles to identify components of inductive reasoning tasks which make them excellent predictors of intelligence was discussed.

# Integrating the Affective Domain into the Instructional Design Process

Robert G. Main, Ph.D.

## ABSTRACT

Educational psychologists, instructional theorists and practitioners generally agree that student attitude and motivation are critical components of the learning process. Historically, more workers are discharged because of behavioral problems than because of their inability to perform job tasks. Achievement scores in public schools continue to decline and the dropout rate in some high schools exceeds 50 percent. A major study shows student interest in learning declines as a function of the length of schooling.

Despite these indicators of the need to address the affective component in curriculum development, instructional design models focus almost exclusively on the cognitive domain. Research in strategies, tools and techniques for instructional developers related to student interest and motivation to learn is virtually ignored.

This study develops an integrated model of instructional design that incorporates the affective domain as an integral component. The model combines the ARCS model of motivation for learning developed by Keller with the traditional five phased military ISD model. The proposed ISD model provides a framework for organizing instructional principles, strategies and techniques concerning the affective domain and furnishes a theoretical base to aid in formulating research hypothesis and collecting empirical data.

The study concludes with recommendations for additional elaborations and research needed to operationalize the model to make it a practical tool for use by instructional designer/developers. Attention to the affective domain is particularly important for technology based instruction that removes the teacher/student interaction from the lesson delivery. This model should be helpful because it provides the systematic consideration of the affective domain in every aspect of the instructional design process.

## Air Force Productivity Issues

Michael D. Matthews  
Drury College

### Abstract

The purposes of the current report are to (1) critically examine the evidence relating to the efficacy of Total Quality Management (TQM) interventions, particularly within operational Air Force organizations; and (2) to explore the literature examining the relationship between individual characteristics and group or unit performance. The first objective of this report focuses on an effort which blends the Method for Generating Effectiveness and Efficiency Measures, or MGEEM (Tuttle, Wilkinson, & Matthews, 1984), with the suggestions of Deming (1986) in implementing TQM programs. The focus of the latter objective is on operational military work groups. Efforts will be made to identify areas of research within the context of these issues which may ultimately produce results that may enhance unit productivity of Air Force organizations. Thus, both objectives of the current paper focus on issues pertaining to unit productivity.

# Individual Differences (Impulsivity) and Personnel Selection

## Final Report

Jim H. Patton, Ph.D.  
M. Denise Brady, B. A.  
Department of Psychology  
Baylor University

Siem, Carretta, & Mercante (AFHRL-TP-87-62, 1988) found a relationship between performance on the Self Crediting Word Knowledge (SCWK) test portion of the BAT and pilot performance in Undergraduate Pilot Training (UPT). SCWK correlated 0.14 ( $p < 0.01$ ) with pass/fail criteria for UPT candidates. One way to interpret these data is to note that subjects who passed UPT : took longer to answer on SCWK, had fewer total correct responses, and bet fewer points on the responses they did make. Even when overall verbal ability was statistically controlled there were smaller but robust differences in time to answer between successful and unsuccessful candidates. Those candidates who completed UPT tended to take longer for their responses. The authors interpreted this finding as a manifestation of a more cautious decision-making style exhibited by successful UPT candidates.

Siem (1991) tested 302 UPT candidates using various tests (BAT) including the SCWK test and the Activities Interest Inventory (AII). Siem found: 1) that response latency measures were related more closely to self-report personality measures than to cognitive response times, 2) that the risk-taking score was associated with a self-report measure of thrill seeking, and 3) that the performance-based self-confidence score was correlated with verbal aptitude but not with a self-report measure of self-confidence. A confirmatory factor analysis performed to examine the data structure provided a three factor model: 1) verbal self-confidence, 2) cautiousness, and 3) thrill-seeking.

What does all this mean mean? We know: 1) pilots need adequate levels of thrill-seeking or they won't fly jets, 2) cautious decision makers do better in UPT, 3) thrill seeking and cautious decision making (the opposite of impulsivity) are components of what purveyors of the "Big 5" call Surgency, or that Eysenck calls Extraversion, and 4) Surgency, by itself, is not strongly associated with pilot characteristics (Ashman & Telfer, 1983).

What would we like to know: 1) will a composite score incorporating high thrill-seeking and low impulsivity, essentially a decomposition of surgency, predict pilot training success, 2) if such a situation occurs what is the magnitude of the relationship, and 3) are there particular "impulsivity factors" associated with poor training performance?

## **D-4. HUMAN RESOURCES LABORATORY: OPERATIONS TRAINING DIVISION (OTD)**

### **A COMPUTER MODEL OF MULTIRAD (Multiship Research and Development)**

Arthur W. Draut

#### **Abstract**

This report describes a first attempt at modelling the aircraft simulator network at the Armstrong Laboratory, Aircrew Training Division, Williams AFB, AZ. The laboratory uses a modification of SIMNET (Simulation Network) as the network connecting the simulators. The modelling tool used was a free trial version of Network 11.5, produced by CACI Products Co. This report includes descriptions of MULTIRAD, SIMNET and Network 11.5. Most of the author's ten-week tenure was spent understanding the configuration of the system as it exists. Simple models of simulation networks were built on Network 11.5 as a means of learning to use the software. The author recommends buying the Network 11.5 software. The building of detailed models of existing and proposed networks is proposed as continuing research.

This work was supported by the Air Force Office of Scientific Research Summer Faculty Research Program.

CERTITUDE ESTIMATES AND PROCESSING TIMES  
MAY FACILITATE STUDENT MODELLING  
FOR THE ADMINISTRATION OF EFFECTIVE FEEDBACK"

Thomas Emerson Hancock  
Assistant Professor of Educational Psychology  
Grand Canyon University

Abstract

The efficiency of training could be improved if the administration of instructional feedback were based upon the inferred cognitive state associated with each trainee's response. The use of certitude estimates and response times may provide reliable sources for computer generated student models of processing characteristics. In this context, several proposals are made for extending the prevailing model of instructional feedback (Kulhavy & Stock, 1989). These suggestions were explored in an item learning paradigm with 26 subjects responding to 200 semantic knowledge multiple choice questions, studying feedback, and taking posttests on two occasions. This work is placed within a theoretical framework using perceptual control theory (Powers, 1973, 1989), along with aspects of an argument model for confidence in judgements (Read, 1991), and current understandings of knowledge activation (e.g. Anderson, 1983, Anderson, 1989). Also reported are the current plans for more complete experimental studies and for modelling higher level control systems.

PRELIMINARY STEPS TOWARD DEVELOPMENT OF RESEARCH PROGRAM

Dr. B.E. Mulligan, Professor, Department of Psychology

The general goal of my work this summer was to explore the feasibility of developing acoustical measures of vocally expressed emotion in man and animals. Under appropriate conditions, virtually all sound-emitting organisms acoustically broadcast signs of their biological condition. The ability to acoustically detect emotional changes in the condition of persons and animals would have potential value not only as a research tool, but also in military, medical and civilian applications.

**D-5. HUMAN RESOURCES LABORATORY: TRAINING SYSTEMS  
DIVISION (TSD)**

**COGNITIVE CONSIDERATIONS FOR TRAINING "WHERE" AND "WHAT"  
SPATIAL KNOWLEDGE AS PROPOSITIONS AND RULES**

**James R. Dykes, Jr.  
Associate Professor of Psychology  
University of Texas at San Antonio**

**Abstract**

The goal of STAMP is to identify the most effective training method for each knowledge type. Psychologists hypothesize a major distinction between declarative knowledge (knowing that) and procedural knowledge (knowing how). Declarative knowledge is composed of propositions and procedural knowledge is composed of rules. First, evidence is reviewed for the importance of this distinction within the domain of spatial knowledge of large scale spaces. Such "where" knowledge includes both knowing the location of landmarks (propositions) and how to navigate through the space (rules). Second, models about how people store "what" knowledge are reviewed. Third, the importance of the student's learning mode on the training of "what" knowledge is reviewed. It is concluded that early STAMP research should focus on two kinds of spatial knowledge: "where" (large scale spaces) and "what" (classification of instances). Each is central to Air Force mission and can be studied by constructing a common data set, but separately training the information as propositions and rules. Important training variables are discussed with an eye toward the importance of individual differences.

Fundamental Skills and Air Force Accessions:  
Linking Individual Abilities and Organizational Needs

Juanita M. Firestone, PhD

Robert L. Caldwell, Research Assistant

Abstract

This paper analyzes data from a wide variety of sources and compiles an inclusive assessment of fundamental skills in the Air Force accession pool. Data from a variety of sources such as The U.S. Census, The U.S. Department of Education, The Department of Defense, The U.S. Air Force, and The U.S. Bureau of Labor Statistics are used to link the material necessary for establishing a general profile of the typical Air Force recruit pool with respect to characteristics associated with fundamental skills and the training of those skills. This demographic information is further coupled with occupational growth patterns, delineating similarities/differences in civilian industries' and the Air Forces' personnel needs. The above information is joined with high school graduation rates and standardized test scores to relate indicators of individual fundamental skill levels to organizational skill needs. Most data are projected from 1980 through the year 2000, taking into account the impact of any important demographic trends on this process.

A Study of The Effects of Cognitive  
Style on Achievement When the Style  
of the Hypertext Matches the Style  
of the Learner

John H. Harris, Ph.D.  
Associate Professor of  
Mathematics and Computer Science

ABSTRACT

This study attempts to look at the effect of one dimension of cognitive style on performance in a hypertext environment. Subjects were classified as either field independent(FI) or field dependent(FD). Hyperdocuments were developed which emphasized either a top down(TD) approach or a bottom up(BU) approach to learning. The subject domain used was BASIC Programming. Subjects were randomly assigned to one of the two hyperdocuments. Each group browsed the hyperdocument for a variable period of time. A pre- and a post test were given in order to assess learning. A questionnaire was administered in order to assess satisfaction of experience.

Results were analyzed with a 2x2 factorial design using the post test as the dependent variable and the hypertext design type and cognitive style as the independent variables. Audit trails were also collected.

It is expected that the FD-BU and the FI-TD groups will do significantly better than the other groups on the post-test. The matching of the hypertext design with the learning style should produce better results. At minimum it is expected that those two groups will be more satisfied with the learning experience.

## STRUCTURED LANGUAGE TRAINING USING A PSEUDO LANGUAGE KERNEL

Professor  
Gerald N. Pitts

### ABSTRACT

The AFOSR Summer Research program provided this researcher the opportunity to investigate ITS's, receive hands on experience with authoring shells, and initiate a two pronged research effort. One research avenue is the application of fuzzy logic to the intelligence module of an ITS as a replacement of the knowledge based inference engine. The second topic area that "bubbled to the surface" was the concept of applying pseudo language structures to the constructs of programming language training. These research ideas have definite potential utility in the long term Air Force project labeled STAMP and possible applications to most all training research projects. The holistic view of a proposed ITS using fuzzy predictors is provided in the first section of this report. The balance of this report describes a new innovative approach to programming training strategy along with detailed structure development.

## **D-6. OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (OEHL)**

### **TEST OF NOVEL DETECTOR FROM NEUTRONS**

**Stanley Bashkin**

#### **Introduction**

The purpose of my Fellowship was to enable me to make and test a novel detector for neutrons, which I had invented. The Armstrong Laboratory at Brooks Air Force Base in San Antonio, Texas, includes the Occupational and Environmental Health Directorate, which, among other things, has a major responsibility for the testing and calibrating of radiation instruments. Consequently, their concerns and facilities made it apparently appropriate for me to carry out the proposed activity under their program.

When I arrived at Brooks, I was told that Dr. Robert Mania, from the Department of Physics at Kentucky State College, had also been selected as a Fellow in the same group as myself; Dr. Mania generously agreed to assist in the prosecution of my project, pending the start of his own work.

**GC/FTIR ANALYSIS OF BENZENE IN COMPLEX MIXTURES USING THE  
HP 5965A INFRARED DETECTOR**

**PROFESSOR VERNE L. BIDDLE**

**I. ABSTRACT**

An analytical method using capillary column GC for the analysis of benzene in complex mixtures, such as JP-4 jet fuel, has been devised and compared with the presently used method. Hewlett-Packard's 5965A FTIR detector is shown to be superior to FID in terms of accuracy, using actual field samples.

## NEW SCINTILLATION DETECTOR

Robert C. Mania Jr.  
Associate 99

### ABSTRACT

A new scintillation detector, for the detection of neutrons, was designed, built, and tested. Two detectors were built, one using Helium-3 and the other Boron Trifluoride. The detectors use the neutron-nuclear interaction to produce ions. These ions come from the detector gas atoms splitting upon interaction with the neutron. The excess energy of interaction is carried away by the motion of the ions produced. These ions while traveling through the gas should excite the electrons in the gas. When the excited electrons decay back to the ground state, light is emitted. Nitrogen gas was added to the tube to increase the amount of light emitted. When the detectors were exposed to a PuBe neutron source, supplying approximately 6,330,000 neutrons/sec, no light was detected. It is felt that a larger neutron source is needed to produce more interactions and either a photomultiplier tube or photodiodes are needed to observe the light signal.

## D-7. SCHOOL OF AEROSPACE MEDICINE (SAM)

### ULTRASOUND PRODUCTION BY ADULT RATS (RATTUS NORVEGICUS)

Suzanne C. Baker  
Assistant Professor, Department of Psychology  
Weber State University

#### Abstract

The literature on ultrasonic vocalizations of adult rats (Rattus norvegicus) was reviewed. The "22-kHz" call, which is emitted in a variety of contexts, has been hypothesized to indicate a state of anxiety or distress. The occurrence of the 22-kHz call during the presentation of startle-eliciting acoustic stimuli was examined in both STS soman-treated rats and untreated controls. Twenty percent of STS rats emitted the 22-kHz call during startle tests, while 22% of the controls did so. Complete acoustical analyses were not possible, but the physical characteristics of the call did not appear to differ between groups. Rat vocalizations also were recorded during presentation of shock and during exploratory behavior. In addition, recordings of rhesus macaque (Macaca mulatta) vocalizations were made in several testing and housing situations, in order to develop a baseline data base for investigating the expression of emotionality and stress in macaque vocalizations.

Dr. David Barnett

Not Available At This Time

## COMPUTER ASSISTED MICROSCOPY OF CELLS

Robert V. Blystone, Ph. D.  
Professor of Biology  
Trinity University

### Abstract:

The project described herein dealt with performing both light and electron microscopy of cells of interest to the lab of Dr. Johnathan Kell, Directed Effects, Armstrong Lab, Brooks Air Force Base, Texas. The microscopy data acquired from Bacillus anthracis and RAW 264.7 mouse macrophage cells were subjected to various computer analysis routines developed for this purpose. Graduate students Christopher Collumb and Tod Romo worked with me on different aspects of the project. Mr. Collumb in his summer report has reported on the efforts to monitor RAW cell growth with an optical scanner. Mr. Romo developed techniques for the three dimensional visualization of the RAW culture growth and early identification of RAW foci formation. My role, in addition to directing the two graduate students, was to assemble the visualization equipment, to visualize the Bacillus, and to develop extensions for the computer analysis techniques devised for cell analysis. We found that microcomputer image analysis could provide a very useful adjunct to the microscopy of cells.

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FINAL REPORT  
AFOSR SUMMER FACULTY RESEARCH PROGRAM

**Proposed Methodology for Synthetic Task Construction**

Dr. Gerald P. Chubb  
Assistant Professor  
Ohio State University  
Department of Aviation  
2160 West Case Road  
Columbus, Ohio 43235

**Abstract**

The assignment was to review synthetic work activities and devise a method for relating them to both the real-world (or simulated) systems they abstractly represent and to performance test batteries that measure abilities. Task taxonomies, verbal protocol analysis for cognitive task analysis, and some of the recent task paradigms used for studying complex human behavior in laboratory experiments were all reviewed. General principles for constructing synthetic tasks are suggested based upon this review. Problems in generalizing from performance batteries and synthetic tasks are also discussed.

**NUTRITION FOR TAC PILOTS: A REVIEW OF LITERATURE**  
**Associate Professor of Home Economics Gene H. Evans, Ph.D., R.D.**  
**Valparaiso University**

**Abstract**

**This report provides a chronological overview of approximately five decades of nutrition research applicable to Tactical Air Command (TAC) pilots under operational conditions with an emphasis upon diet and acceleration tolerance. Current sources of nutrition recommendations and information for TAC pilots are also surveyed. Areas where paucity of data exist are identified and recommendations for nutrition research outlined.**

THE ANALYSIS OF PULSE PROPAGATION IN LINEAR DISPERSIVE MEDIA  
WITH ABSORPTION BY THE FINITE-DIFFERENCE TIME-DOMAIN METHOD

Fred J. German

Faculty Research Associate

ABSTRACT

The finite-difference time-domain (FDTD) method is used to solve the Maxwell equations in media which exhibit frequency dependant complex permittivity using two conceptually different approaches. The first approach uses a convolution integral to relate the electric field (E) to the electric flux density (D) while the second approach relates the two via an ordinary differential equation. It has been observed that the differential equation method is the more accurate technique. Several examples illustrating pulse propagation in both Debye and Lorentz dispersive media are presented and the results obtained with the FDTD method are in good agreement with other available data. While the present work addresses only the one dimensional problem of a dispersive half-space, the method itself is applicable to general two and three dimensional problems as well.

EFFECTS OF LOSS OF CONSCIOUSNESS ON THE MEMBRANE POTENTIAL  
OF NEOCORTEX CELLS OF RATS:  
A MODEL OF GRAVITY-LOSS OF CONSCIOUSNESS (G-LOC)

ABSTRACT

Kirk L. Hamilton, Ph.D.

The effects of loss of consciousness (LOC) on membrane potentials of neocortex cells of the rat was examined with microelectrodes. Loss of consciousness was induced by performing an aortic transection, thus, resulting in cerebral ischemia. Preliminary experiments were conducted to characterize different types of membrane potential recordings. Two types of recordings were noted. First, most recordings of membrane potential were "flat" and were greater than  $-50$  mV. Some cells had membrane potentials which were greater than  $-80$  mV. The second type of recording of membrane potential possessed "spike" activity. Generally, cells which exhibited spike activity had membrane potentials which ranged between  $50$  to  $-60$  mV. Recordings of membrane potentials from cells which were subjected to LOC due to cerebral ischemia showed various recordings. Once again, cells had membrane potentials greater than  $-70$  mV. Once the aorta was transected, the EEG was isoelectric within  $14 - 25$  sec and the membrane potential went through varying phases of depolarizing and hyperpolarizing potentials. Additional studies are needed to further characterize the effects of LOC on the membrane potential of neocortex cells. These results, though preliminary, represent a good "bench-top" model of LOC which will provide important additional information which can aid in the evaluation of the physiological phenomena of gravity-induced loss of consciousness (G-LOC).

PREDICTION OF MAXIMAL OXYGEN UPTAKE FROM SUBMAXIMAL  
EXERCISE TESTING IN AEROBICALLY FIT AND NONFIT SUBJECTS

G. Harley Hartung, Ph.D.  
Faculty Research Associate (Professor of Physiology)

ABSTRACT

Aerobic physical fitness as determined by the body's maximal capacity to utilize oxygen ( $\dot{V}O_{2max}$ ) during demanding work is an important determinant of a person's ability to perform many military job tasks. The need to easily and accurately estimate this important factor on a periodic basis is becoming evident as dissatisfaction with the present 1.5 mi run mounts. This paper reviews prior studies of a test which uses heart rate response to known workloads on a cycle ergometer to predict  $\dot{V}O_{2max}$ . This test, as revised by scientists at the USAF Armstrong Laboratories at Brooks AFB, Texas, was validated on 20 male subjects by comparing the test results with laboratory measurements of  $\dot{V}O_{2max}$  obtained by analysis of expired air during maximal treadmill exercise. The cycle ergometry prediction underestimated the measured  $\dot{V}O_{2max}$  in all subjects, but there was a correlation of 0.93 between the estimated and measured values. Both estimated and measured  $\dot{V}O_{2max}$  were significantly higher in the group of trained runners than in the inactive subjects.

A COMPARISON OF THERMOREGULATORY RESPONSES AND WORK PERFORMANCE  
IN SUBJECTS WEARING  
STANDARD CHEMICAL DEFENSE AND CWU-77P ENSEMBLES

Richard A. Hengst, Ph.D.

Abstract

Two chemical defense ensemble configurations were tested for human subject performance under heat stress conditions (40°C; 20% relative humidity). The CDE+BDU is the configuration currently issued by the U.S. Air Force while the CWU-77P represents alternate design concepts currently under consideration for protective clothing. Physiological parameters of Heart rate, skin temperature, rectal temperature ( $T_{re}$ ), sweat production and clothing temperatures were measured while subjects walked at a constant rate of 1.34 m/sec (5% grade). Subjective perception of thermal comfort and perceived exertion were also evaluated. Experiments were terminated when  $T_{re}$  increased 1.5°C above starting values. CWU-77P allowed for 62% longer performance periods under heat stress conditions. Reasons for this improvement appear to be a lower mean skin temperature and higher evaporation rates through suit cloth. This appears to allow slower rates of heat storage and rise in core temperature thus prolonging activity times. No other physiological parameters could account for these differences. Subjects rated both suits equally in regards to thermal comfort or perception of work load imposed by the protective clothing.

# WHITE-NOISE ANALYSIS OF CAROTID BARORECEPTOR FUNCTION

by  
Arthur J Koblasz, PhD  
Associate Professor of Engineering Science & Mechanics  
Georgia Institute of Technology

## Abstract

A feasibility study was performed on an adult male New Zealand White rabbit to determine whether it is possible to "white-noise" modulate blood pressure in the vicinity of the carotid baroreceptors. Pressure variations were induced by varying the flow rate of IV fluid injected into the carotid artery approximately 1 centimeter below the baroreceptors. Equal volumes of blood were periodically removed from the femoral vein. The resulting modulations of carotid blood pressure were random. However, the pressure data has not been analyzed yet to verify that the power spectrum was flat over the desired range of frequencies, DC to 5 Hz.

THE EFFECT OF HYPERBARIC OXYGENATION ON MUSCLE REGENERATION  
FOLLOWING TOXIN INDUCED NECROSIS

Dr. Arnold Nelson, Summer Faculty Researcher

Abstract

Skeletal muscle's viability and its capacity to recover from injury are tied to the amount of oxygen present in the tissue. Hyperbaric oxygenation therapy (HBO) has been shown to reduce the amount of muscle necrosis and thus maintain viability during acute conditions of ischemia and compartmental syndrome. It is not known, however, if HBO will continue to slow the rate of necrosis under more chronic conditions or if it will accelerate the recovery from a necrotic condition. The purpose of this project was to determine if the rate of muscle regeneration or recovery from a chemical toxin induced muscle necrosis can be accelerated by HBO.

Bioeffects of Microwave Radiation on  
Amino Acid Metabolism by Mammalian  
Cells

by

Donald K. Robinson

Abstract

In this study we sought to determine if microwave radiation (2450 MHz, 30 minutes) has an effect on the amino acid composition of the growth media. Three separate cell lines were used: RAW mouse macrophage cells; C3H mouse embryo cells and 3T3 mouse embryo cells. The effects of microwave and sham treatment on cell number or cell density were also evaluated in order to determine if the effects are the result of changes in cell metabolism of amino acids or due to changes in cell number. In addition, studies were performed on all three cell lines using two cell densities; a standard density and a 1:10 dilution. The changes in amino acid profiles were determined by thin-layer chromatography 24 hours post microwave and sham exposure. Two amino acid antagonists were used to amplify the effects of microwave radiation. The amino acid bands were found to be less intense in the microwave treated pairs of two of three cell lines examined. In addition, the bands were also less dense in the microwave exposed groups that had been diluted 1:10 and in the groups that contained the amino acid antagonists. The cell number did not appear to differ significantly, thereby indicating that the changes are due to an effect on metabolism rather than on cell number.

# EVOKED ELECTRICAL ACTIVITY IN THE HAMSTER SUPRACHIASMATIC NUCLEUS MONITORED OPTICALLY WITH VOLTAGE-SENSITIVE DYES

David M. Senseman, Ph.D.

Associate Professor

Division of Life Sciences

The University of Texas at San Antonio

## ABSTRACT

The optimal conditions for monitoring the spatial/temporal patterns of neural activity evoked in the hamster suprachiasmatic nucleus (SCN) using optical recording techniques were determined. 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 an *in vitro* slice preparation of the SCN to be directly visualized and quantitatively analyzed following electrical stimulation of the transected optical nerve. In most preparations, a single 0.5 ms shock to the optical nerve evoked widespread neuronal activity that could be detected from both ipsilateral and contralateral SCN's after staining with the voltage-sensitive dye RH155. Control experiments demonstrated that the recorded optical signals were not seriously distorted by either the stimulus artifact or by changes in intrinsic light scattering. The feasibility of using multiple-site optical recording techniques to study evoked activity in the hamster SCN was clearly demonstrated.

## FINAL REPORT

### Development of an Enhanced Hydraulic Cardiovascular Model/Test Apparatus for In-Vitro Simulations in Altered-g Environments.

Richard D. Swope, Ph.D.

#### **ABSTRACT**

This report concerns the design of a mechanical/hydraulic model which can be used to study cardiovascular system responses to low, high and very high gravitational fields. The model will require lumped element equivalents of major circulation components including the heart, the aorta, the lungs, and major systemic vascular beds. A design tool (compliance box) for determining the parameter values of the mechanical elements required to hemodynamically model the body parts is evaluated and tentatively found to be successful. The mechanical model is considered a good substitute for the actual body part if the input impedance and compliance are properly scaled and modeled. The statistical design of experiments (Full Factorial Analysis) is introduced and used as a tool for developing the design equations of the lumped elements. A variety of transducer systems for measuring flow velocity and pressure in the model are considered and it is found that the hot film anemometer is an excellent choice for velocity and remote pressure transducers connected to the flow system via short lengths of copper tubing are suitable for pressure measurements.

**An Investigation of the Checkmark Pattern and the Effects  
of Measurement Error and Collinearity  
in Covariates in the Air Force Health Study**

by

**Ram C. Tripathi  
Division of Mathematics, Computer Science and Statistics  
The University of Texas at San Antonio  
San Antonio, TX 78249**

**ABSTRACT**

The scientists working with the Air Force Health Study data observed a pattern between the prevalence of diabetes and dioxin exposure in the Comparison group as well as in the Ranch Hand group. Under this pattern, the Ranch Hand rate of disease is less than the Comparison rate among subjects with low current dioxin levels (less than 10 parts per trillion (ppt)), and greater than the Comparison rate in Ranch Hands with high current dioxin level (greater than 33 ppt). A similar pattern was observed regarding the association between the mean triglyceride and dioxin. A statistical model is derived that explains this pattern. It is likely that some variables in this study are subject to measurement errors. The effect of measurement errors in covariates on the estimates of various parameters is assessed and quantified. The assessment and diagnosis of collinearity among covariates while fitting logistic regression model, not yet available in packaged programs, has been implemented in a SAS program given in the Appendix.

## **D-8. WILFORD HALL MEDICAL CENTER (WHMC)**

### **TEMPERATURE EFFECTS OF ESR, CELL VOLUMES AND VISCOSITIES: FINAL REPORT**

**Professor W. Drost-Hansen**

#### **ABSTRACT**

Erythrocyte sedimentation rates and erythrocyte and platelet volumes of blood from 13 different species of mammals have been found to change abruptly near 46 - 46°C. The often dramatic drop in sed rates for temperatures above 45°C reflect a histologically proven change in shape of the red cells from biconcave disks to nearly spherical. This change in morphology prevents rouleaux formation and thus lowers the sed rate. Furthermore, the viscosity of blood plasma increases rapidly and abruptly above the critical temperature of 45°C thus further lowering the sed rate. Finally, even resuspended erythrocytes in the absence of the plasma proteins show markedly reduced settling rates above 45°C. Abrupt changes are also seen in some parameters near 30°C; these and the 45°C anomalies reflect the effects of structural changes in the vicinal water associated with both the cells and the biopolymers in solution. This interpretation is further supported by notable thermal anomalies seen in the viscosities of a variety of polymers in aqueous solution, including both synthetic model polymers and naturally occurring biopolymers (such as BSA and fibrinogen.)

## D-9. ASTRONAUTICS LABORATORY (ASTRO)

### SOME RELATIONSHIPS OF ACOUSTICALLY MEASURABLE PARAMETERS TO MICRO-STRUCTURAL DAMAGE AND MECHANICAL PROPERTIES OF SOLID ROCKET PROPELLANTS

David M. Elliott, Ph.D.  
Associate Professor  
Arkansas Tech University

#### ABSTRACT

This work consists of an analysis of the results of a previous experimental program which measured acoustical as well as mechanical parameters of an inert solid rocket propellant subjected to complex uniaxial loading histories. The objective of the current work was to determine additional relationships between acoustic parameters and microstructural damage and mechanical properties which might be used to enhance the fundamental understanding of the micromechanics of solid rocket propellants and lead ultimately to a non-destructive test to measure the microstructural damage accumulated over complex time dependent loading histories. It was found that, of the two acoustic parameters measured, relative attenuation is a better measure of microstructural damage than is a sound speed parameter. For constant strain rates, relative attenuation was found to be Gaussian in strain. This result was used as the basis for a new model to predict volume dilatation as a function of strain. While not yet verified by comparison to experiment, this model appears to give reasonable results. It was found that the energy dissipated within the sample during cyclic loading was correlated with microstructural damage as measured by relative attenuation. Three such correlations are presented. The secant modulus of this inert solid rocket propellant was found to be linearly correlated with relative attenuation and to exhibit a definite shift with strain rate.

## FINAL REPORT

### RESEARCH IN VIBRATION IDENTIFICATION, ISOLATION, AND SUPPRESSION FOR LARGE SPACE STRUCTURES

James Michael Argento  
Robert Alan Carlin  
Marco David D'Amore  
Ephraim Garcia, Ph.D.

#### **I. INTRODUCTION**

The loads and vibrations that impinge upon a payload during launch have historically been the focus of structural and design engineers. My summer research focused on one particular Air Force satellite, and the possibility of reducing the loads from the two launch vehicles currently used: the Titan IV, and the Space Shuttle. The first step in this ongoing project was to learn about the structure of this satellite and perform an eigenanalysis using Nastran, NASA's Structural Analysis program. The next step involves a parametric study of the passive and/or active system that would be required to reduce said loads. It is assumed that this vibration isolator would be positioned between the satellite and the Inertial Upper Stage (IUS) upon which the satellite sits during launch in both vehicles.

Every satellite and its own substructures must be designed in such a way that they can withstand "launch cycle loads", and be able to perform their duties once they reach orbit. A considerable savings could be gained if these loads were reduced by some means. The savings are numerous and could include a decreased mass for the main load bearing members in the satellite, and in turn, an increased allowable mass for other components, such as electronics and propellant for attitude rockets. Another benefit is longer satellite life, since more propellant could mean a greater number of attitude adjustments while on orbit. The electronics on board might also exhibit longer life and have an even greater endurance, since the dynamic loading on the circuitry during launch would be reduced. With this in mind, the investigation into a vibration isolator for satellite systems has great potential.

Analytical and Experimental Investigation  
of The Mode Dampings in Laminated Composite Beams

H. Ghoneim

Abstract

A viscoelastic constitutive equation which accounts for damage is proposed. The equation is implemented into a finite element program and used to predict the mode dampings of a cantilever laminated beam. The results are compared with the corresponding experimental ones for a graphite epoxy laminated beam. The effect of the frequency and amplitude of vibration as well as damage is addressed. Discussion of the results and conclusion are presented.

THE SYNTHESIS AND PROPERTIES OF ENERGETIC SALTS WITH POTENTIAL FOR  
DEVELOPMENT AS SOLID ROCKET PROPELLANTS

Dr. Vincent P. Giannamore

ABSTRACT: Energetic salts with potential for use in solid propellants have been investigated. Three nitroformate salts have been prepared. Each combines a cation which can serve as a fuel with the oxidizing nitroformate anion. The characterization of these compounds is reported as well as some of their thermal properties and sensitivity to impact and friction. Triaminoguanidinium nitroformate, while highly energetic, is probably too sensitive to warrant further development. Guanidinium nitroformate, however, appeared to be a candidate for further development as a propellant ingredient. Hexaamminecobalt(III) nitroformate may have been prepared but more investigations are required for its characterization and demonstration of its value as a propellant ingredient.

## **DROP SIZE INSTRUMENTATION FOR ROCKET INJECTOR TESTS**

**William M. Grissom  
Assistant Professor of Physics  
Morehouse College**

### **ABSTRACT**

Three drop sizing instruments were studied for tests in liquid rocket injector sprays. These included two commercial instruments, a Malvern Particle Analyzer and a Phase Doppler Particle Analyzer, as well as a Coaxial Beam Particle Analyzer developed by the author. The main effort involved design and construction of an improved Coaxial Beam Particle Analyzer.

# **LIQUID JET INJECTION PROCESSES IN LIQUID ROCKET ENGINES**

**S. D. Heister, Assistant Professor**

**AFOSR Summer Faculty Program Final Report**

**Purdue University, School of Aeronautics & Astronautics**

## **ABSTRACT/SUMMARY**

**This report summarizes efforts completed during the time period 16 May - 26 July, 1991 while on assignment within the AFOSR Summer Faculty Program at Phillips Laboratory Rocket Propulsion Division at Edwards Air Force Base, California. A review of the current state-of-the-art in the analysis of liquid jet injection processes as applied to liquid rocket engine injectors has been conducted. Fundamental physical mechanisms and analytic treatments of atomizing jets is discussed herein. In addition, an improved correlation technique is described and recommended for future data reduction of atomizing jet experiments. It is anticipated that this correlation technique will improve descriptions of experimental results thus making correlations more useful for the design of future liquid rocket engine injectors.**

## ABSTRACT

### XAFS of AP and AP/Binder Systems

R. W. Hoffman

Phillips Laboratory  
Edwards AFB Ca

Techniques of Lytle detection in x-ray fluorescence were applied to 26 distinct chemical samples at the Cl edge, 1 at the K edge, and 7 at the Ti edge. The specimens commonly were pressed from powders, 2.5  $\mu\text{m}$  particle size in the case of AP to thicknesses of about 1/32 in., thus obtaining samples for further experiments of adding binders or remaining uncoated. A special sample holder was designed and constructed to aid in the specimen transfer. The sample thickness necessitated fluorescent detection with an estimated probing depth of 25  $\mu\text{m}$ . The experiments were carried out on beam line X-19A at Brookhaven National Laboratory and are in the process of being quantitatively evaluated. Differences in the XANES spectra between binders are noted, and tentatively related to the steric chemistry and to the local structure and valence of the Cl containing samples. Several new polymeric materials were also examined.

# **Polymeric Ionic Conductors - Electrolytes for Solid Polymer Batteries**

I.A. Howard  
Department of Physics, University of Texas at Arlington

OLAC PL/STPP,  
Edwards AFB, CA 93523

## **Abstract**

A survey has been conducted of the state of development of polymeric ionic conductors suitable as electrolytes for secondary battery applications. Criteria for suitability involve conductivity, structural stability, and anion transfer number. Although a number of modifications have been tried, it appears that a (poly(ethylene oxide) [PEO] + Li salt) complex is the best overall candidate at present. An approach to the problem that will allow predictive capability is, from a theoretical point of view, difficult since a macroscopic treatment necessarily involves some sort of statistical averaging over chain configurations of the amorphous conducting phase. It is suggested that a series of single-chain calculations on PEO segments plus cations and anions will be useful in clarifying the positions of ions relative to the backbone, the equilibrium distortions of the PEO chain segment in the vicinity of the ions, and the activation energies for motion of ions from one backbone oxygen site to another. Substitutions on sidegroups and/or backbone can also be explored. Several possible methods are discussed.

# MODEL REDUCTION AND CONTROL OF ASTREX

Ashok Iyer

Associate Professor

Department of Electrical and Computer Engineering

University of Nevada, Las Vegas

Las Vegas, NV 89154

Summer 1991

## Abstract

The Advanced Space Structures Technology Research Experiments (ASTREX) is a precision structure situated at the Phillips Laboratory, Edwards Air Force Base, CA. The structure is a testbed to develop, test and validate control strategies for large-angle, three axis slewing maneuvers and vibration suppression. The ASTREX facility consists of the test article (with primary, secondary and tertiary substructures along with mirrors. Model Reduction using Schur decomposition and balanced truncation and control strategies using state estimation and regulator design and optimization using LQG to reduce vibrations were implemented. The controller was evaluated using the full order ASTREX model.

**Research in Emerging Technologies  
at Phillips Laboratory**

**P.W. Langhoff**

**Department of Chemistry  
Indiana University  
Bloomington, IN 47405**

**Abstract**

**Progress is reported in theoretical and computational studies related to the research interests of the Emerging Technology Branch at Phillips Laboratory, Edwards AFB. Topical areas under investigation include (i) photoassisted formation and detection of metal diatomic molecules, (ii) aspects of high-temperature solar absorbers for rocket propulsion systems, (iii) homopolar induction as a zero-point energy device, (iv) spectra of trapped atomic radicals, and (v) metal atom recombination dynamics in cold fluids. Individual technical reports in each topical area are in preparation and will be provided subsequently. Attention centers here on report of progress in studies of the formation and detection of metal diatomics and in related aspects of high-temperature absorbers for the solar rocket program. Specifically, calculations are performed of AlLi absorption profiles, estimates are provided of Raman-assisted formation rates of this compound, and the thermodynamics and spectral lineshapes of Li vapor in H<sub>2</sub> and buffer gases are investigated.**

## MECHANICAL TESTING OF ISOGRID STRUCTURES

Dr. Christopher A. Rotz  
Brigham Young University

### Abstract

Isogrid triangles without skins were tested in compression to collect data for comparison with computer models under development at Phillips Laboratory. Descriptions of the testing system, isogrid geometry, and specimen preparation are given. Test results from six strain gages attached to the isogrid are given as a function of the applied load. Load-deflection curves were also determined.

# NONLINEAR ADAPTIVE CONTROL OF ASTREX SYSTEM USING GAUSSIAN AND MULTILAYER NEURAL NETWORKS

Sahjendra N. Singh

Professor

Department of Electrical and Computer Engineering

University of Nevada Las Vegas

Las Vegas, NEVADA 89154

## Abstract

This paper considers large angle rotational maneuvers and vibration damping of the Advanced Space Structures Technology Research Experiment (ASTREX) System. Multilayer neural networks (MNNs) and gaussian networks are used in the adaptive control and stabilization of the system. Large angle rotational maneuvers of the ASTREX system cause significant nonlinear coupling of the rigid and elastic modes. We derive adaptive control law for nonlinear maneuvers of the ASTREX system. Interestingly, in the closed-loop system, the elastic dynamics asymptotically decouple from the rigid dynamics. A control law is derived for the vibration suppression using the auxiliary actuators. This stabilizer includes layered neural networks in the control loop. The stabilizer is synthesized using estimated states from an observer. The observer includes a layered neural network.

## D-10. GEOPHYSICS LABORATORY (GEO)

### SOME ASPECTS OF REMOTE SENSING

Frank P. Battles  
Professor and Chairman,  
Department of Basic Sciences  
Massachusetts Maritime Academy

#### ABSTRACT

This report summarizes research done at the Geophysics Directorate of the Phillips Laboratory in the Optical Environment Division of the Optical Measurements Branch under the direction of Edmund A. Murphy, focal point. This research consists of efforts along two distinct areas of remote sensing: one involving the re-analysis of stellar scintillometer derived profiles of  $C_n^2$ , the refractive index structure parameter, the other involving the stability of the solution of certain linear systems of equations involved in the Lidar measurement of certain atmospheric properties. The re-analysis of the scintillometer data was necessitated by the recent discovery that the originally assumed weighting functions were incorrect. We have also made comparisons to similar data obtained using an isoplanometer. These results are being prepared for publication. The Lidar work was suggested by Robert Beland of the Geophysics Directorate and involves the stability of solutions to the matrix equation  $\gamma = W C$  for  $C$  where  $\gamma$  is a Lidar measured vector function of height and  $W$  is lower triangular matrix involving certain weighting functions. We have begun to look at the stability of solutions,  $C$ , using several types of weighting functions and measurement vectors.

## THEORETICAL STUDIES OF COLLISIONAL VIBRATIONAL RELAXATION OF OH

Professor Ronald J. Bieniek

Experimental measurements of vibrational relaxation of OH through collisions with atmospheric constituents is an ongoing project of the LABCEDE group. Theoretical methods of computing multi-quanta transitions were required to interpret experimental data confidently. To achieve this, a method was developed to utilize T-matrix elements, based on adiabatic vibrational wavefunctions, in the exponential approximation for the scattering matrix. From quantum mechanical computations, multi-quanta transitions were found to be insignificant compared to single quanta transitions for experimental conditions and atmospheric disturbances of interest. Furthermore, a very simple scaling law was devised that readily and accurately tracks the sensitivity of relaxation rates to initial vibrational excitation. Rates for the relaxation of the  $n$ th-vibrational state were shown to be proportional to  $n \cdot \exp(\beta n)$ , where  $\beta$  is a constant determined from system parameters. This form successfully predicted changes in rates over several orders of magnitude.

## THE FORM OF CYCLONIC PRECIPITATION AND ITS THERMAL IMPACT

Stanley David Gedzelman  
Professor of Meteorology  
City College of New York

### Abstract

A two-dimensional parameterized cloud microphysics model has been developed and applied to explain the form of cyclonic precipitation and its thermal impact. A description of the model including several of the numerical techniques and physical processes is given. The model is then used to simulate three idealized case studies. The first is a strong front in which a zone of sleet separates regions of rain and snow. The second is a case of weak advection in which rain changes to snow. The third is a shallow supercooled cloud that produces freezing drizzle.

**A GEOGRAPHIC INFORMATION SYSTEMS IMPLEMENTATION ANALYSIS  
FOR THE GEOPHYSICS DIRECTORATE/ATMOSPHERIC STRUCTURE BRANCH  
PHILLIPS LABORATORY**

William L. Hamilton, Ph.D.  
Phillips Lab/Geophysics Directorate/Atmospheric Structure Branch

**Abstract:** The purpose of this document is to present an analysis for Geographic Information Systems (GIS) implementation within the USAF Phillips Lab/Geophysics Directorate/Atmospheric Structure Branch (GL/LYA). Methodology included three analysis partitions; GIS needs and functions identification, spatial data dictionary design recommendations, and hardware and software platform review and recommendations. Results indicated possible GIS applications within tactical cartography and modeling, cloud climatology, and mesoscale meteorologic modeling with common functional use of digital elevation models and associated first and second order derivative information. GIS hardware and software recommendations utilize existing computer platforms and public domain software to reduce integration cost and speed GIS implementation.

# **E. CARTAN MOMENT OF ROTATION IN ASHTEKAR'S THEORY OF GRAVITATION**

by

**Arkady Kheyfets**

## **Abstract**

The geometric construction of the E. Cartan moment of rotation associated to the spacetime curvature provides a geometric interpretation of the gravitational field sources and describes geometrically how the sources are "wired" to the field in standard geometrodynamics. E. Cartan moment of rotation yields an alternate way (as opposed to using variational principles) to obtain Einstein equations. The E. Cartan construction uses in an essential way the soldering structure of the frame bundle underlying the geometry of the gravitational field of general relativity. The geometry of Ashtekar's connection formulation of gravitation theory is based on a complex-valued self-dual connection that is not defined on the frame bundle of spacetime. We show how to transfer the construction of the E. Cartan moment of rotation to Ashtekar's theory of gravity and demonstrate that no spurious equations are produced via this procedure.

# PRELIMINARY ANALYSIS OF THE WESTERN NORILSK - LAKE BAIKAL DEEP SEISMIC SOUNDING PROFILE

Keith F. Priestley, Seismological Laboratory, University of Nevada,  
Reno, Nevada 89557

John Cipar, Phillips Laboratory, Hanscom AFB, Ma 01731

## INTRODUCTION

During the 1991 summer, we began a more comprehensive study of the Western Norilsk - Lake Baikal deep seismic sounding profile (Fig. 1.). The purpose of our investigation is to improve our understanding of the Eurasian crust and upper mantle velocity structure. A better comprehension of these factors in these areas will help in evaluating the significant factors controlling the propagation of regional seismic phases; in "calibrating" the IRIS seismographs and the Scandinavian arrays in terms of the seismic wavefield resulting from Kazakh Test Site (KTS) explosions; and in assessing the efficiency of high frequency propagation, and its use in elucidating source characteristics of Central Asian seismic events. An improved understanding of the propagating characteristics of regional seismic phases will facilitate interpretation of source characteristics from regional seismograms.

## **RDL Summer Research Report:**

A. S. Marathay, Optical Sciences Center,

Atmospheric dynamics is a very broad topic of research. There is a lot of activity at Hanscom. The group headed by Dr. Richard H. Picard is involved with multidisciplinary areas such as: atmospheric gravity waves, airglow and auroral phenomena, radiative transfer calculation, to mention a few. I found my involvement with the group highly educational and intellectually stimulating. Of all these projects, I was mainly involved with the radiative transfer calculation.

The radiative transfer equation (RTE) has been used in the study of planetary atmospheres for several decades. It describes what happens to a pencil of radiation travelling in a medium that can absorb and emit radiation. It does so by providing a formula for the space rate of change of specific intensity by appropriate accounting of the absorption (loss) and emission (gain) processes. The loss term contains the absorption coefficient and the specific intensity. The gain mechanism is best described by a generalized source term that includes spontaneous emission and scattering. In any problem of practical interest the RTE is coupled to the rate equations of populations which are governed by collisional processes and photochemical reactions in the atmosphere.

Atmospheric dynamics is complicated by the numerous small and large scale complex processes continually going on in the atmosphere. The chemical species and their interactions, the temperature profile, the atmospheric waves etc., in one form or another affect the radiative energy transfer. The atmospheric waves are mainly of three types: the gravity waves (vertical and transverse to the direction of propagation) acoustic waves (longitudinal to the direction of propagation) and Rossby waves (horizontal and transverse to the direction of propagation). The absorption of incoming and reradiated solar radiation is responsible for a majority of things going on in the atmosphere.

In this report we focus our attention on radiative transfer. In Section 2 the radiative transfer equation is discussed. In Section 2.1 we give some examples from applications. In Section 2.2 a formal solution is given and is applied to plane-parallel atmosphere in Section 2.2.1. Armed with this background material we look at some modifications of the equation of radiative transfer in Section 3.

# PRELIMINARY ANALYSIS OF THE WESTERN NORILSK - LAKE BAIKAL DEEP SEISMIC SOUNDING PROFILE

Keith F. Priestley, Seismological Laboratory, University of Nevada,  
Reno, Nevada 89557

John Cipar, Phillips Laboratory, Hanscom AFB, Ma 01731

## INTRODUCTION

During the 1991 summer, we began a more comprehensive study of the Western Norilsk - Lake Baikal deep seismic sounding profile (Fig. 1.). The purpose of our investigation is to improve our understanding of the Eurasian crust and upper mantle velocity structure. A better comprehension of these factors in these areas will help in evaluating the significant factors controlling the propagation of regional seismic phases; in "calibrating" the IRIS seismographs and the Scandinavian arrays in terms of the seismic wavefield resulting from Kazakh Test Site (KTS) explosions; and in assessing the efficiency of high frequency propagation, and its use in elucidating source characteristics of Central Asian seismic events. An improved understanding of the propagating characteristics of regional seismic phases will facilitate interpretation of source characteristics from regional seismograms.

FINAL REPORT

**STRUCTURAL AND VIBRATIONAL ANALYSES  
OF THE  
WAKE SIDE PLASMA SENSOR  
FOR THE  
WAKE SHIELD FACILITY**

Dr. Joseph J. Rencis, Associate Professor, P.E.  
Timothy J. Urekew, Ph.D. Candidate  
Christopher Scarpino, M.S. Student

**SCOPE**

This report serves as supporting documentation in certifying the Wake Side Plasma Sensor (WSPS) for flight as a secondary structure on the Wake Shield Facility. The WSPS is an experiment package that mounts on the free-flying Wake Shield Facility (WSF). A sectional view of the WSPS is shown in Fig. 1.

# **A PRELIMINARY INVESTIGATION OF HIGH RESOLUTION INTERFEROMETRY OF THE SOLAR DISK**

**E. J. Seykora  
Professor of Physics  
East Carolina University**

## **ABSTRACT**

Spatial interferometry was investigated as a high resolution method for the measurement of the solar angular diameter as well as short term variations in the solar angular diameter as a result of 5-min. oscillations. The interferometer used in this investigation was based on the Talbot self-imaging effect and its application in a lensless mode and telescopic exit pupil mode were investigated. Potential applications of spatial interferometry toward the measurements of the solar diameter, sunspots and their motion, and the solar angular position at the fraction of an arcsec level are discussed.

IMPROVED HITRAN DATA FOR MOLECULAR OXYGEN

R. H. Tipping

Department of Physics

University of Alabama

ABSTRACT

Improved molecular parameters including transition frequencies, strengths, transition moments, and halfwidths for the ground electronic state magnetic dipole and electric quadrupole transitions and two electronic transitions (the  $a^1\Delta_g \leftarrow X^3\Sigma_g^-$  and  $b^1\Sigma_g^+ \leftarrow X^3\Sigma_g^-$ ) of molecular oxygen have been calculated. These results have been assembled in the HITRAN 1986 format and will supplant the current values in a forthcoming edition.

## D-11. WEAPONS LABORATORY (WL)

### COHERENT LASER RADAR AND ARRAY IMAGING

Richard Anderson

Professor of Physics

University of MO-Rolla, Department of Physics

#### Abstract

Coherent heterodyne laser radar detector array imaging has been suggested. This paper is a theoretical study for laboratory measurements. The heterodyne signal measured is averaged over  $N$  different target perspectives to reduce speckle. This yields a signal proportional to the square root of the target intensity distribution. In theory this signal should yield the line of sight velocity component. The averaged autocorrelation of the heterodyne signal yields a quantity proportional to the target intensity distribution. The average cross correlation of the signals from different target positions of different samplings allows the transverse velocity to be determined.

# **EXPERIMENTAL TECHNIQUES FOR HETERODYNE LASER SPECKLE IMAGING**

**J.K. Boger,  
Oregon Institute of Technology  
3201 Campus Drive  
Klamath Falls, OR 97601**

## **ABSTRACT**

**Targets in the laboratory have been successfully imaged using a coherent illumination/heterodyne detection scheme. In principle the technique allows both spatial and temporal Doppler target information to be recovered. Speckled images where averaged to approximate an incoherent image.**

## FIBEROPTIC INTERFEROMETER STUDIES

Douglas A. Christensen, Professor  
University of Utah

### Abstract

Work was accomplished in the following three areas: 1) white light fringes were obtained through a prototype 2 x 60m fiberoptic interferometer by first utilizing a variable coherence length laser diode source to balance the arms; 2) the interferometer was characterized with regard to temperature sensitivity, fringe contrast and polarization properties; and 3) the effect of fiber dispersion in an interferometer with unequal fiber lengths was experimentally and theoretically explored.

## CONSTRUCTION AND INITIAL OPERATION OF THE WORKING FLUID EXPERIMENT

John Gahl, Assistant Professor, The University of New Mexico

### Abstract

A working fluid experiment was successfully constructed, operated, and initial data characterizing its performance collected. The experiment was designed to generate a cold ( $\sim 1$  eV), high density ( $\sim 10^{19}$  cm $^{-3}$ ) plasma that would be useful as a medium for shockless compression. This report describes the construction of the experiment and the initial data collected from it.

# **FINITE ELEMENT ANALYSIS OF HARDENED AIRCRAFT SHELTERS**

**Walter Gerstle, Assistant Professor**

## **Abstract**

The Shock Physics Division is presently involved in a multi-million dollar effort to upgrade existing US and NATO reinforced concrete protective shelters. The finite element analysis of such structures subject to blast loading is currently an art, not a science, because it can give the engineer only a rough approximation of the actual behavior of the structure. The purpose of my AFOSR-sponsored summer research was to develop better numerical analysis tools for simulation and visualization of structures subject to dynamic loading.

## ALTERNATING DIRECTIONS OPTIMIZATION AN APPROACH TO LINEAR EQUATION SOLVING

Dr. Jerald A. Kabell

### Abstract

*In this paper we explore a new iterative method for the solution of systems of linear equations proposed by Arman. We first show that the method converges for all non-singular systems. We then establish some bounds on the rate of convergence and identify the features of a system which may have a negative impact on that rate. Coupled with these are some issues of computational precision which can in some cases render the method unsuitable. A geometric interpretation leads to some enhancements of the method which can in some cases improve its performance. After exploring several serial implementations, we investigate the potential for parallel implementation of the method.*

# **SPACE DEBRIS IMPACT EFFECTS ON SPACECRAFT MATERIALS**

by

**Jon H. Shively  
School of Engineering  
California State University at Northridge**

Space debris arise from many sources; spent motor cases, deorbiting satellites, exploded satellites, space shuttle discards are a few examples. The disintegration of major components produces hunks of materials which continue to orbit the earth. The size distribution ranges from whole components to parts only a millimeter in diameter. Space debris are not particularly a problem unless they happen to collide with spacecraft. If this occurs the resulting damage can be very serious with the possible loss of mission. Some debris particles are estimated to be travelling at hypervelocities of 3-15 km/sec. It is estimated that the energy in the collision of a piece of aluminum only one centimeter in diameter is equivalent to that of a car travelling sixty miles per hour. No wonder spacecraft designers worry about survivability of a spacecraft facing collision with this energy.

NUCLEAR AND PLASMA PHYSICS WITH ANTIPROTONS  
AT SHIVA STAR

PROF. GERALD. A SMITH  
DEPT. OF PHYSICS  
PENNSYLVANIA STATE UNIVERSITY

ABSTRACT

Prof. Gerald A. Smith spent the 10 week period July 22-September 29, 1991 as an AFOSR Summer Faculty Awardee in residence at the Phillips Laboratory, Kirtland AFB, Albuquerque, NM. An important purpose of the visit was to become more familiar with the operation and properties of SHIVA Star, an electromagnetic solid liner imploder operated by the High Energy Plasma Branch. SHIVA Star will be used to compress fissile targets which will be exposed to short bursts of antiprotons. This work is being sponsored by AFOSR under a joint proposal from the Phillips Laboratory and Penn State University. The goal of this program is to test features of subcritical microfission in small targets. This concept has been proposed by Prof. Smith and colleagues at Penn State University as a potential source of propulsion power for missions requiring large thrust and  $I_{sp}$ . During the visit Prof. Smith refined and extended calculations on yields of neutrons in the device, including using external magnetic fields. In addition, he presented several seminars and lectures on the subject, internal to the Phillips Laboratory and external to professional groups. All prior objectives of the visit were addressed. Considerably more work is anticipated before experiments on SHIVA Star will be ready for execution. Prof. Smith and his group will continue their active collaboration with the Phillips Laboratory for the next several years until the objectives of the program are met.

## **CONSTITUTIVE MODELING OF SLURRY INFILTRATED FIBER CONCRETE (SIFCON)**

**David J. Stevens, Assistant Professor  
Department of Civil and Env. Eng.  
Clarkson University**

### **ABSTRACT**

Slurry Infiltrated Fiber CONcrete (SIFCON) is a unique material, containing 5 to 20 percent, by volume, of steel fibers; in contrast, Fiber Reinforced Concrete (FRC) contains only 0.5 to 2 percent fibers. SIFCON exhibits high compressive and tensile strengths (up to 35 ksi and 5.5 ksi, respectively), and it is extremely "tough", capable of carrying a compressive stress of 10 ksi to a strain in excess of 10%. Thus, SIFCON has great potential for energy absorbent components in civilian and military structures. SIFCON also typically exhibits a low modulus of elasticity (usually less than half of plain concrete), and its response strongly depends upon the orientation distribution of the fibers. In order to represent these unique characteristics of SIFCON, a new constitutive model was developed this summer, for the Shock Physics Division of the Phillips Laboratory, Albuquerque, New Mexico. The terminal goal of this model is implementation into a Finite Element code, which would be used to analyze SIFCON structures. The Finite Element application of the model will be proposed in a follow-on study.

The SIFCON model was developed within the theory of mixtures. An anisotropic, continuum damage/plasticity model, previously developed by the author for concrete, was modified to represent the slurry. A simple model that accounts for the resistance of the fibers and the enhanced resistance of the plain slurry was developed. The predictions of the model are compared to data from a number of laboratory tests.

SURFACE DEACTIVATION EFFICIENCIES FOR  $O_2(^1\Delta)_g$  QUENCHING ON A RANGE OF COIL

RELATED MATERIALS

P.D. Whitefield,  
Cloud and Aerosol Science Laboratory,  
University of Missouri - Rolla,

Abstract

A kinetic model is presented that describes both homogeneous ( $k_1$ ) and heterogeneous ( $\gamma$ ) deactivation of  $O_2(^1\Delta)_g$  in a flow reactor experiment. The model is validated through measurements made on pyrex surfaces where  $k_1$  and  $\gamma$  were found to be  $(1.64 \pm 0.04) \times 10^{10} \text{ cm}^3 \text{ s}^{-1}$  and  $(7.7 \pm 0.4) \times 10^{-4}$  respectively. The model has been used to interpret data recorded for the aged surfaces of the following metals: Nickel  $\gamma = (3.5 \pm 0.1) \times 10^{-4}$ , Copper  $\gamma = (2.8 \pm 0.3) \times 10^{-4}$ , Nickel - Copper alloy  $\gamma = (4.0 \pm 0.1) \times 10^{-4}$  and Inconel  $\gamma = (0.11 \pm 0.05) \times 10^{-4}$ . Results obtained on fresh, non-oxidized metal surfaces are also discussed.

## D-12. ENGINEERING & SERVICES CENTER (E&SC)

### ESTIMATION OF CONTAMINANT TRANSPORT PARAMETERS FROM LABORATORY STUDIES: BATCH AND COLUMN TECHNIQUES WITH SORBING ORGANIC SOLUTES

William P. Ball

Assistant Professor  
Dept. of Civil and Environmental Engineering  
Duke University  
Durham, NC 27706

Dirk F. Young

Graduate Student  
Dept. of Civil and Environmental Engineering  
Duke University  
Durham, NC 27706

#### **ABSTRACT**

Batch and column experiments were performed with halogenated organic solutes and sandy aquifer solids. Column results were analyzed with two solute transport models that incorporated nonequilibrium sorption as a) first-order mass transfer and b) Fickian spherical diffusion. The diffusion model was able to predict the column results using input parameters from prior independent batch tests. On the other hand, the first-order model required 3 to 4 parameters to be varied for good simulation, and fitted parameters were often not in good agreement with the batch results.

## MICROBIAL DEGRADATION OF 4-NITROPHENOL

Joseph H. Dreisbach, PhD

### ABSTRACT

Several gram positive bacterial isolates (designated 443, 428 and 402) have previously been isolated and demonstrated to actively degrade 4-nitrophenol. Previous research revealed these isolates convert 4-nitrophenol to 1,2,4-benzenetriol prior to ring fission and mineralization. The purpose of this project was to characterize the biochemical pathway of 4-nitrophenol conversion to 1,2,4-benzenetriol by these isolates.

Circumstantial evidence supports the hypothesis that 4-nitroresorcinol is an intermediate on this pathway. This compound induces full oxygenase activity against 4-nitrophenol and 1,2,4-benzenetriol. Evidence of an active monooxygenase enzyme was obtained by observing the conversion of 3-nitrophenol to 3-nitrohydroquinone by 443. It is unclear from the O-18 atmosphere studies as to how the intermediates may be formed.

**EXTRACTION OF AROMATIC POLYMERS FROM MONTMORILLONITE  
CLAY USING SUPERCRITICAL FLUIDS**

Larry E. Gerdcn, Ph.D., Research Associate  
Headquarters Air Force Engineering and Services Center  
Environics Division, Site Restoration Branch

**ABSTRACT**

The extraction by supercritical fluids of aromatic polymers formed during reflux on the surface of montmorillonite clay has been investigated. The supercritical fluid used was carbon dioxide with methanol as a solvent modifier. These materials have been partially characterized by gas chromatography with a mass spectrometer detector, GC/MS.

# **DATA ACQUISITION AND INSTRUMENTATION INTEGRATION FOR THE TYNDALL AFB ANTI-PENETRATION LABORATORY**

**Bobby Green  
Assistant Professor  
Department of Technology  
Texas Tech University**

## **Abstract**

**The goals of this project were to bring several data acquisition systems on line and perform data acquisition and reduction at the Anti-Penetration Laboratory, integrate the new data acquisition systems with the instruments on site and with future instrumentation requirements of the HQ AFESC/RCDS Anti-Penetration Laboratory. The work required subsystem assembly, system testing, calibration, and operational testing to insure system reliability and accuracy of the data acquisition systems and associated instruments. After the data acquisition systems and instruments were operational, acquisition and reduction of test data and preparation of a user manual for the instrumentation systems began. As time permitted some electronics was redesigned and assistance to the RCDS group with instrument selection, design, and operation was accomplished.**

THE COMPARISON OF COMPLEXATION-ULTRAFILTRATION TO  
CHELATION ION EXCHANGE IN THE TREATMENT OF  
SPENT ELECTROLESS NICKEL PLATING BATHS

Dr. Douglas Klarup  
Assistant Professor  
Department of Chemistry  
University of Montana

ABSTRACT

Chelation ion exchange has proved problematical for recycling electroless metal plating baths, so currently the Air Force uses hydroxide precipitation and disposal to treat spent baths. This is expensive and produces a large amount of hazardous waste. An alternative technology, complexation-ultrafiltration, may be a more appropriate method to treat spent plating baths, but quantitative information is required. The project reported here compares complexation-ultrafiltration using polyethylenimine with chelation ion exchange using Duolite ES-467 in the treatment of contaminated electroless nickel plating baths. A simple model is developed to understand the chemistry in each process. The results show that Duolite ES-467 is selective toward the zinc contaminant over nickel, but to remove all of the zinc will require removing much of the nickel as well. The polyethylenimine is more selective toward nickel, so to remove the zinc contaminant virtually all of the nickel must be removed. However, complexation-ultrafiltration may prove to be more efficient than hydroxide precipitation in removing all of the metals from the waste stream.

**FEASIBILITY STUDY TO USE THE GYRATORY TESTING MACHINE FOR FIELD  
COMPACTION CONTROL OF AGGREGATE BASE COURSE IN FLEXIBLE AIRFIELD PAVEMENTS**

Cheng Liu

Professor

The University of North Carolina of Charlotte

**ABSTRACT**

The purpose of this study was to evaluate the feasibility of using the Gyratory Testing Machine (GTM) to determine density requirements for aggregate base course in flexible airfield pavements trafficked by heavy weight, high-tire pressure aircraft. A trench 8-ft wide, 18-in deep was cut across the wheel path of Tyndall flexible pavement test sections which had been trafficked by simulated combat-ready F-15 C/D aircraft. Nuclear density, moisture content, bearing strength and gradation tests were performed at the various depths of trafficked and untrafficked areas of aggregate base and subgrade sand. A field CBR test was conducted at the top of compacted sand subgrade. Gyratory compaction tests were also performed on the base course aggregate and subgrade sand to determine ultimate dry densities. The results of field and laboratory tests indicated that there may be a correlation between ultimate gyratory density and field density after both construction and traffic compaction.

## **USE OF A CENTRIFUGE IN INVESTIGATION OF DYNAMIC PHENOMENA IN PARTIALLY SATURATED SANDS**

**Teresa Taylor, Assistant Professor  
Virginia Polytechnic Institute & State University**

### **ABSTRACT**

Centrifuge tests were conducted to investigate different dynamic phenomena in partially saturated soils. The primary research effort involved studying the influence of degree of saturation on transmission of explosion-induced stress waves in compacted soils. Tests were conducted using different charge masses and g-levels to simulate different prototype explosive masses. In conjunction with these tests, the resulting explosion-induced apparent crater dimensions and volumes were measured; comparisons were made to full-scale test results and results of other investigators for centrifuge crater tests in dry sands. Finally, a limited number of the tests were conducted using different materials placed against the walls of the sample bucket to assess relative capabilities of minimizing reflected waves resulting from the explosions. These results are described in a separate report.

**DRAFT TEST METHODS TO ASSESS THE PERFORMANCE OF EXTERNAL  
VAPOR-PHASE LEAK DETECTION DEVICES FOR UNDERGROUND STORAGE TANKS:  
A VALIDATION AND MODIFICATION STUDY**

Brian S. Vogt, Ph.D., Research Associate  
Headquarters Air Force Engineering and Services Center  
Enviro-nics Division, Site Restoration Branch

**Abstract**

Draft test methods for evaluating sensor devices to be used to monitor vapor-phase hydrocarbons in monitoring wells around underground storage tanks were validated. Although the test apparatus specified by the draft methods was found to be basically sound in design, it was necessary to make some modifications so that device testing will be more realistic and thus better suited to Air Force needs. Most of the conclusions concerning any sensor device tested with the draft methods ultimately rely on accurately knowing the concentrations of hydrocarbon vapors in the test apparatus. For this reason it was necessary to eliminate several erroneous assumptions implicit in apparatus construction and data handling. Some changes were made in the apparatus and testing protocol to simplify testing. Several ways of presenting sensor device accuracy data were devised to permit quicker and more intuitive understanding of device response. Numerous other recommendations regarding apparatus construction, apparatus calibration and use, hydrocarbon test products, and calculations and data presentation were made. These are summarized toward the end of this report

# MICROBIAL CHLOROBENZENE DEGRADATION

In-Soon You

Associate Professor of Biology

California State University, Fresno

## ABSTRACT

*Pseudomonas* sp. strains JS6 and JS150 are able to use *para*-dichlorobenzene as the sole source of carbon and energy. Catabolic genes involved in the metabolism of *p*-dichlorobenzene were studied by using hybridization. The dichlorobenzene catabolic genes of JS6 and JS150 did not appear to show any significant homology to known chloroaromatic catabolic genes including gene *tfdC* of the 2,4-dichlorophenoxyacetate plasmid pJP4. Dichlorobenzene (*dcb*) catabolic genes were further characterized by cloning in *Escherichia coli* and *Pseudomonas putida*. The upper-pathway genes (*dcbA* and *dcbB*) and/or the lower-pathway genes (*dcbC*, *dcbD* and *dcbE*) have been cloned as evidenced by the growth of recombinant clones on chlorobenzene or 3-chlorobenzoate.

## **D-13. ROME LABORATORY/GRIFFISS (RADC)**

### **SOFTWARE ENGINEERING TOOLS FOR PARALLEL SOFTWARE DEVELOPMENT**

**John K. Antonio**  
School of Electrical Engineering  
Purdue University  
West Lafayette, IN 47907

**Richard C. Metzger**  
Rome Laboratory/COEE  
Griffiss AFB, NY 13441

#### **Abstract**

The major objectives of this summer research project were to: (1) evaluate some of the currently available software engineering tools for developing and maintaining parallel software, (2) parallelize a computationally intensive portion of serial code contained within the Air Force's data fusion model and (3) propose new and/or enhanced tools and methodologies to aid in the development and maintenance of parallel software. Objectives (1) and (2) were accomplished concurrently by employing two software engineering tools to the process of parallelizing a small portion of the serial data fusion model. The primary focus here was not so much on the resulting parallel software, but rather on the *process* involved in developing the parallel code. The tools were found to be useful aids in the sense that they either simplified or automated certain low-level aspects of developing parallel software; thus allowing for rapid testing and prototyping of various system-level software designs. Future research in the area of parallel software engineering tools and techniques is suggested at the end of this report.

Dr. Abdul Aziz Bhatti

Not Available At This Time

# A TAXONOMY FOR ADAPTIVE FAULT MANAGEMENT IN SURVIVABLE C3 SYSTEMS

Final Report  
AFOSR Summer Faculty Research Program

Rex E. Gantenbein, Associate Professor  
Department of Computer Science  
University of Wyoming  
P.O. Box 3682  
Laramie WY 82071

## ABSTRACT

Most strategies for fault management are effective for a narrow range of fault classes. In survivable C3 systems, a wide range of operating environments may be encountered that require different strategies to be used at different times. This report presents a classification for fault management strategies that can be used to define the most appropriate methods for assuring survivability under conditions that can suddenly and drastically change.

Two metrics by which this adaptivity can be specified and evaluated -- the *objective function* and a *consistency measure* -- are defined. These metrics can be used to determine how well a survivable system meets its requirements under the current operating environment. Policies are discussed that group strategies by the tradeoffs that can be made when the system is unable to meet its requirements for objectives or consistency due to failures, as well as by the fault classes that can be handled.

# ANALYSIS OF THE ELECTROMIGRATION-INDUCED FAILURE IN THE VLSI INTERCONNECTION COMPONENTS AND THE MULTISECTION INTERCONNECTIONS

Ashok K. Goel, Assistant Professor, and

Matthew M. Leipnitz, Graduate Student

Department of Electrical Engineering  
Michigan Technological University

## ABSTRACT

We have carried out a first-order analysis of the electromigration induced failure effects in the various VLSI interconnection components including the multisection interconnections using the series model for failure mechanism. The Components include a straight interconnection segment, an interconnection bend, an interconnection step, an interconnection plug, an interconnection via, an interconnection overflow, a horizontal multisection interconnection, a vertical multisection interconnection, a mixed multisection interconnection, and a power/ground bus. First, by considering the effect of average flux density on the grain-boundary migration, we have reduced each interconnection component in to a series or series-parallel combination of straight segments. Then, for each of the components, we have investigated the dependence of the median-time-to-failure and the Log-normal standard deviation of the corresponding failure distribution on the various component parameters. The results can be utilized to choose optimum values of the component parameters for minimum probability of interconnection failure due to electromigration.

**Phillipp Kornreich**

**AFOSR SUMMER FACULTY RESEARCH PROGRAM**

**INTRODUCTION**

My original plan was to work this summer on optical wave guides and an optical Tunneling AND gate. The tunneling devices have to be fabricated completely in vacuum. A robot mask and substrate changer for a vacuum system at Syracuse University Micro-Electronics Laboratory (SUMEL) that is to be used for the fabrication of the tunneling devices was to be fabricated in the Rome Laboratory (RL) machine shop.

The robot mask changer was designed and it is now being fabricated in the RL machine shop. Preliminary test have been performed indicating that a light sensitive tunneling diode can be fabricated. Indeed, the continuation of this work using the robot mask changer is the subject of my follow on proposal.

While I was waiting for the robot mask changer I worked on two other projects. We tested a liquid crystal Spatial Light Modulator (SLM). and a binary lens for replicating light beams. This work is described below.

## CHARACTERIZATION OF RADAR CLUTTER AS AN SIRP

CHARLES T. WIDENER and JAY K. LEE, Ph.D.

### ABSTRACT

It has been proposed that radar clutter can be modeled as a spherically invariant random process or SIRP. SIRPs seem well suited to this role since by variation of certain parameters the Weibull, K- or Rayleigh distributed clutter envelopes are obtained. These distributions are significant since they fit well with experimental radar clutter data under different circumstances. In this report, a radar clutter model based on rough surface scattering is developed to show that SIRP characterization can be based on electromagnetic principles. Small perturbation analysis of a two-scale randomly rough surface is chosen since the form for the backscattered field has the proper form for an SIRP, under certain conditions. This is an important step in being able to predict the proper statistical distribution of radar clutter based on surface geometry and electromagnetic properties.

PHOTOREFRACTION IN  $\text{Bi}_{12}\text{SiO}_{20}$  AND SEMI-INSULATING  $\text{InP:Fe}$

Wallace B. Leigh  
Assistant Professor, Division of Electrical Engineering  
Alfred University, Alfred, New York 14802

Final Report for Work Performed at  
Rome Laboratories, Solid State Directorate  
RL/ERX, Hanscom AFB MA 01731

ABSTRACT

This is the final report concerning results of a summer research program at Rome Laboratories. Four separate areas of research were investigated. The first areas focused on analyzing the mechanisms of photorefraction in Czochralski (Cz) and Hydrothermal  $\text{Bi}_{12}\text{SiO}_{20}$  (BSO) grown at Rome. Deep defects in the bandgap of BSO were characterized and defect phenomena related to photorefraction measurements in BSO. Electrical conductivity was measured below and above room temperature for different samples of this material. Above RT conductivity indicates a rapid increase in current in BSO that is thermally activated, and appears dependent on deep defects. A deep defect of  $1.3 \pm 0.1$  eV was found and measured in both Cz and Hydrothermal material. Below RT thermally stimulated current (TSC) studies, however, indicate that the concentration of traps of activation energy  $< 0.7$  eV in the Hydrothermal samples is approximately a factor of  $10^3$  smaller than in Cz BSO. At least five different defects were identified in the TSC measurements.

**DEVELOPMENT OF A METHODOLOGY FOR  
EXTRACTING SEMANTIC RELATIONS FROM DEFINITIONS**

Elizabeth D. Liddy  
School of Information Studies  
Syracuse University

**ABSTRACT**

A methodology was developed for the task of automatically extracting semantic information from dictionary definitions by means of Relation Revealing Formulae (RRF) which are based on lexical, syntactic and semantic regularities in Longman's Dictionary of Contemporary English and which make use of the additional information provided on the machine-readable tape. Those verb definitions which use 'to make' comprise the sample on which the generic Constant Comparative research paradigm was applied for the development of the specific steps of a new methodology for extracting semantic relations. RRF which successfully disambiguate the senses of 'make' as used in definitions were developed and a plan for further testing of the RRF and refinement and application of the methodology is proposed.

Collecting Data for Markov Models of Error  
Patterns on Data Communications Links

Wayne D. Smith

**ABSTRACT:** Rome Laboratory 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 effort were to continue the research initiated in 1990 to find Markov tables to load into the EIUs. A portion of the research involved searching current literature for Markov tables or error gap data. Alternative approaches to obtaining the desired Markov tables were also considered. This included research into the use of simulation models to produce Markov tables, and some further work on the concept of "heuristic error models." The most substantial effort was devoted to the design of a data collection experiment that could be used at Rome Laboratory to produce the needed data. This effort included the design of a microcomputer interface that would permit a microcomputer to monitor a "Fireberd" bit error rate tester and record the error statistics for analysis and conversion to a Markov table.

# OPTICAL FIBER AMPLIFIERS AND OSCILLATORS

Kenneth J. Teegarden  
Salahuddin Qazi

## I. Introduction

Optical amplifiers and oscillators based on fiber waveguides doped with luminescent impurities have been studied for many years. Recently the advantages of in line optical amplifiers for fiber communication systems have been recognized and this has led to intense efforts to develop amplifiers for the wavelengths where commercial monomode optical fibers have the lowest loss and can be designed to have zero dispersion, namely at about 1.30 and 1.50 microns. The most successful amplifier to date is one using the rare earth erbium which luminesces at 1.55 microns. Developmental models of erbium doped fiber amplifiers which achieve small signal gains of up to 30db and power amplification of 13dbm are currently on the market and are being evaluated in the field. These amplifiers are pumped with relatively expensive strained quantum well laser diodes operating at .980 or 1.48 microns. An increase in available pump power and a reduction in cost could be achieved if efficient operation at a pump wavelength of .800 microns was possible and the discovery of a glass composition which would eliminate excited state absorption of this pump wavelength would be an important breakthrough. Also, an increase in the optical bandwidth of erbium based amplifiers would permit the advantages of wavelength multiplexing to be more fully realized. This again is a problem whose solution depends on the development of glass compositions which widen the gain curve of erbium, even at the expense of maximum gain.

Collecting Data for Markov Models of Error  
Patterns on Data Communications Links

Wayne D. Smith

**ABSTRACT:** Rome Laboratory 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 effort were to continue the research initiated in 1990 to find Markov tables to load into the EIUs. A portion of the research involved searching current literature for Markov tables or error gap data. Alternative approaches to obtaining the desired Markov tables were also considered. This included research into the use of simulation models to produce Markov tables, and some further work on the concept of "heuristic error models." The most substantial effort was devoted to the design of a data collection experiment that could be used at Rome Laboratory to produce the needed data. This effort included the design of a microcomputer interface that would permit a microcomputer to monitor a "Fireberd" bit error rate tester and record the error statistics for analysis and conversion to a Markov table.

## APPROXIMATING NEURAL NETS WITH $C^1$ NEURAL NETS

Michael D. Taylor, Associate Professor of Mathematics

### Abstract

Given a neural net whose architecture is defined by continuous functions, a method is exhibited for constructing a second neural net whose behavior approximates that of the first one arbitrarily closely and whose architecture is defined by continuously differentiable functions. This provides a means of "training" the first network by error back-propagation even in instances where back-propagation is not directly applicable. This in turn gives a tool for studying neural nets with "nonstandard" architectures.

# OPTICAL FIBER AMPLIFIERS AND OSCILLATORS

Kenneth J. Teegarden  
Salahuddin Qazi

## I. Introduction

Optical amplifiers and oscillators based on fiber waveguides doped with luminescent impurities have been studied for many years. Recently the advantages of in line optical amplifiers for fiber communication systems have been recognized and this has led to intense efforts to develop amplifiers for the wavelengths where commercial monomode optical fibers have the lowest loss and can be designed to have zero dispersion, namely at about 1.30 and 1.50 microns. The most successful amplifier to date is one using the rare earth erbium which luminesces at 1.55 microns. Developmental models of erbium doped fiber amplifiers which achieve small signal gains of up to 30db and power amplification of 13dbm are currently on the market and are being evaluated in the field. These amplifiers are pumped with relatively expensive strained quantum well laser diodes operating at .980 or 1.48 microns. An increase in available pump power and a reduction in cost could be achieved if efficient operation at a pump wavelength of .800 microns was possible and the discovery of a glass composition which would eliminate excited state absorption of this pump wavelength would be an important breakthrough. Also, an increase in the optical bandwidth of erbium based amplifiers would permit the advantages of wavelength multiplexing to be more fully realized. This again is a problem whose solution depends on the development of glass compositions which widen the gain curve of erbium, even at the expense of maximum gain.

# SIMULATION MODEL INTEGRATION METHODOLOGY FOR ROME LABORATORIES

JEFFREY D. TEW

*Virginia Polytechnic Institute and State University, Blacksburg, Virginia*

This document provides an outline for implementing a successful hierarchical, integrated simulation model at Rome Laboratories for the purpose of modeling tactical battle engagement scenarios. It is recommended that an analytical framework be used to guide the development of the integration process. This analytical framework focuses on: (a) the transfer of data elements between model modules, (b) the estimation of response population characteristics of interest, (c) the design of simulation experiments in order to estimate a regression model of interest, and (d) the application of variance reduction techniques throughout the integrated model. The result of fully integrating the existing simulation models would be the ability to *accurately* and *validly* model tactical battle engagement situations with unprecedented, varying levels of detail that could be selected according to the modeler's agenda. Thus, the fully integrated model would serve as a valuable test bed for evaluating: (a) existing and proposed hardware systems, (b) existing and proposed simulation models, and (c) battle engagement strategies.

**D-14. ROME LABORATORY/HANSCOM (RADCH)**

# **HIGH PERFORMANCE MICROSTRIP ARRAYS FOR POLARIMETRIC BISTATIC RADAR(PBR) APPLICATIONS**

**Marat Davidovitz  
Assistant Professor  
Department of Electrical Engineering  
University of Minnesota**

## **Abstract**

Novel approaches to Polarimetric Bistatic Radar antenna design were investigated with the goal of improving such parameters as cross-polarization and isolation. A feeding arrangement for linear microstrip arrays, which facilitates compact array configurations, was proposed. A design methodology was developed to implement the developed designs. A small-scale prototype was built and tested in order to verify the viability of the new concepts. Preliminary calculations were carried out to design a full-scale array for the PBR experimental facility at the RL, Hanscom AFB.

# USER ASSISTED INFORMATION EXTRACTION

Pradip Peter Dey

Hampton University

Computer Science Department

## ABSTRACT

User assisted information extraction from formatted and unformatted messages requires a friendly user interface, knowledge based natural language processing, and utilities for integrating future developments in message processing technology. Parallel and distributed processing will play an important role in the future enhancement of the message processing technology. Two research tools were developed in the summer of 1991 that allow one to experiment with a prototype information extraction system available in the IRDS branch of Rome Laboratory. Some components of the prototype system can be executed concurrently by means of these tools. In order to exploit the enormous potential of the system a detailed study of parallel processing architectures, algorithms, data and control structures for the system is recommended.

## MILLIMETER-WAVE NOISE MODELING INVESTIGATION

Lawrence P. Dunleavy, Asst. Professor

Steven M. Lardizabal

Department of Electrical Engineering

University of South Florida

### ABSTRACT

A new method is described that provides valid mm-wave noise models for field effect transistors, including MESFETs and HEMTs. This method avoids the complications of a variable impedance tuner, and requires only the knowledge of a small signal equivalent circuit, and noise figures measured across a range of frequencies for a single known source impedance. Noise parameters derived from this method are shown to agree well with those obtained from tuner based measurements. A review of previously reported noise modeling techniques, summarized here, reveals either their common dependence on tuner based measurements or the use of approximations that are not valid at mm-wave frequencies.

# **SINUSOIDAL TRANSFORM CODER PARAMETER MANIPULATION TECHNIQUES AND THEIR USE IN NETWORK AND DATA STORAGE APPLICATIONS**

*Dr. Joseph B. Evans*

Department of Electrical & Computer Engineering  
Telecommunications & Information Sciences Laboratory  
University of Kansas

## **Abstract**

This research involved increasing the capabilities of the Sinusoidal Transform Coder (STC), a high quality, low bit rate speech coder. The new methods developed in the course of this work provide a means for the compression of digital speech data for applications such as voice mail. Previous methods suitable for such applications allow only fixed compression ratios; that is, given a specified amount of input data, the stored file size must be a certain (smaller) fixed size. The speech quality is also fixed when the traditional compression methods are used. The new algorithms allow quality to be balanced against memory requirements, so that substantially greater compression can be attained, albeit at lower quality. In the new method, parameter space transformations are performed, so that the speech quality is high for a given compression ratio, as compared to alternate methods. The compression can be performed in multiple stages of any selected size, extending the previous parameter transformation techniques. Other results of this research are algorithms which provide a method for the reconstruction of lost packets of digital voice data for various loss environments were developed. The new algorithms allow very high packet loss rates to be endured, although some slight reduction in quality as compared to the equivalent unimpaired speech might be experienced. These techniques can be applied to

# A GENERAL ONE-DIMENSIONAL III-V HETEROJUNCTION DEVICE SIMULATOR

Dr. Ronnie E. Owens, Assistant Professor

## 1 Introduction

This report describes a general one-dimensional III-V heterojunction device simulation program which was developed by the author during the 1991 ten week summer appointment with Rome Laboratories at Hanscom Air Force Base. Research on heterojunction devices, as well as the related materials research, are important ongoing efforts which will lead to high-speed digital and high-frequency analog circuitry far outstripping the performance of silicon. In addition, almost all optoelectronic devices in use today are based on the III-V heterojunction technologies. Modeling is an especially important part of this research and can be crucial in device design and analysis. The program described herein represents an effort to provide a tool which will be useful to the device designer and analyst. The program is capable of simulating heterojunction devices composed of III-V ternary materials with compositional grading, impurity grading, optical excitation, and a general trap model intended for use in modeling the InP/oxide interface. Significant effort was expended in providing a convenient user interface to the program. In the succeeding sections the following topics are discussed: the physics background of the simulation program, a description of the use and internal structure of the program, some examples including simulations of an InP/InAlAs power MISFET, and some suggestions for future improvements.

**FDTD ANALYSIS OF THE RADIATION PROPERTIES  
OF A PARABOLIC CYLINDER  
ILLUMINATED BY A VERY SHORT PULSE**

Carey M. Rappaport  
Assistant Professor

**ABSTRACT**

This report addresses the problem of extremely short-time pulse excitation of a parabolic reflector antenna. The pulse is selected to be short compared to the time required for it to traverse the reflector, so that only a fraction of the reflector is illuminated at any given time. Because the pulse is so short, standard frequency domain methods of analysis are impractical. Instead, the Finite Difference Time Domain method is used to analyze the wave propagation and reflection. The field distributions have been simulated for a deep parabola in both transmit and receive modes. The results indicate that commonly perceived assumptions of differential transient reflection are inaccurate.

**D-15. ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC)**

**THERMODYNAMIC AND TRANSPORT PROPERTIES OF MOLECULAR IONS**

**FINAL REPORT**

**PREPARED BY:**

**MURTY A. AKUNDI, Ph.D**

**ABSTRACT**

Thermodynamic properties, enthalpy, free energy and heat capacity of six ionized species ( $\text{CO}^+$ ,  $\text{C}_2^+$ ,  $\text{H}_2\text{O}^+$ ,  $\text{H}_3^+$ ,  $\text{H}_3\text{O}^+$ , and  $\text{HCN}^+$ ) are calculated using spectroscopic data. These thermodynamic properties are a function of temperature and were calculated to a temperature of 20,000 K. Results are compared with the values obtained from earlier workers.

# **NON-INTRUSIVE TESTING OF COMPOSITE AIRCRAFT ENGINE COMPONENTS**

**Laurence J. Jacobs, Assistant Professor  
Engineering Science and Mechanics Program  
Georgia Institute of Technology**

## **ABSTRACT**

**Advanced, high temperature composite engine components will add new complications to established testing procedures and increase the need for innovative non-intrusive technologies. Lightweight composite materials are inhomogeneous and anisotropic in nature; these conditions complicate any potential structural model and question the validity of surface, dynamic stress measurements. Laser ultrasonics has the capability to provide useful engineering information about the structural integrity of an in-service engine component without interfering with the process being monitored. Since elastic waves propagate through the component thickness, laser ultrasonics examines the condition of the entire specimen and not just a limited number of surface points. Ultrasonics is a powerful tool for the characterization of structural materials, but to be effective, the propagation characteristics of the elastic waves themselves must be understood. This report concludes with a review of the basic aspects of wave propagation in an anisotropic media and discusses the potential for material characterization using laser ultrasonics.**

## IMPLEMENTATION OF MULTIGRID IN THE PARC CODE

Steven M. McKay

**Abstract.** The PARC code is a general purpose Navier Stokes solver developed at Arnold Engineering Development Center at Arnold Air Force Base, Tennessee. It is used continuously in design and analysis of flow characteristics of aircraft. However, these types of flows are very complicated and difficult to solve. Time dependent multigrid has been implemented in the PARC code which accelerates convergence to steady state. Convergence of the multigrid solver is on the order of convergence of the coarsest grid.

## X-RAY SPECTROMETERS FOR PULSED BREMSSTRAHLUNG

Carlyle E. Moore  
Morehouse College

### ABSTRACT

The Photoactivation Spectrometer, Differential Absorption Spectrometer and Compton Spectrometer are examined as possible detection systems for the measurement of the spectra of pulsed bremsstrahlung. Detectors considered include the Ionization Chamber, PIN Junction Diode, Thermoluminescent Dosimeter (TLD) and Scintillator. The Photoactivation Spectrometer samples the spectrum at a relatively small number of points, and is limited by a lack of complete and reliable data on the nuclear parameters involved. Since the absorption characteristics of available absorbers do not vary significantly at energies above about 0.8 Mev, Differential Absorption Spectrometers show poor energy resolution in that region. They do, however, provide good results in the low energy end of the spectrum. The Time Projection Compton Spectrometer (TPCS) shows the greatest promise as a detection system for the measurement of pulsed X-ray spectra in the whole range of interest, 0.1 Mev to 2.0 Mev, although its deployment may be costly in terms of time, money and manpower.

**THE EFFECT OF CARBON PARTICLE COMBUSTION ON THE  
INFRARED SIGNATURE OF A MAGNESIUM-FLUOROCARBON FLARE**

**Dr. Olin Perry Norton**

**Abstract**

A burning magnesium-Teflon 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 combustion of carbon particles has been incorporated into SMIRF (Signature Model for InfraRed Flares), an existing model for predicting the plume structure and signature of these flares. It is shown that the inclusion of carbon particle combustion has a significant effect on the predicted plume signatures.

## Software for 2D and 3D Mathematical Morphology

by

Richard Alan Peters II

### ABSTRACT

Mathematical morphology is a powerful tool for image analysis and enhancement. Morphological operators are shape-dependent, nonlinear image transforms such as erosion, dilation, opening, closing, and rank filters. The mathematical operators are defined in  $n$  dimensions so it is possible to create programs that will operate on 1D signals, 2D images, or 3D datasets using exactly the same concepts. As operators on 2D binary images, mathematical morphology is well known; much software is available which performs binary morphology. However, the true power in morphology lies in its ability to transform grayscale 2D pixel images and 3D voxel datasets. Yet there is no commercially available software that performs these functions.

This is a description of a morphological software package written under the auspices of the US Airforce Office of Scientific Research at Arnold Airforce Base during the 1991 Summer Faculty Research program. The software includes a 2D image morphology program, a 3D voxel image morphology program, a program for enhancement and noise reduction of 2D images, and related support routines for image arithmetic and logical operations. These programs will perform many - if not all - of the possible morphological operations on both binary and grayscale images. They provide many of the commonly used features automatically or permit the user to customize the operation to fit an application. The user programs operate on Sun rasterfiles. However, the main morphological routines are c-code subroutines. These are independent of specific file formats, so a users can easily write an interface program to operate on other file formats.

## **A REVIEW OF CADDMAS**

**Dean Lance Smith, Ph.D., P.E.  
Associate Professor  
Department of Electrical Engineering  
Memphis State University**

### **Abstract**

The CADDMAS project was reviewed. The architecture of the prototype of the proposed full scale system appears sound, although some potential problems will probably be found as the users of the system gain more experience. The software development and operating environment for CADDMAS is adequate, but less than ideal. The ideal software environment will probably not exist for several years until better software standards are developed for parallel computer systems.

# WAKE AND PROJECTILE VELOCITY ESTIMATION

D. Mitchell Wilkes & Georges Badih Aboutanos

Vanderbilt University

Department of Electrical Engineering

Nashville, TN 37235

## Abstract

Digital signal processing techniques were used to estimate the velocity of a projectile and its wake. The observed data was collected by one or multiple doppler radars in an underground ballistic range.

A classical FFT-based spectral estimation approach was used to identify the frequency characteristics of the data. These frequencies were later translated into velocities leading to accurate velocity profiles of the projectile and of the wake.

A C program was also developed to implement the spectral estimation approach and to provide an automated analysis of the data with extensive graphical display of the results. These graphical presentations include velocity profiles, 3-D surface plots, and contour plots.

**D-16. FRANK J. SEILER RESEARCH LABORATORY (FJSRL)**

**NEW REACTION TRANSFORMATIONS USING  
NITRONIUM TRIFLATE**

**Christopher M. Adams, Ph. D.**

**Assistant Professor**

**Department of Chemistry**

**Oklahoma State University, Stillwater, Oklahoma 74078-0447**

**Major Scott A. Shackelford, Ph. D., USAF**

**Frank J. Seiler Research Laboratory (AFSC)**

**FJSRL/NC, United States Air Force Academy**

**Colorado Springs, Colorado 80840-6528**

**ABSTRACT**

New, non-protic N-nitration methods were explored using nitronium triflate,  $\text{NO}_2\text{OSO}_2\text{CF}_3$  ( $\text{NO}_2\text{OTf}$ ), generated in situ from tetrabutylammonium nitrate,  $\text{Bu}_4\text{NNO}_3$ , and trifluoromethanesulfonic anhydride,  $(\text{CF}_3\text{SO}_2)_2\text{O}$  ( $\text{Tf}_2\text{O}$ ). 2-Pyrrolidinone, pyrrolidine, N-acetyl-pyrrolidine, N-acetyl-piperidine, N-acetyl-4-piperidinone, imidazolidinone, succinimide, and hydantoin were nitrated using these methods. Aqueous and non-aqueous workups gave yields ranging from 20-76%. The reaction methods are significantly improved and eliminate the hazard potential, catalytic and solubilizing necessity and reaction workup requirements of nitromethane as a reaction solvent previously reported. Investigations were performed at the F. J. Seiler Research Laboratory, AFSC FJSRL/NC, U. S. Air Force Academy, Colorado Springs, Colorado.

THERMAL DECOMPOSITION OF TNT, NTO, AND THEIR MIXTURES  
VIA ISOTHERMAL DIFFERENTIAL SCANNING CALORIMETRY

DR. GARY S. BUCKLEY

ABSTRACT

The thermal decomposition of 2,4,6-trinitrotoluene (TNT), 3-nitro-1,2,4-triazol-5-one (NTO), their deuterated analogs, and mixtures thereof have been studied using isothermal differential scanning calorimetry. Primary isotope effects previously noted for both TNT and NTO decompositions were diluted or altered, probably due to the different sample pan configuration used here. TNT decomposition appears to be catalyzed by the presence of Viton rubber, while the NTO decomposition appears to be catalyzed by confinement of its product gasses. Mixture studies indicate that a 2:1 mole ratio of TNT to NTO is sufficient to cause the accelerated decomposition of TNT and consume all of the NTO present in the process.

Introduction

Although NTO was first synthesized in 1905<sup>1</sup>, interest in its use as an explosive has just recently been shown<sup>2</sup>. NTO does not appear to suffer the sensitivity problems associated with its more famous counterparts such as TNT, RDX, and HMX. A less sensitive explosive currently in use, TATB, does not have the energetic performance of RDX or HMX. Thus a need exists for the development of an explosive that is more safely handled than TNT, HMX, and RDX but that will also deliver the explosive characteristics. NTO could potentially fill such a role.

## TERNARY PHASE DIAGRAM OF MEIC/NaCl/AlCl<sub>3</sub>

Dr Do Ren Chang  
Chemistry Department, Averett College, Danville, VA 24541

### Abstract:

Phase diagram of MEIC/NaCl/AlCl<sub>3</sub> ternary system for solid-liquid transitions has been investigated extensively using DSC. A contour map of isotherms has been constructed from these measurements. It reveals that the vast domain of this system is liquid at room temperature and along 0.5 mole fraction of AlCl<sub>3</sub> line parallel to the MEIC/NaCl binary is the ridge of the system. The MEIC/NaCl binary phase diagram has been studied also for the completeness. A new compound is formed with MEIC/NaCl in 2:1 ratio.

# **PHOTO-ELECTRONIC NONLINEAR EXCITATIONS AND WAVE PROPAGATION IN PERIODICALLY MODULATED MEDIA**

**Dr. Marek Grabowski**

*Frank J. Seiler Research Laboratory, US Air Force Academy, CO 80840-6528*

The propagation of electronic and electromagnetic waves in periodically modulated, nonlinear media is studied in terms of a discrete dynamical system. The analysis of this dynamical system is applied to the problems of tunneling of carriers in one-dimensional arrays of semimagnetic quantum dots, nonlinear photo-electronic excitations in saturable, dispersive and absorptive periodic medium, and bichromatic optical wave propagation in electrically poled waveguides. New results include the intensity dependent transmission coefficient, photonic bands with intensity dependent stop gaps, coherent soliton like states within forbidden states of linear theory, and phase-matched second harmonic generation in inversion symmetric systems.

# FINAL REPORT

## **An Ab Initio Study of the Adducts**

**between HF and HCl**

**and**

**Aluminum Hydrides, Halides, Hydroxides, and Oxides**

**Prepared by: Dr. Gilbert J. Mains**

**Academic Rank: Professor of Physical Chemistry**

**Department and University:** Department of Chemistry  
Oklahoma State University  
Stillwater, OK 74078

### Abstract

The adducts of HF and HCl with aluminum hydrides, aluminum halides, aluminum hydrohalides, aluminum hydroxides and aluminum oxides have been studied using both semi-empirical and ab initio molecular orbital methods. When the electron rich region of HF or HCl is placed between 2.5 - 3.5 Å above the aluminum atom, Lewis Acid/Base adducts are generally found. In a few cases, the starting geometry rearranged to give a hydrogen bonded structure. In fewer cases, chemical reactions were observed. The structures observed are reported and briefly discussed.

## **D-17. AERO PROPULSION & POWER LABORATORY (PROP)**

### **INFLUENCE OF OPERATING TEMPERATURE ON QUENCH AND STABILITY OF OXIDE HIGH- $T_C$ SUPERCONDUCTORS**

M.K. Chyu

Department of Mechanical Engineering  
Carnegie Mellon University  
Pittsburgh, PA 15213

C.E. Oberly

Aero Propulsion and Power Directorate  
Wright Laboratory  
Wright Patterson Air Force Base, OH 45433

#### **ABSTRACT**

This paper examines the influence of operating temperature, ranging from 20K to 80K, on the stability and normal zone propagation in a silver sheathed, YBCO superconductor tape. The distributions of temperature and heat generation are obtained numerically by solving a transient, two-dimensional energy equation with temperature-dependent properties and a current-sharing model. The present results suggest that a 20K operation is considerably more stable than its 80K counterpart. In addition, during a pulse-induced quench zone propagation, most of the ohmic heating is generated in the YBCO superconductor for a 20K operation. On the other hand, the silver sheath generates most of the heat for an 80K operation. Imposing transverse cooling significantly promotes stability and reduces normal zone propagation velocity. However, it has little influence on the instantaneous rise in local temperature during a disturbance. Such a temperature spike, largely caused by the low thermal diffusivity of YBCO, may exceed YBCO melting temperature.

# TURBULENT LENGTH SCALE MEASUREMENTS IN AXISYMMETRIC SUDDEN EXPANSION USING LDV

Dr. Richard D. Gould

Mechanical and Aerospace Engineering  
North Carolina State University

## ABSTRACT

Successful two-point velocity correlation measurements were made in the anisotropic flow field of an axisymmetric sudden expansion. Both longitudinal and lateral spatial correlations were measured. The integral length scales were estimated and compared with those obtained from autocorrelation measurements in conjunction with Taylor's hypothesis. The agreement between these two methods was poor and it is believed that the spatial correlation measurements give more reliable results.

## ELECTRIC FIELD EFFECTS ON PROPANE/AIR FLAMES

Harold H. Harris  
Department of Chemistry  
University of Missouri-St. Louis

Report of investigations performed  
in collaboration with Dr. Bishwa Ganguly  
at the Aero Propulsion Laboratory of  
Wright-Patterson Air Force Base

### Abstract

The effect of fields of several hundred to a few thousand volts per centimeter on propane/air flames burning at atmospheric pressure have been determined by measurements of the changes in the spatial distribution of the flames as revealed by emission spectra from such flames, and the approximate potentials in the flames caused by the interaction of the flame plasma and an applied field. It is shown that the effects are very pronounced in slightly rich flames (air slightly lower than the stoichiometric ratio) and almost nonexistent in slightly lean flames. Flames susceptible to deflection by the field coincide almost always to those which exhibit emission from  $C_2$  ( $A \ ^3\Pi_g \rightarrow X \ ^3\Pi_u$ ), but there are exceptions to this rule when flames are seeded with alkali metals. The observations are suggestive of a mechanism involving particular ionic or molecular species, rather than the more general "ionic wind" hypothesis.

## FINAL REPORT

### Investigation of the Combustion Characteristics of Swirled Injectors in a Confined Coannular System with a Sudden Expansion

Paul O. Hedman, Professor

David L. Warren, Master Candidate

Chemical and Mechanical Engineering

#### 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." The burner, referred to as the Pratt & Whitney Task 150 Combustor, uses a swirling fuel injector from an actual Pratt & Whitney turbojet engine installed in a sudden expansion combustor that closely simulates the geometry of a combustor from an actual jet engine. The Task 150 configuration has been configured so that the geometry around the injector is nearly axi-symmetric, but the combustor incorporates quartz windows so that optical (laser based) instruments can be used to make measurements in the flame. The Task 150 configuration uses a swirling injector similar to those used in the Task 200 combustor, and the inlet diffuser sections and Inconel chimney of the Pratt & Whitney Task 100 burner. This unique configuration allows complex diagnostic measurements to be measured in a simpler geometry than the Task 200 combustor, but embodies most of the features of an actual jet engine combustor in an axi-symmetric configuration that is easier to mathematically model.

# **CRITICAL ASSESSMENT OF RESEARCH IN ELASTOHYDRODYNAMIC LUBRICATION**

by

**Michael M. Khonsari  
Department of Mechanical Engineering  
University of Pittsburgh  
Pittsburgh, PA 15261**

## **SUMMARY**

Presented in this report is a portion of the work performed by the author as a Visiting Summer Faculty in the Lubrication Branch at Wright Patterson Air Force Base.

Two major tasks both dealing with the subject of elasto-hydrodynamic lubrication (EHL) of bearings were undertaken. First, a critical assessment of published research in EHL was made with particular attention to those sponsored by the United States Air Force. To this end, a number of important key subjects were investigated and critical problem areas were identified. This report provides a brief discussion of the effort.

The second portion of the work dealt with developing a computer program which can accurately calculate the pressure distribution and film thickness in concentrated contacts. Particular attention was given to the execution time and the efficiency of the algorithm as it is well known that EHL calculations are very delicate and time-consuming.

Due to the page limitation imposed on this report (maximum: 20 pages), the derivation of equations and the working of the program is not discussed herein. This program is to be used as a research tool. It is anticipated that it will be expanded upon in an applied research which is to be proposed as follow-up work.

**Effects of Riblets on Turbine Blade Heat Transfer**  
**and**  
**Velocity and Heat Transfer Measurements in a Ribbed Channel**

**Paul K. Maciejewski**  
**University of Pittsburgh**  
**Mechanical Engineering Department**  
**Pittsburgh, PA**

**Abstract**

This report describes two experiments in the general area of gas turbine heat transfer. The first is a study of the effects of riblets on the average heat transfer rate on a turbine blade in a cascade for cases with and without free stream turbulence. The second is a study of the velocity and heat transfer in a ribbed channel for six different flow geometries. Each experiment will be presented separately.

ELECTRON DENSITY MEASUREMENTS IN THERMIONICALLY-ASSISTED  
DISCHARGES IN CESIUM-ARGON PLASMAS

S. Douglas Marcum, Associate Professor of Physics  
Miami University, Oxford, OH 45056

Abstract

Electron excitation temperature and density were measured in a low pressure (0.05 Torr Cs, 2 Torr total pressure) cesium-argon discharge that uses a heated cathode (1100 K). The excitation temperature determination is based upon a model that allows for the calculation of cesium excited state densities and resulting absolute emission intensities for low electron density, thermionically-assisted Cs-Ar discharges. The model assumes that the dominant creation processes for Cs excited states are electron impact excitation and radiative cascade from higher levels. De-excitation is assumed to be by spontaneous emission only. Electron excitation temperature is determined by comparison of measured and calculated emission spectra. Measured absolute emission intensities then allow for electron density determination. For the low current ( $0.035 \text{ mA/cm}^2$ ) discharge studied, an excitation temperature of 4900 K and an electron density of  $2.5 \times 10^7 \text{ cm}^{-3}$  was determined. The measured density was, as expected for such non-equilibrium plasmas, considerably lower than the roughly  $10^9 \text{ cm}^{-3}$  value obtained from current continuity.

**A Numerical Method for Time-Dependent Incompressible  
and Compressible Navier-Stokes Flows**

**Summer Faculty Member:  
Tien-Mo Shih (employee number #132)  
Department of Mechanical Engineering  
The University of Maryland  
College Park, MD 20742**

**ABSTRACT**

**During the 10-week stay at the WPAFB, several tasks have been finished:**

- 1. The AMDEK computer code was studied, run, and shortened cosmetically. It was further found that the code cannot converge as is. See Appendix A.**
- 2. The subject of developing a numerical scheme capable of handling both the incompressible flow regime and the compressible regime was explored. See the main text.**
- 3. A one-dimensional code was written and applied to computing isentropic flows in convergent-divergent nozzles. See Appendix B for the FORTRAN listing.**
- 4. A two dimensional code was written and applied to computing flows in planar combustors. See Appendix C for the FORTRAN listing.**

# Experimental and Analytical Investigation of Effects of Noncondensable Gases On On-Axis Rotating Heat Pipes

Kaveh A. Tagavi & Brynn T. Martin  
Department of Mechanical Engineering  
University of Kentucky  
Lexington, Kentucky

## ABSTRACT

During the ten week summer appointment, we conducted an investigation of the effects of noncondensable gases on the performance of on-axis rotating heat pipes. Our efforts were divided in two fronts: experimental and analytical.

On the experimental front we designed and manufactured a rotating heat pipe made principally of oxygen-free-hard-copper with water as the working fluid. The assembly was isolated from the working table and electrical motor by using two air bearings. To study the effects of noncondensable gases some predetermined amount of nitrogen will be added to the working liquid. The heat pipe's inner wall was tapered at about two degree slope so that the centrifugal force would help the transfer of the working liquid from the condenser end to the evaporator end. Several thermocouples were installed both throughout the vapor passage and at the inner and outer sides of the heat pipe's wall. This will facilitate the measurement of temperatures of the heat pipe wall and the vapor inside. Accordingly, heat flux through the wall and the amount of noncondensable gases may be calculated from the temperature measurements. The thermocouples are connected to a data acquisition system by a slip-ring. The condenser end, which is covered by radial fins, is cooled by the aid of a Vortex tube while the evaporator end is heated radiantly via a set of element heaters.

Although no systematic set of experiments was performed during this period, several sets of experiments are planned for the follow up study during the next academic year.

**MEASUREMENTS OF DROPLET VELOCITIES AND SIZE  
DISTRIBUTIONS IN 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. The water flow was maintained at 2.75ml/sec; and air flow was either zero or 4089 ml/sec. Horizontal traverses were made across the spray near the sheet break-up region. With no air flow, the traverse was made at 10mm from nozzle; with air flow, the traverse was made at 5mm from the nozzle. More than 140,000 samples were taken in each traverse. The results show that the spray is axially symmetric which is important for the planned theoretical analysis. A new procedure is being developed to analyze the data. This required collecting the raw data and then placing them in velocity (two components) and diameter bins. When using this procedure, there will be no restriction on the size of windows used during the collection of the data. This is an improvement on the procedure that was developed two years ago to analyze spray data from a pressure atomizer. Measurements were also made on a spray that was driven by a piezoelectric unit.

TRANSIENT EFFECTS IN GLOW DISCHARGES  
USING THE GEC REFERENCE REACTOR

Dr. Fred V. Wells  
Associate Professor  
Idaho State University  
Pocatello, ID 83209

Abstract

Transient effects in pulsed rf (radio frequency) excited Ar, He and N<sub>2</sub> plasmas were investigated in the GEC (Gaseous Electronics Conference) reference reactor. The build-up time constant for the DC bias on the order of 50 to 300  $\mu$ s for Ar and He and 1 to 3.5 ms for N<sub>2</sub>. This time constant was a function of the coupling capacitor which provides a measure of the time scale for breakdown and establishment of the resistive component of the discharge for the gases studied. On switch-off, a fast decay depending on the pressure and power was observed in addition to a slow decay that is due to the circuit time constant was observed for all the gases.

## **D-18. ARMAMENT LABORATORY (ATL)**

### **SIGNAL PROCESSING FOR HIGH SPEED VIDEO TECHNOLOGY**

**Eugene R. Chenette, Professor  
University of Florida**

#### **Abstract:**

**This report presents the results of several experiments on the characteristics of video signals and of the performance of electronic systems used to process those signals. High Speed Video Technology has the potential for providing new and innovative tools for scientific and engineering research. Electronics components and systems capable of performing at the rate required for HSVT are only now becoming available. The need for large area high resolution imagers was one of the early prime movers motivating intensive research to build silicon with dimensions precisely controlled at the micrometer and submicrometer level. And the development of imaging arrays with multi-millions of pixels, with every pixel operating, and the dimensions of every pixel sensibly identical is one of the great achievements. The bottom line is that an HSVT camera meeting all of the requirements defined by WLMNGI can be built. Building it will develop an engineering knowledge base that will be of value for many years.**

## LIGHT-GAS GUN FIRING-CYCLE DESIGN FOR HIGH VELOCITY AND LOW PROJECTILE LOADING

Robert W. Courter  
Associate Professor of Mechanical Engineering  
Louisiana State University

### ABSTRACT

A study is made of a novel light-gas gun firing cycle that will produce higher muzzle velocity at lower model loading than can be achieved with a conventional cycle. The study centers on the application of the new cycle to the existing light-gas gun in the Aeroballistic Research Facility at Eglin AFB, Florida. A one-dimensional, unsteady, compressible-flow computer code obtained from the Arnold Engineering Development Center is adapted to permit simulation of the Eglin gun. Taguchi optimization techniques are employed to design a sequence of gun firing cycle simulations that isolate important effects. The results of the simulations indicate that for a given shot condition, modulation of internal wave interactions through judicious selection of the spacing between the piston face and projectile base can result in the multiple benefits of increased muzzle velocity and reduced projectile accelerations and system pressures. It is concluded that the Eglin gun must be provided with a shorter pump tube to adapt it for operation with the new cycle. Further, it is recommended that the gun be instrumented to provide data for more accurate simulation and that the numerical studies be continued to determine the sensitivity of the optimal cycle to projectile weight and desired launch velocity.

## TWO DIMENSIONAL SIMULATION OF RAILGUN PLASMA ARMATURES

by

Dr. Manuel A. Huerta, Professor of Physics and Mr. George C. Boynton

### ABSTRACT

Our code uses the equations of two-dimensional resistive MHD with Ohmic heating and radiation heat transport to simulate the internal dynamics of a railgun plasma armature. All quantities are advanced in time using an explicit Flux Corrected Transport scheme. We have done some theory to describe the initial fuse explosion and have modified the simulation to have a more realistic initial state. We now allow the driving current to be input from a data file. We also have developed a version that computes only one half of the rail to rail distance and forces mirror symmetry for the other half to save running time. We have done the background work to use an electrical conductivity that accounts for nonideal effects and to include turbulent viscous drag. We also studied the problem of the lubrication and drag of the projectile against the rail walls and found that it could be made to have little effect. A good deal time was spent doing a review of a new scheme for pulse radiation.

NONLINEAR ESTIMATION FOR EXOATMOSPHERIC TRAJECTORIES:  
THE DAUM-BASED FILTER

Dr. Antonio A. Magliaro

Abstract.

A sequential nonlinear filter based on the work of Daum and applied to the problem of estimating the location and motion of a boosting ICBM was evaluated in terms of its performance relative to the current state-of-the-art estimator, the extended Kalman Filter. The Daum-based filter was modified by tuning critical parameters involving process noise, maneuver detection and the guidance law associated with the estimator. Stability of the filter, significant increase in the probability of hit, and reduction of the total miss to the target was achieved as a result. Recommendations for further testing and enhancements of the filter are discussed.

PRACTICAL CONSIDERATIONS FOR A FIRST CUT  
MULTI-SENSOR FUSION SEEKER

by

Charlesworth R. Martin

ABSTRACT

The significant technical issues impacting on design are explored. The selection of an appropriate sensor suite. The physical constraints imposed on sensor geometry, side-by-side, or common aperture. The challenges of maintaining an appropriate radome geometry to achieve low aerodynamic drag. Decision on what point in the implementation should fusion actually occur for the data from the selected sensor suite and the most practical algorithm for doing so. Multi-sensor fusion seeker performance trade off with hardware complexity, cost associated with the fusion process, packaging challenges and increase computational load.

# NEWTON'S METHOD SOLVERS FOR THE NAVIER-STOKES EQUATIONS

Dr. Paul D. Orkwis

Assistant Professor

University of Cincinnati

## Abstract

Several issues involving improvements to the performance of Orkwis and McRae's exact Jacobian Newton's method solver for the Navier-Stokes equations have been explored. Development and storage of the sparse Jacobian matrix has been greatly simplified so that expensive sorting routines can be avoided. An evaluation of local timestepping versus global timestepping was performed which indicates that global timestepping is superior for a variety of reasons. The conjugate gradient squared (CGS) scheme was added to the method as an alternative to a direct  $LU$  decomposition solution of the system  $Ax = b$ . Preconditioners based on incomplete  $LU$  ( $ILU$ ) factorizations were tested. Comparisons were made between exact and approximate inversion routines and between exact and approximate Jacobian matrices. Results indicate that the approximate Newton schemes work well for cases with weak shock waves but perform poorly as shock strength increases.

# AFOSR SUMMER RESEARCH PROGRAM—FINAL REPORT ANALYSIS AND DESIGN OF NONLINEAR MISSILE AUTOPILOTS

Jeff S. Shamma  
Department of Electrical Engineering  
University of Minnesota

## Abstract

This report discusses the following two problems in missile autopilot design: (1) nonlinear stability analysis in the presence of dynamic modelling errors and (2) nonlinear autopilot design via gain-scheduling. Traditionally, these problems are addressed by linearizing the missile dynamics and applying linear theory. In this report, we present an alternate approach which does not resort to linearizations. First, we derive necessary and sufficient conditions for the robust stability of nonlinear dynamics subject to unstructured nonlinear dynamics uncertainty. Second, we present a novel approach to gain-scheduled autopilot design which relies on an alternate representation of the missile dynamics rather than linearizations.

QUALITATIVE EFFECTS OF KKV IMPACT LOCATIONS ON  
HYDRAULIC RAM IN FUEL TANKS AT  
FIFTY PERCENT ULLAGE  
(Hydrocode Analysis)

Steven A. Trogdon, Associate Professor  
Department of Mathematics and Statistics  
University of Minnesota - Duluth

and

Research Associate  
AFOSR Summer Faculty Research Program  
Wright Laboratory

ABSTRACT

The impact of a KKV traveling at 7 km/sec and interacting with a non-pressurized fuel tank at fifty percent ullage had been modeled with the CTH hydrocode. It was determined that proximity of the KKV to that portion of the fuel tank which is empty can produce significantly different responses of the tank to hydraulic ram. Two different impact scenarios were analyzed to exhibit that different responses are possible. From a lethality point of view one would like to know which factors will produce what distribution of impulse loading. Hydrocode calculations provide a useful tool for not only giving a qualitative assessment of which factors are important but for also giving the desired distribution of impulse loading for these factors. This research effort forms a starting point for future efforts to characterize lethality effects associated with hydraulic ram in fuel tanks.

## MOUNTING TECHNIQUES FOR HIGH G IMPACT SENSORS

Wayne J. Zimmermann, PhD

The design of a smart, real-time, earth penetrating device capable of identifying the enveloping strata requires a complex system having the following characteristics: highly shock resistant, quick response, completely self contained, reliable sensors and low self generated noise. Figure 1 presents a functional view of the primary components of such a system.

For the remainder of the report such a device will frequently be referred to by the phrase: EP device.

## **D-19. AVIONICS LABORATORY (AVION)**

### **Multiresolution FLIR Image Analysis**

**Dr. Raj Acharya**

**Electrical and Computer Engineering**

**State University of New York at Buffalo**

**Buffalo, NY 14260**

#### **Introduction**

In this progress report we present some initial results on FLIR image analysis using nonlinear scalespace. We have proposed a nonlinear multiresolution approach to image analysis(1). We implement the multiresolution pyramid within the framework of Mathematical Morphology (2,4). We propose the use of ASF(Alternating Sequential Filters) for nonlinear scale space generation.

## **AUTOMATIC SEGMENTATION OF INFRARED IMAGES**

Dr. D.V. Satish Chandra

### **ABSTRACT**

Image segmentation is an important step in any image processing or target recognition system. The motivation behind this research is to investigate if the performance of the segmentation algorithms can be improved by setting the parameters of the segmentation algorithms depending on the global image and target characteristics such as contextual scene information, time of the day, weather conditions etc. This report presents the performance of a segmentation algorithm based on probabilistic relaxation on several infrared tank images taken at various times of the day.

# Performance Evaluation of Rule Grouping Algorithm Running on the Activation Framework Architecture

Ing-Ray Chen and Bryant Poole\*

August 9, 1991

## Abstract

The objective of this research is to design and develop rule grouping algorithms for maximizing the performance of real-time rule-based systems running on the Activation Framework (AF) architecture [GRE 87]. This research involved the development of a formal theory for quantifying the estimation of performance metrics based on probabilistic parameter modeling and the design of a rule grouping algorithm based on Kernighan-Liu (KL) heuristic graph-partitioning for a single processor system. A demonstration system based on the theory and algorithm has been developed and tested on a portion of Advanced GPS Receiver (AGR) and Manned Maneuvering Unit (MMU) knowledge bases.

**A NOTE ON PRONY'S METHOD**

David B. Choate, Associate Professor, and Wendy Barkman

**ABSTRACT-** Prony's method can be used to compute the frequencies of two signals using four receivers. It is shown in this note that this can be done with only three receivers.

CORRELATION DIMENSION OF CHAOTIC ATTRACTORS

Thomas K. Gearhart, Ph. D.

Associate Professor, Capital University

**Abstract**

The correlation dimension, introduced by Grassberger and Procaccia, provides a means of quantifying the degree of chaos in strange attractors associated with nonlinear dynamical systems. This report compares various methods of estimating the correlation dimension and discusses some of the difficulties associated with obtaining reliable estimates. Estimation algorithms are used to investigate the chaotic attractors associated with the Mackey-Glass differential delay equation.

FIBER LASER PREAMPLIFIER FOR LASER RADAR DETECTORS

by

Richard E. Miers, Associate Professor of Physics

ABSTRACT

Nd-doped fiber laser amplifiers for incorporation into a laser radar test system were developed around two Nd-doped fibers provided by Rutgers University and Brown University. Both fibers exhibited a fluorescent band peaking at or near 1064 nm. A gain of 10 dB was measured in an amplifier incorporating the double-clad fiber provided by Rutgers University. Recommendations and designs for improved amplifiers using both fibers are given.

# A METHODOLOGY FOR EMPLOYING MODULATION QUALITY FACTORS IN THE ANALYSIS OF LPI WAVEFORMS

Glenn E. Prescott  
Lawrence L. Gutman

## Abstract

*LPI system quality factors were described in a previous effort [1] in order to provide a quantitative analysis tool for the system engineer to employ in evaluating the effectiveness of LPI techniques in the presence of jammers and intercept receivers. These LPI system quality factors were derived from the system link equations which describe the signal power gains and losses as a function of system link parameters. In this paper, we focus on the issue of detectability of LPI waveforms as defined by the modulation quality factor. The LPI modulation quality factor is a measure of the covertness of a particular type of modulation when detection is attempted by a particular type of intercept receiver. Intercept receiver detection models are provided for wideband nonlinear feature detectors. The utility of this quality factor is illustrated by an example and performance curves*

REUSABLE ADA SOFTWARE  
EVALUATING THE REUSABLE ADA AVIONICS SOFTWARE PACKAGES (RAASP)

Brian J. Shelburne Ph.D.

ABSTRACT

RAASP is a Air Force reusable software effort for avionics currently being performed by Westinghouse Electric Corporation. Under the effort, a library of Reusable Software Objects (RSOs) is maintained using a hypertext based library system which supports the administration, user browsing, and extraction of RSOs. This report evaluates a prototype reuse system from the RAASP contract. Although this reuse system is configured to handle avionics software, the prototype version used for this evaluation only contained RSOs dealing with numeric routines and Booch data structure parts. The system was tested by writing sample applications using the hypertext based library system to select the proper RSO. Preliminary indications are that the RAASP reuse system can be an effective software reuse system.

# Filtering by Similarity

Thomas Sudkamp

Department of Computer Science

Wright State University

**Abstract:** A fuzzy filter is a mapping that employs similarity information to transform a fuzzy set to enhance the continuity of compatibility (membership) values. The objective of filtering is to discount noise that may be introduced into domain information by the knowledge elicitation process or by the limitations of mechanical sensors. The effect of filtering is determined by a similarity relation and the aggregation methods employed. Four families of fuzzy filters based on t-norms and t-conorms are presented. Iterative applications of the filters extend the influence of elements beyond their immediate similarity neighborhoods.

# ASPECTS OF PATTERN THEORY

James S. Wolper  
Summer Faculty Research Fellow  
WL/AART-2

and

Department of Mathematics  
Idaho State University

**Abstract.** *Pattern Theory* (PT) is an attempt to create an engineering theory of algorithm design, analagous to control theory. The basic idea of PT is that binary functions which are "patterned" should decompose nicely. PT uses *Decomposed Function Cardinality* (DFC) of a function as a measure of its patterned-ness. This report details applications of PT to Signal Processing and Theoretical Computer Science, as well as attempts to improve the algorithms for computing DFC.

## VELOCITY DISTRIBUTION IN A DEGENERATELY-DOPED SUBMICRON-LENGTH FIELD EFFECT TRANSISTOR

Vijay K. Arora  
Professor of Electrical Engineering  
Wilkes University, Wilkes-Barre, PA 18766

### Abstract

Quantum-well microstructures for the design of submicron-length field effect transistors are investigated. As the electric field in the channel can become very high, an understanding of the velocity-limiting mechanism, a primary motivation behind this project, is achieved. It is shown that there is a poor correlation between the saturation velocity and the ohmic mobility. For nondegenerate semiconductors, the saturation velocity is limited by the appropriate average of the random thermal velocity. For degenerately-doped semiconductors, especially at low temperatures, the saturation velocity is found to be limited by the Fermi velocity which arises due to transfer of electrons from the parallel to the antiparallel direction of the electric field. The emission of an optical phonon was included by defining an inelastic scattering length at which point the energy absorbed by an electron equals the energy of an optical phonon. In order to study the validity of the theoretical ideas proposed, a comparison with the experimental data on bulk Si and GaAs quantum well was made, and excellent agreement obtained. The room-temperature velocity-field profiles obtained are used to evaluate the electric-field distribution, the velocity distribution, and carrier distribution in the channel of an 0.25- $\mu\text{m}$  High Electron Mobility Transistors (HEMT). The long-channel limit of the theoretical results indicates that the *pinchoff* behavior is absent when velocity saturation is considered even in the long-channel FET's. These results have advanced our thinking of the mechanism behind velocity saturation and will have an impact on the design of transistors with material structures of various dimensionalities. In the concluding section, the possible applications of these ideas in designing new experiments are suggested. Two papers, one each on 2-D and 1-D quantum wells, based on this report are in the process of preparation. An oral presentation of this report was given at WPAFB on 24 June, 1991.

## SOL-GEL WAVEGUIDE LASER FABRICATION

Dr. Raymond Zanoni

Recently there has been growing interest in developing solid-state integrated optical lasers. At British Telecom a waveguide laser was formed by Nd ion implantation in YAG<sup>1</sup>, at NTT a neodymium doped SiO<sub>2</sub> film was fabricated by CVD onto a silicon substrate<sup>2</sup>, at Thomson-CSF in France a waveguide and amplifier were demonstrated in LiNbO<sub>3</sub><sup>3</sup>, and ion exchange waveguide lasers have been made in neodymium doped glasses<sup>4</sup>. The intent of this investigation is to study the feasibility of fabricating waveguide lasers using sol-gel materials. "Sol-gel" processing is a low-temperature route for making glasses. The ability to chemically modify or dope the sol-gel together with the capability of simplified processing by means of spin coating, spraying, or vapor depositing the sol-gels makes these materials ideal candidates for novel, low-cost integrated optical components in a variety of military and civilian applications.

**D-21. FLIGHT DYNAMICS LABORATORY (FDL)**

**HYPERSONIC VEHICLE CONTROL STRATEGIES:  
PRELIMINARY CONSIDERATIONS**

**Dr. Daniel J. Blezad**  
**AFOSR 1991 Faculty Research Program**

**Mr. Phuong Vu**  
**AFOSR 1991 Graduate Student Research Program**

**Aeronautical Engineering Department**  
**Cal Poly State University**  
**San Luis Obispo, CA 93407**

**presented to**

**Mr. Chuck Suchomel**  
**AFOSR Research Focal Point**  
**WL/FIGC**  
**WPAFB, Ohio 45433-6553**

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A STUDY ON INTERFEROMETRIC TOMOGRAPHIC APPLICATION  
OF  
THE AERODYNAMIC EXPERIMENTAL FACILITIES AT WRIGHT LABORATORY

Soyoung S. Cha  
Summer Research Faculty at Wright Laboratory  
Department of Mechanical Engineering, University of Illinois at Chicago

ABSTRACT

The Aeromechanics Division of the Flight Dynamics Directorate at Wright Laboratory conducts high-speed aerodynamic research in five in-house facilities. The experiments have depended heavily on classical surface-mounted probes. However, for investigation of modern aerodynamic problems and verification of computational codes, quantitative three-dimensional gross-field measurements are very desirable. Optical interferometric tomography can be very attractive in this aspect due to its noninvasiveness, instantaneous capture of a three-dimensional field, good measurement accuracy, and high spatial resolution. However, the practical application of the technique to existing facilities poses some challenges due to peculiar operating environments that produce ill-conditioned operational data. During a short period of his summer research program, the investigator carefully studied the existing facilities, quickly collected necessary information, and conducted evaluation. He then drew important results and corresponding conclusions in order to apply the interferometric tomographic technique to the aerodynamic research facilities.

EVALUATION OF THE ANALYTICAL DESIGN PACKAGE (ADP)  
FOR FRAMELESS TRANSPARENCY PROGRAM

David M. Russell, Ph.D. Student  
Joe Chow, Assistant Professor  
Clarkson University, Potsdam, New York

**Abstract**

The increasing demand for more efficient transparency design, low cost manufacturing, and longer service life has lead to the concept of frameless transparencies for high performance fighter and trainer type aircraft. The frameless transparency program investigates the use of a transparent panel which directly interfaces with the aircraft structure without using a frame. Computer programs, such as Patran, MAGNA, STAPAT, and C-Mold, have been used to create, assess and optimize traditional transparency designs. However, these stand alone programs can be difficult to run, as the user is expected to be quite proficient with all procedures for running these programs. To aid in the transparency design procedure, an Analytical Design Package, ADP, is being developed by General Dynamics (GD), which integrates these computer programs into one module. The main

# A MASSIVELY PARALLEL ALGORITHM FOR LARGE-SCALE NONLINEAR COMPUTATION

S. K. Dey  
Mathematics Department  
Eastern Illinois University  
Charleston IL 61920

## Abstract

A perturbed functional iterative scheme (PFIS) discussed in [1] is now modified with massive parallel computation for large-scale nonlinear models. Several implicit finite difference models were successfully solved by this technique. However, the algorithm is yet to be tested on a massively parallel machine like a CM2 machine. The algorithm is fully vectorized and is called PVPFI (Parallel Vectorized Perturbed Functional Iteration). While solving implicit finite difference equations PVPFI eliminates inversions of block matrices for 2D models and block-of-block matrices for 3D models which are generally required for most implicit finite difference solvers. Furthermore, PVPFI minimizes linearization, reduces the number of arithmetic operations significantly and generates a high degree of accuracy. With appropriate number of parallel processors, the algorithm should converge quadratically.

# DECENTRALIZED CONTROL OF FLEXIBLE STRUCTURES WITH UNCERTAIN INTERCONNECTIONS

George T. Flowers  
Assistant Professor  
Department of Mechanical Engineering  
Auburn University, AL 36849-5341

## Introduction

Typically, control strategies are developed assuming that the controller has access to all the states of the system (or at least their estimates). For many large scale systems, such a formulation is not practical. Adequate control may require too many states for it to be practical to deal with all simultaneously or the system may be geographically extended such that communication of states back to a central controller is prohibitively expensive and involves excessive time delays. The solution to this problem has been to develop decentralized control techniques that are based only upon local states which are convenient subsets of the total system states. This field has advanced rapidly in recent years. Such techniques have been shown to be effective for many large scale systems, including power distribution networks, telecommunication networks, and large, flexible structures.

There has been a great deal of recent interest in the decentralized control of flexible structures. For decentralized control design, a flexible structure can be modelled as a collection of flexible appendages attached to a flexible support structure. Knowledge of the components (support structure and appendages) is typically fairly complete and can usually be modelled quite adequately using linear mode shapes and frequencies. However, knowledge of the interconnection dynamics is typically not so complete. The interconnections may be nonlinear (a pinned interconnection with friction, for example) and a great deal of uncertainty may exist

**COMPUTATIONAL PREDICTION OF STATIC AND ROLLING RESPONSE OF AN  
AIRCRAFT TIRE ON A RIGID SURFACE AS A PRELUDE TO WEAR STUDIES**

by

**MANJRIKER GUNARATNE, P.E.**

**Assistant Professor**

**ABSTRACT**

The 3-dimensional finite element program TIRE3D is used to predict the static and rolling response of a KC-135 aircraft tire on a rigid surface. The tire tread and the casing are modeled respectively by 20-node brick elements and 16-node layered shell elements. As for the constitutive relations, Mooney-Rivlin model was used for the tread material while orthotropic properties based on laminate theory were used for the cord-rubber casing.

It was found that the numerical results were in remarkable agreement with the static tire load test data. Although the program possesses the capability of incorporating visco-elastic rubber behavior, numerical stability under rolling was achieved only under elastic conditions. Further, a simple numerical procedure was developed to determine the slip velocities at nodal points on the rolling tire contact patch. Determination of slip velocities is certainly a useful stride in the analytical prediction of tire wear.

Deply of Laminated Panels with Perforation due to Impact

by

John Lair and David Hui

ABSTRACT

Deply techniques were used in composite material laminated plates were used in low velocity impact of panels where there no perforation occurs. Some preliminary data were obtained by Foos (1989). Such deply technique by pyrolysis (heat it in an oven at approx 800 deg F for about 40 min and then separate the plies with a scalpel) has not been commonly applied on perforated plates. Such deply technique will give more accurate delaminated areas and hole sizes than C-Scan techniques. Further, matrix cracks were observed in deply laminates which cannot be observed by C-Scan. Six panels from previous composite panels perforated by spherical projectiles (Altamirano 1991) are used for deply and the separated plies are analyzed in an image processing machine. The delaminated areas are seen quite clearly since they were pre-soaked in gold chloride prior to heating in an oven.

**Monitoring of Damage Accumulation for the Prediction of  
Fatigue Lifetime of Cord-Rubber Composites**

by

Byung-Lip ("Les") Lee and Pat K. Hippo

**ABSTRACT**

The study examined the effect of a broad range of the combination between different loading parameters on the fatigue resistance of *model* cord-rubber composites. Among them, stress amplitude was found to play a dominant role in determining fatigue lifetime of composites with an exception of the case where minimum stress approaches zero. The observed higher rate of strength degradation of composites at the zero minimum stress may be attributed to the alteration of the failure mode. The process of damage accumulation of cord-rubber composites was accompanied by a continuous increase of cyclic strain (i.e. dynamic creep), temperature and acoustic emission (AE). The dynamic creep rate and the rate of temperature increase were inversely proportional to the fatigue life according to a power law. In contrast, the extent of dynamic creep at gross failure was found to be independent of stress amplitude. When the minimum cyclic stress was high enough, distinctly different rates of AE signal accumulation could be assigned to the debonding and delamination failure modes. The results demonstrated a great potential of the measurement of local strain change, heat generation and AE as a viable experimental technique for real-time monitoring of the damage accumulation process.

# **IN-FLIGHT STRUCTURAL COMBAT DAMAGE DETECTION AND EVALUATION FOR ENHANCED SURVIVABILITY OF MILITARY AIRCRAFT**

Vernon C. Matzen  
Associate Professor of Civil Engineering

## **ABSTRACT**

A procedure is proposed for detecting - in flight - combat damage of military aircraft. This could be accomplished by using measured excitation and response data in a mathematical modelling technique known as system identification. An evaluation of the resulting damage information, using computational fluid dynamics algorithms and finite element models, would provide information on the relationship between the structural integrity of the aircraft and restricted flight variables such as speed and acceleration. This information, provided to the pilot in an obvious but unobtrusive manner, would make it more likely that the aircraft would be able to return to base, and do so without sustaining additional damage from normal maneuvers. Besides allowing for safer flight following damage, this information, if transmitted ahead, would allow repair crews to assemble the appropriate resources so that repairs could be made in the shortest possible time. To develop these ideas, a series of tests is conducted on a plate model having the configuration of an F-16 wing. Finally, a long-term project is proposed in which damage detection, evaluation, and pilot displays are developed to the point where they are implemented in a prototype model.

## A REPORT ON ROBUST CONTROL DESIGN FOR STRUCTURED UNCERTAINTIES

Dr. Jenny L. Rawson

Abstract: A method is presented for the construction of design equations for low-order controllers to stabilize and provide disturbance rejection for uncertain plants. The multi-goal robust stability and performance problem is broken down into subproblems, each with a simple design goal. Design Riccati inequalities are easily written for each of the subproblems, then the various terms are collected from each to form design equations for the multi-goal problem. This method is based on theorems fundamental to  $\mu$ -synthesis so that the results can be used to start the D-K iteration process in  $\mu$ -synthesis.

**EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF  
CONSTRAINED-LAYER DAMPING TREATMENT ON PARAMETRIC AND  
AUTOPARAMETRIC RESONANCES IN NONLINEAR STRUCTURAL  
SYSTEMS**

Lawrence D. Zavodney  
Assistant Professor

Joseph A. Schudt  
Graduate Research Assistant

Department of Engineering Mechanics  
The Ohio State University  
209 Boyd Laboratory  
155 West Woodruff Ave  
Columbus, Ohio 43210

**ABSTRACT**

The influence of viscoelastic constrained-layer damping treatment on parametric resonances of single-degree-of-freedom (SDOF) systems and autoparametric resonances of multiple-degree-of-freedom (MDOF) nonlinear systems possessing internal resonance was investigated. The results show that commercially available aluminium treatment is effective in suppressing parametric resonances of a particular mode (SDOF); it essentially adds linear viscous damping to the system and moves the regions of parametric resonance away from the frequency axis. In the MDOF systems the damping affects the nonlinear coupling between modes and has the ability to actually suppress the modulation between modes even when the excitation amplitude is increased. In general, its effect is to reduce the regions of nonlinear modal interaction and, in some cases, actually suppress it entirely with sufficient amount of damping treatment. Experimental results include stochastic excitation, transient response, sine-dwell, slow sine sweeps at constant amplitude, and slow amplitude sweeps at constant frequency. Particular attention was paid to the nonlinear modal interaction regions and regions bounded by the Hopf bifurcations.

## D-22. MATERIALS LABORATORY (MAT)

### SEMI-EMPIRICAL SELF-CONSISTENT CALCULATIONS OF GAAS SURFACE RESTRUCTURING

by  
Dr. Shashikala Toke Das  
Physics Department,

#### ABSTRACT

A semi-empirical molecular orbital program (MOPAC) was used for determining the position and binding energy of arsenic atoms adsorbed on a gallium arsenide substrate. Total energy calculations are performed for different cluster sizes to determine the difference between the binding energies of an arsenic atom adsorbed on the  $(\bar{1}\bar{1}\bar{1})$  surface of GaAs at the hexagonal-closed-pack (T4) and zincblende sites. It was found that the surface layer termination and the size of the cluster were very important in determining the binding energy accurately. The binding energies of As atoms at both sites were found to be of the same order of magnitude, supporting the recently proposed model for the  $(\sqrt{19} \times \sqrt{19})$  reconstruction of the surface, which was based on scanning tunneling microscopy observations [1]. The present work also establishes that semi-empirical approaches of the kind adopted here are appropriate for such surface studies from consideration of both speed and accuracy.

**X-RAY CRYSTALLOGRAPHIC STUDIES OF MODEL SYSTEMS  
FOR RIGID ROD POLYMERS AND OF MOLECULES WITH POTENTIAL  
NONLINEAR OPTICAL PROPERTIES**

**Albert V. Fratini, Ph.D.**

**The Polymer Branch of the Materials Directorate at Wright Laboratory, Wright-Patterson Air Force Base is engaged in a materials development program aimed at generating organic polymeric materials having structural and nonlinear optical (NLO) applications. The research program is a multi-faceted one, incorporating the areas of synthesis, processing, characterization, structure-property correlation, and the design and predictive features of computational chemistry methods. Organic materials are considered to be structurally diverse and multifunctional, and as a result, are expected to exhibit more long-term promise than inorganic materials.**

**The morphological characterization of polymers frequently involves the use of x-ray scattering techniques. The determination of ordered polymer structure generally involves first studying the structure of the various polymer repeat units by single crystal x-ray diffraction methods, followed then by a detailed packing analysis of polymer chains. Knowledge of polymer structure can lead to meaningful structure-property correlations.**

# COMPUTER-AIDED PROCESS PLANNING FOR GRINDING OPERATIONS

Rakesh Govind  
Professor  
University of Cincinnati

## ABSTRACT

Research was conducted on the development of a systematic approach for computer-aided process planning as applied to grinding operations. A decision making module using fuzzy sets was developed for grinding wheel selection. The module was tested on several industrial problems, with good success. A quantitative description of the grinding process was developed and a computer program for grinding cycle design was developed. Two cases have been presented here to demonstrate the results from the grinding cycle module.

Future work will involve the integration of the decision module and the grinding cycle design program with a process planning system, such as METCAPP.

**TRANSMISSION ELECTRON MICROSCOPY of  
DEFORMATION at the INTERFACE of  
Ti-6-4 // SCS6 SiC FIBER COMPOSITES**

**WARREN J. MOBERLY**

***Abstract***

Numerous FEM calculations have predicted plastic deformation to first occur at the interfaces of Ti-alloy-matrix // SiC-fiber composites, both as a result of thermal processing and/or as a result of applied external stress. This research utilizes TEM to experimentally observe the early stages of deformation at the interface region of a Ti-6Al-4V // SCS6 SiC composite containing three parallel, continuous fibers. The as-processed composite, which displayed a less extensive chemical reaction at the interface as compared to that typically reported, exhibited dislocations in the  $\alpha$ -Ti grains near the interface only in regions between closely spaced fibers. In some grains these dislocations appeared in "rows" parallel to, and displace  $\sim 0.5$  microns from, the interface. After being pulled in tension to  $\sim 1/2\%$  plastic strain, significant dislocation multiplication had occurred throughout all of the matrix. A slightly higher dislocation density was observed in the  $\alpha$  grains of the matrix region between fibers. Grains contiguous to the interface exhibited dislocations in both "rows" parallel to and perpendicular to the matrix / fiber interface. However, only the dislocations in rows perpendicular to the interface exhibit pile-ups at grain boundaries. In addition, significant planar slip (often associated with oxygen impurities in Ti alloys) was observed in the matrix grains in close proximity to the interface, especially between fibers.

ULTRASONIC BEAM PROPAGATION: DIFFRACTIONLESS BEAMS AND  
BEAMS IN ANISOTROPIC MEDIA

Byron Newberry, Assistant Professor  
Mark Preischel, Graduate Student  
University of Cincinnati

ABSTRACT

Two problems were addressed during the summer research activity, both dealing with the propagation of ultrasonic beams as used in the nondestructive evaluation of materials. First, the possibility of making a transducer which produces an ultrasonic beam that does not diffract, or spread, as it propagates was explored. As a result of the work, such a beam was produced and a proposal for the construction of a practical device was developed. The second topic concerned the modeling of ultrasonic transducer beam propagation through anisotropic materials, such as fiber reinforced composites. As a result, simple formulas which predict the on-axis field profiles of beams in such materials were derived and validated through comparison with more complex models.

## GEOMETRIC REASONING FOR PROCESS PLANNING

Dr. Joseph H. Nurre

### Abstract

Geometric tolerance and dimensioning information is of primary importance in the design and manufacturing process. The current tolerance standard is intended to ensure the functionality of a part. This shifts more of the burden of understanding how to manufacture the geometry, to the process planner. In this report, the issues surrounding manufacturing to achieve a specified geometric tolerance is presented. Of particular interest in this report will be the topic of tolerance interaction among multiple features. A technique known as tolerance charting is presented as one method of handling geometric feature tolerance interaction. Tolerance charting is a highly structured technique which would lend itself to integration into an intelligent Computer Integrated Manufacturing system.

# **SYNTHESIS AND CHARACTERIZATION OF CHIRAL MESOGENS FOR USE IN CYCLIC SILOXANE LIQUID CRYSTALLINE MATERIALS**

**Steven K. Pollack  
Assistant Professor of Materials Engineering  
Dept. of Materials Science & Engineering  
University of Cincinnati**

## **ABSTRACT**

**Chiral mesogens based on 1,3 dioxanes were synthesized in order to compare the physical properties and molecular packing of cyclic siloxane liquid crystals (CLC's) based on these new mesogens with those previously studied based on cholesterol as the cholesterogenic group. Molecular modelling was utilized to predict the relative compatibility of the 1,3-dioxane based mesogens and cholesterol with hydroxy biphenyl based mesogens. In an additional study, an efficient synthetic scheme was developed for the esterification of 1-(4-nitrophenyl)-prolinol (NPP) using phase transfer catalyst conditions.**

## FINAL REPORT

### Ab Initio Computational and NMR Relaxation Time Investigations of Rotational Barriers and Chain Dynamics in Perfluoropolyalkylethers

Martin Schwartz

#### ABSTRACT

Like the perfluoropolyalkylethers, the barrier to internal rotation about the C-C bond in 1,1,2-trichloro-1,2,2-trifluoroethane [TCTFE] is affected by both steric and electronic substituent interactions. In order to establish a methodology for quantum mechanical investigations of PFPAE model compounds, the geometries, energies and vibrational frequencies of TCTFE were studied by *ab initio* calculations using basis sets ranging from 3-21G through 6-311G(2df). Bond lengths and angles calculated with the 6-31G(d) and 6-311G(d) bases were in close agreement with each other and with experimental results. Comparable energies of the equilibrium conformers and torsional barriers were obtained by MP2 calculations using the 6-31G(d), 6-311G(d) and 6-311G(2df) bases. The calculated equilibrium energy difference is in qualitative agreement with experimental results. It was concluded that results using the 6-31G(d) basis set provide satisfactory structural parameters and conformational energies, comparable to those obtained using larger polarized bases.

# On Photoreflectance Spectra from Two Dimensional Electron Gas in GaAs/AlGaAs Heterojunctions

by

Michael Sydor  
Physics Dept.

University of Minnesota, Duluth  
RDL Summer Faculty Research Program

Summer 1991

**ABSTRACT:** We use differential Photoreflectance and indirectly modulated photoreflectance to examine the signature from high mobility Two-dimensional electron gas in GaAs/AlGaAs heterojunctions. The samples with the highest electron mobility show an additional photoreflectance signal at  $\sim 1.45$  eV. The signal can be attributed to the optical transitions from the valence band to the second conduction subband ( $E_1$ ). Indirect Photoreflectance obtained by modulating the sample slightly off the probe illumination, accentuates the 1.45 eV signal. The amplitude and time dependence of the indirectly modulated Photoreflectance appears to depend on sample quality and may thus be useful in optical assessment of electronic materials.

# CREEP BEHAVIOR OF A FINE-GRAINED $Y_3Al_5O_{12}+YAlO_3$ (18 Vol.%) MATERIAL

Jeff Wolfenstine

Assistant Professor

University of California, Irvine

Department of Mechanical and Aerospace Engineering

## Abstract

The creep behavior of a fine-grained two-phase  $Y_3Al_5O_{12}+YAlO_3$  (18 vol.%) material prepared from mixed alkoxides powders was investigated in a temperature range between 1600 to 1680°C. It was observed that at strain rates less than  $10^{-3} s^{-1}$  the two-phase material deforms by a Nabarro-Herring diffusional creep mechanism controlled by cation lattice diffusion. In the diffusional creep regime the two-phase material can be deformed to true strains between 40 to 50% without microcracking or void formation. At strain rates above  $10^{-3} s^{-1}$  severe microcracking and void formation occurred which caused the stress exponent to be greater than unity and limited the strain-to-failure.

# ELASTIC MODULI OF FIBER REINFORCED BRITTLE MATRIX COMPOSITES WITH INTERFACIAL DEBONDING

Fuh-Gwo Yuan  
Assistant Professor  
Department of Mechanical and Aerospace Engineering  
North Carolina State University

## ABSTRACT

A theoretical analysis using finite element methods has been applied to fiber reinforced brittle matrix composites in order to predict the influence of the debonded interface on "effective" elastic moduli of the composites. Two types of geometry layout of the composites (a) composite cylinder model, (b) periodic square array model are considered in the analysis. The prescribed displacement boundary conditions and constraints equations are imposed for different deformation modes in order to maintain the geometric compatibility between neighboring RVE. The results show that the elastic constants obtained from composite cylinder model give much less degree of the unsymmetry than those of periodic square array model. Furthermore, some discrepancies about transverse moduli prevail between finite element analyses and the approximate model proposed by Pagano and Tandon(1990).

## APPENDIX E. GSRP REPORT ABSTRACTS

### E-1. ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY (AAMRL)

STUDY AND DESIGN OF A THREAT AND ASSOCIATED EMITTER PARAMETER  
DATABASE FOR THE B1-B ENGINEERING RESEARCH SIMULATOR AND  
ADVANCED DEFENSIVE MISSION PLANNING SYSTEM.

Stephen T. Ameling  
Graduate Assistant  
School of Technology  
Kent State University

#### ABSTRACT

The aim of this research is to create a realistic and accurate simulation of a ground site threat, store this in a emitter database, and then incorporate this data into the Advanced Defensive Mission Planning System (ADMPS). Close modeling of the electronic emissions and geographic laydown are essential for worthwhile electronic countermeasure crew simulator training. The ADMPS program and B1-B Engineering Research Simulator (ERS) at Armstrong Aerospace Medical Laboratory is the focal point of this study. A key goal is to create a ground threat simulation with methods that are compatible with other defensive system simulations. Emphasis is placed on crew training and EWO mission standards, so a high level of accuracy and realism is demanded of the hardware and software.

Simulation of Head/Neck Response to +Gz Impact Acceleration due to

Additional Head Mass

by

Amit Lal Patra (Summer Faculty Research Fellow)

University of Puerto Rico at Mayaguez

Christina Estep (Graduate Student Research Fellow)

Virginia Polytechnic and State University

ABSTRACT

This work was to extend research initiated at the Armstrong Laboratory (AL) to investigate the effects of added head mass on the dynamics of the neck and head during +Gz impact acceleration. The original effort was conducted to provide an analytical modeling foundation for a better understanding of the dynamic response of the head/neck system when encumbered with additional masses such as helmet, night vision goggles, mask or other performance enhancing or protective equipment. The summer effort include a literature search and the validating of a modelling methodology for +Gz impact response. The emphasis was on modelling experimental data obtained from tests on human volunteers for head acceleration and neck flexion. The work predicted loading at the occipital condyle interface, and performed extensive model parametric studies to explore the changes in acceleration, flexion and neck loading due to variations in the amount and placement of mass on the head.

# **COMPARING THE EFFECTS OF CHARACTER SIZE AND DIAL SEPARATION ON RAPCOM AND SPATIAL DISPLAYS**

**Kurt M. Joseph  
Department of Psychology  
Kansas State University  
Manhattan, KS 66506-5302**

## **ABSTRACT**

Matin and Boff (1988) have shown that RAPCOM display formatting can potentially increase performance in human-computer interactions involving high information transfer rates. More recently, an attempt by Uhlarik and Renfro (1990) to confirm these results has produced somewhat conflicting results. It was hypothesized that these differences were primarily a result of the different character sizes and degree of spatial separation between dials in the two respective experiments. The present study was conducted to investigate these differences. Performance was measured in terms of latency to response and accuracy. Results indicated performance differences resulted from differences in character size and spatial separation. RAPCOM displays produced more accurate performance overall. However, the use of minimally-separated digital dials with large characters produced the most accurate performance. It is recommended that designers consider these results when evaluating performance for these displays.

TOXICOLOGICAL VALUES IMPLEMENTED IN  
TESTING OF HALON REPLACEMENT AGENTS

Timothy Scott Keen  
University of Florida

ABSTRACT

An international consensus to remove Chlorofluorocarbon (CFC) compounds from production and U.S. national policy to implement the resulting protocols has motivated the U.S. Air Force to embark on a program to find a suitable replacement for Halon 1211, currently used to extinguish flight line fires. This research addressed the feasibility of conducting a combustion toxicology (CT) program to assess the toxic products of the combustion interaction of JP-8 and the Group 1 or so-called "Near Term" candidate replacement agents for Halon 1211: HCFCs 123, 124, and 142b. A laboratory scale experiment benchmarked on large scale testing of a 150 ft<sup>2</sup> pool fire was developed on the basis of Froude scaling of the full scale fire to a 15 x 15 cm pan fire. A prototype apparatus was developed and investigation into the use of animal behavior methods as an indicator of human incapacitation was conducted. The result is a new method which may potentially be utilized for future toxicity studies of the combustion interaction of current and future U.S. Air Force fuels with various fire extinguishants.

ILLUSORY SELF MOTION  
IN FLIGHT SIMULATION

Jeffrey H Schmidt

Abstract

The objective of the current research effort was to conduct a pilot study to investigate the effects of operator control and type of texture pattern on the experience of illusory self motion in flight simulation. The results support the hypothesis that active controllers of a flight simulation experience an illusion of self motion to a greater degree than do passive observers of a flight simulation. Limited support is found for the hypothesis that the presence of a wire grid texture enhances the illusion. Possible confounds in the experiment are noted and plans for a new experiment are given.

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## ANIMAL TESTING IN COMBUSTION TOXICOLOGY OF HALON REPLACEMENT AGENTS

VINCENT W. STONE

Research Associate

University of Florida

### ABSTRACT

An international consensus to remove Chlorofluorocarbon (CFC) compounds from production and U.S. national policy to implement the resulting protocols has motivated the U.S. Air Force to embark on a program to find a suitable replacement for Halon 1211, currently used to extinguish flight line fires. This research addressed the feasibility of conducting a combustion toxicology (CT) program to assess the toxic products of the combustion interaction of JP-8 and the Group 1 or so-called "Near Term" candidate replacement agents for Halon 1211: HCFCs 123, 124, and 142b. A laboratory scale experiment benchmarked on large scale testing of a 150 ft<sup>2</sup> pool fire was developed on the basis of Froude scaling of the full scale fire to a 15 x 15 cm pan fire. A prototype apparatus was developed and investigation into the use of animal behavior methods as an indicator of human incapacitation was conducted. The result is a new method which may potentially be utilized for future toxicity studies of the combustion interaction of current and future U.S. Air Force fuels with various fire extinguishants.

Mr. Cortney Vargo

Not Available At This Time

## E-2. HUMAN RESOURCES LABORATORY: LOGISTICS & HUMAN FACTORS DIVISION (LHFD)

### The Shared Meanings of Teamwork

Joan Centsch, Ph. D.

Eusong Blacketer, B.A.

#### EXECUTIVE SUMMARY

The purpose of this project was to assess how members of teams in the Air Force interpret teamwork. It was predicted that some general themes, or interpretations, of teamwork would be shared by members of most teams. It was also predicted that on some teams, members would share a meaning of teamwork, and that on other teams, members would have different meanings of teamwork.

Information from team members was obtained in two stages. In the first stage, 54 military and civilian team members representing 21 teams in the Air Force were interviewed in small groups of 3 to 6 individuals, with a maximum of 3 individuals participating from each team. The information obtained from the interviews was used to develop a 3-part survey. In the second stage, all members of the participating teams were asked to complete the survey, and 00 completed surveys were obtained.

The survey required members of teams to rate 15 events that occur as a team works (e.g., The team makes decisions by consensus). They rated each event in terms of what it meant to them about teamwork. Members also rated their particular teams as to how well the team performed, how satisfied they were with the team, and how much team experience they had.

## MODELING COMPOSITE WINGS: AN OBJECT ORIENTED SIMULATION APPROACH USING MODSIM II

A.J.G. Babu and Jacqueline C. Schnepf

In this report, we describe a discrete event simulation model of an United States Air Force base-level aircraft maintenance organization serving a composite wing of aircraft. A composite wing is a mix of multiple types of aircraft under one commander in one general location. In contrast, a traditional wing, which we will call monolithic, contains many aircraft of the same type. For a composite wing consisting of F-16, F-15, and KC-135 aircraft, a prototype simulation model is constructed using a modular object-oriented design and the MODSIM II programming language. An arriving aircraft goes through flight line check and maintenance, obtains service at a selection of intermediary shops and finally gets reconfigured to take off. In reality, there would be more than twenty such intermediary shops. However, a simplified model is conceived for ease of prototyping. It consists of airframe repair shop, electrical shop, and environmental control shop in addition to flight line and reconfiguration shop. The prototype provides an understanding of the nature and scope of the problem as well as modularity and flexibility of the object oriented simulation approach. While demonstrating the modeling feasibility, it makes a case for the development of a complete model. A full scale model would help assess the maintenance resource requirements versus the sorties per aircraft. It can also be used to compare the cost and contributions of maintaining composite versus monolithic wings. The report concludes with suggestions for future directions of research.

### **E-3. HUMAN RESOURCES LABORATORY: MANPOWER & PERSONNEL DIVISION (MPD)**

## **Individual Differences (Impulsivity) and Personnel Selection**

### **Final Report**

**Jim H. Patton, Ph.D.**  
**M. Denise Brady, B. A.**  
**Department of Psychology**  
**Baylor University**

Siem, Carretta, & Mercante (AFHRL-TP-87-62, 1988) found a relationship between performance on the Self Crediting Word Knowledge (SCWK) test portion of the BAT and pilot performance in Undergraduate Pilot Training (UPT). SCWK correlated 0.14 ( $p < 0.01$ ) with pass/fail criteria for UPT candidates. One way to interpret these data is to note that subjects who passed UPT: took longer to answer on SCWK, had fewer total correct responses, and bet fewer points on the responses they did make. Even when overall verbal ability was statistically controlled there were smaller but robust differences in time to answer between successful and unsuccessful candidates. Those candidates who completed UPT tended to take longer for their responses. The authors interpreted this finding as a manifestation of a more cautious decision-making style exhibited by successful UPT candidates.

Siem (1991) tested 302 UPT candidates using various tests (BAT) including the SCWK test and the Activities Interest Inventory (AI). Siem found: 1) that response latency measures were related more closely to self-report personality measures than to cognitive response times, 2) that the risk-taking score was associated with a self-report measure of thrill seeking, and 3) that the performance-based self-confidence score was correlated with verbal aptitude but not with a self-report measure of self-confidence. A confirmatory factor analysis performed to examine the data structure provided a three factor model: 1) verbal self-confidence, 2) cautiousness, and 3) thrill-seeking.

What does all this mean mean? We know: 1) pilots need adequate levels of thrill-seeking or they won't fly jets, 2) cautious decision makers do better in UPT, 3) thrill seeking and cautious decision making (the opposite of impulsivity) are components of what purveyors of the "Big 5" call Surgency, or that Eysenck calls Extraversion, and 4) Surgency, by itself, is not strongly associated with pilot characteristics (Ashman & Telfer, 1983).

What would we like to know: 1) will a composite score incorporating high thrill-seeking and low impulsivity, essentially a decomposition of surgency, predict pilot training success, 2) if such a situation occurs what is the magnitude of the relationship, and 3) are there particular "impulsivity factors" associated with poor training performance?

## PROTOTYPING GAIDA: A LEARNING AND DEVELOPMENTAL PROCESS

Steven W. Hancock, Summer Research Associate

### Abstract

The automation of instructional design is a subject of great interest to people involved in education and training. The military is one entity that is heavily involved in education and training and would profit from the automation of instructional design. Armstrong Laboratory's Human Resources Directorate is implementing and testing the feasibility of these ideas. The GAIDA (Guided Approach to Instructional Design Adviser) project is testing the idea that a novice can produce effective computer-based instruction by merely following appropriate guidance given through a computer-based system. In order to test the feasibility of this idea a prototype was built using Asymetrix's ToolBook®. This prototype will be used to conduct research in order to determine whether a system of this type is effective. The knowledge gained from the prototyping process and this research will guide further developments of GAIDA.

THE LEADERSHIP EFFECTIVENESS ASSESSMENT PROFILE (LEAP)  
SUMMER RESEARCH ACTIVITIES

AMIE HEDLEY-GOODE

ABSTRACT

This paper describes the major tasks assigned to me while on summer internship with the Personnel Assessment Technology Function, Individual Attributes Branch, Manpower & Personnel Division, Armstrong Laboratory, Human Resources Directorate, Brooks Air Force Base. These responsibilities centered around the Leadership Effectiveness Assessment Profile (LEAP) instrument currently under development for the Air Force. The projects included organizing a LEAP Laboratory Advisory Group meeting, identifying and acquiring available criteria to use for LEAP validation, and the development and implementation of peer performance ratings to gather additional criteria for validation.

## The Relationship Between Working Memory Capacity and Context Effects in Lexical Access

David J. Hess

The research project that was initiated during the Summer Research Program had two separate goals. First, I wanted to build upon the growing literature that has established the central role of working memory in higher level language processing. In two studies addressing context effects in lexical access, I will be examining how individual differences in working memory capacity affect the ability to use prior context to facilitate lexical access. The first study, a replication of Hess & Foss (1991) with the Air Force population, will look at how working memory capacity affects the use of global and local information in a naming task. I anticipate that performance of recruits with larger working memory capacities will replicate the Hess & Foss findings, which were based on college students. However, I predict that recruits with smaller working memory capacities will be less able to make use of global information and will rely more heavily on local information. The second study is similar to the first but uses a standard memory load technique to manipulate effective working memory capacity. I predict that because the memory load will reduce effective memory capacity, both large and small working memory capacity recruits will be less able to take advantage of the global information.

The second goal of the summer research project was to begin exploring the components of the working memory system. To this point there are no "pure" measures of articulatory loop capacity. In the third study I constructed a number of articulatory loop tasks which have minimal processing demands and thus are considered to be "purer" measures of the articulatory loop. I expect performance on these tasks to be highly intercorrelated and to define a single articulatory loop factor. This project has the eventual goal of explicitly defining the properties of the articulatory loop and the central executive and determining how the properties of these components relate to various aspects of comprehension.

**E-4. HUMAN RESOURCES LABORATORY: OPERATIONS  
TRAINING DIVISION (OTD)**

***VISUAL COGNITIVE PROFILE FOR PILOTS***

Itiel E. Dror  
Harvard University

*Abstract*

U.S. Air Force pilots and control subjects performed seven visual cognitive tasks, each tapping into different underlying processing subsystems. We found that pilots visually rotate objects better than non-pilots, and that although pilots make categorical spatial judgments like non-pilots, they make strikingly better metric spatial judgments than non-pilots. Pilots' abilities to track motion, scan images and, extract visual features from objects--with or without visually noisy input--were like those of non-pilots. The results imply that specific processing subsystems are especially important for, and characteristic of, pilots. Different applications and uses of such research are discussed.

## VISUAL ATTENTION and OPTIMAL SEARCH

Lawrence R. Gottlob

Arizona State University

### ABSTRACT

Optimal search theory was used to determine whether observers allocate attention to a visual display optimally, given prior probabilities of target location. A location cuing paradigm with various probabilities of cue validity was used to measure observers' accuracy as a function of stimulus onset asynchrony (SOA). The general findings were that observers may be either optimally allocating a fixed amount of attention, or increasing the amount of total attentional resources, in response to task demands.

## E-5. HUMAN RESOURCES LABORATORY: TRAINING SYSTEMS DIVISION (TSD)

Fundamental Skills and Air Force Accessions:  
Linking Individual Abilities and Organizational Needs

Juanita M. Firestone, PhD  
Robert L. Caldwell, Research Assistant

### Abstract

This paper analyzes data from a wide variety of sources and compiles an inclusive assessment of fundamental skills in the Air Force accession pool. Data from a variety of sources such as The U.S. Census, The U.S. Department of Education, The Department of Defense, The U.S. Air Force, and The U.S. Bureau of Labor Statistics are used to link the material necessary for establishing a general profile of the typical Air Force recruit pool with respect to characteristics associated with fundamental skills and the training of those skills. This demographic information is further coupled with occupational growth patterns, delineating similarities/differences in civilian industries' and the Air Forces' personnel needs. The above information is joined with high school graduation rates and standardized test scores to relate indicators of individual fundamental skill levels to organizational skill needs. Most data are projected from 1980 through the year 2000, taking into account the impact of any important demographic trends on this process.

# The Efficacy of Multimedia Instruction

Mark J. Gavora  
Brooks AFB  
Research Associate

## ABSTRACT

A review of literature was conducted to determine if there is support for the belief that multimedia presentations influence learning and to identify the criteria necessary for a multimedia presentation to facilitate learning. Based on the findings of research involving linear and nonlinear multimedia as well as comments about research conducted, it is suggested that a multimedia presentation can influence learning. Such presentations should get students to mentally process information presented. Research in areas (Dual coding theory, Multiple resource theory, Transfer, Attributions and Modeling) that contribute to the effective design of multimedia presentations are discussed.

## E-6. OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (OEHL)

### COMPARISON OF BACILLUS ANTHRACIS AND BACILLUS CEREUS DNA USING PULSED FIELD ELECTROPHORESIS

Cristina A. Cardoso  
Research Associate

#### ABSTRACT

Pulsed field electrophoresis (PF), a method that permits resolution of large DNA fragments (3-50 megabases)(2,7), was used to compare the analogies between *Bacillus anthracis* (BA) and *Bacillus cereus* (BC) DNA banding patterns.

BA and BC were grown in nutrient broth and 3AT media (nutrient broth, nitrate, luminol and 3AT) for 24 hours or 6 days. DNA was extracted from the cells and digested with restriction enzymes(RE). Digested and undigested DNA were run in the pulsed field gel. Gels were photographed and DNA photos were compared.

**IMPROVING THE WORK OF THE HAZARDOUS WASTE BRANCH OF ARMSTRONG  
LABORATORY**

by

Dion D. Farrell

**ABSTRACT**

The Hazardous Waste Branch of Armstrong Laboratory is responsible for monitoring environmental quality through contract negotiations necessary to accomplish field work. My job was to assist in the contract formatting and to aid in several other projects. These tasks were successfully completed and thus furthered the mission of the branch.

## UNDERGROUND STORAGE TANKS (UST) REGULATIONS AND COMPLIANCE PROCEDURES

Research Associate  
Karen Dennis Somers

### Abstract

The Hazardous Waste Management Division of the Bioenvironmental Engineering Division of the Occupational and Environmental Health Directorate (formerly Armstrong Laboratory) provides environmental consultants to the US Air Force on a variety of projects involving compliance and remediation. One of the rapidly growing areas concerns USTs. The focus of my research was three-fold. First, I researched the regulations, methodologies and technologies concerned with USTs. Second, I created, organized, and conducted a comprehensive DOD seminar on USTs. Third, I served as project manager for several government contracts on sites involving USTs, as well as other hazardous waste remediation and clean up projects.

**Excitatory amino acid antagonists attenuate light induced c-fos gene expression in the hamster SCN**

**Becky Buckley**

**Sustained Operations Branch  
Armstrong Laboratory  
Brooks AFB, TX . 78235-5301**

**Introduction**

Mammalian circadian rhythmicity has been studied in great detail in order to determine the underlying mechanisms which generate and entrain behavioral rhythms to environmental day/night cycles. The light-entrainable pacemaker is located in the ventral hypothalamus, in association with the suprachiasmatic nuclei (SCN; 16). When environmental cues are absent, the pacemaker continues to measure time and oscillates with its own natural period. The pacemaker, therefore, must be an endogenous clock which measures time by a physiological mechanism. However, in the presence of an 24 hour light-dark (LD) cycle, the period of the pacemaker oscillation is adjusted to reflect that of the LD cycle.

# **Computer Image Analysis of Growth Characteristics of RAW 264.7 Mouse Macrophage Cells**

**Christopher J. Collumb**

## **ABSTRACT:**

The computer can allow for quick unobtrusive analysis of growth patterns and cell densities of cultured cells without the use of microscopy. RAW 264.7 cells are grown in culture at 37° C in 8-well Lab-Tek slides. Various stages of cell growth can be recorded by scanning the culture surface with an HP flatbed scanner attached to a Mac IIci. The cells may be either fixed and stained or still living. Cell density can be recorded as a greyscale value. Greyscale values can be obtained by thresholding the wells of the slide. After thresholding these values can be plotted to show cell growth over time. As the numbers of cells per well varies so to will the greyscale value vary. The fixed cells are stained prior to scanning causing the cells to appear dark to the computer. Thus the more cells present the higher the greyscale value of the well. The living cells are whitish and reflect the light of the scanner. Thus the more cells present, the lower the greyscale value. The greyscale values of both the fixed and living cells can be plotted and graphed to show the growth curve of the cells. The methodology provides a quick approach to monitor cell growth in cell culture.

## **BARORECEPTOR CONTROL OF BLOOD PRESSURE FOLLOWING SIMULATED MICROGRAVITY IN HIGH AND LOW FIT SUBJECTS**

**CRAIG CRANDALL M.S.**

### **Abstract**

Following microgravity exposure, astronauts have been reported to have decreased blood volume, maximal aerobic capacity, and orthostatic tolerance. Prior research demonstrate the loss of blood volume alone is insufficient to explain the observed decreased tolerance to gravitational stress. It has been hypothesized that microgravity induced detraining may reduce baroreflex responses to a given drop in blood pressure. The purpose of this report is to present a proposal to evaluate the response of the carotid sinus, aortic, and cardiopulmonary baroreflexes following detraining. In addition, the responses of these baroreflexes to perturbations in arterial and central venous blood pressures in high and low fit individuals will be investigated to determine if microgravity induced detraining elicits a greater change in blood pressure regulation in one group versus the other. The proposed investigation makes use of novel procedures to isolate the three distinct baroreflexes. The carotid sinus baroreceptor reflex will be examined by placing a lead collar around the anterior two-thirds of the subjects neck. Suction and pressure will be applied such that carotid sinus distending pressure will be altered. To determine the effectiveness of this baroreceptor, the changes in R-R interval, as well as vascular responses at various carotid sinus pressures, will be measured. Sub-hypotensive lower body negative pressure (LBNP) will be employed to examine the cardiopulmonary baroreflex. Graded LBNP will be applied from -5 to -15 mmHg. At each stage, heart rate, forearm vascular resistance (FVR), central venous pressure (CVP), and mean arterial pressure (MAP) will be recorded. The slope of the relationship of the decreases in CVP to the changes in FVR represents the responsiveness of this baroreflex.

# Manual Tracking Follows Induced Rotary Motion

## But Not Roll Vection

Michael Donnelly

### ABSTRACT

We investigated whether induced rotary motion (IRM) or roll vection (RV) is responsible for subjects' performance of a manual tracking task. Subjects are known to bias the orientation of a central display when it is surrounded by a rotating visual stimulus. Four experiments were performed in which we systematically varied conditions to evoke IRM and RV in different directions simultaneously, using first a depth manipulation like that of Heckmann & Howard (1991), then an eccentricity manipulation. Manual bias was found in the first two experiments to follow IRM closely, but RV results were indeterminate. Bias and IRM were found to be dominated by the farther of two inducing fields. The purpose of the third experiment was to generalize our finding that induced motion is dominated by the farther of two inducers to horizontally moving inducers more like those of Heckmann & Howard (1991). The last experiment successfully evoked IRM and manual bias without RV in one condition and RV without bias or IRM in another condition. These findings are relevant for design of displays which superimpose a smaller, central target (like an attitude display on a HUD) over a distant background.

DERIVATION OF A FINITE-DIFFERENCE TIME-DOMAIN (FDTD)  
ALGORITHM FOR MODELING DISPERSIVE MEDIA

Griffin K. Gothard  
Summer Research Student

ABSTRACT

The finite-difference time-domain (FDTD) algorithm is used to model dispersive material. Since current FDTD algorithms cannot model dispersive media, a reformulation of the traditional FDTD algorithm is required. This can be accomplished by including a discrete time-domain convolution [1] or a differential equation approach [2] that can be used to model frequency-dependent constitutive parameters. The traditional Yee formulation uses second-order accuracy to approximate Maxwell's equations. Since it was possible that for highly dispersive media higher-order approximations to Maxwell's equations might be required, finite-difference schemes employing fourth-order accuracy and sixth-order accuracy have been developed and investigated.

THE EFFECT OF HYPERBARIC OXYGENATION ON MUSCLE REGENERATION  
FOLLOWING TOXIN INDUCED NECROSIS

Christopher Hearon, Graduate Student

Abstract

Skeletal muscle's viability and its capacity to recover from injury are tied to the amount of oxygen present in the tissue. Hyperbaric oxygenation therapy (HBO) has been shown to reduce the amount of muscle necrosis and thus maintain viability during acute conditions of ischemia and compartmental syndrome. It is not known, however, if HBO will continue to slow the rate of necrosis under more chronic conditions or if it will accelerate the recovery from a necrotic condition. The purpose of this project was to determine if the rate of muscle regeneration or recovery from a chemical toxin induced muscle necrosis can be accelerated by HBO.

DEVELOPMENT OF COMPLIANCE / RESISTANCE ELEMENT  
RELATIONSHIPS FOR USE IN DESIGNING HEMODYNAMIC MODELS OF  
SECTIONS OF THE HUMAN CIRCULATORY SYSTEM

Dora Y. Hsie

Abstract

In this study, a flexible compliance/resistance system for designing hemodynamically accurate portions of the human circulatory system is designed and tested. A full factorial design is used to measure the effects of resistance, water/air capacitance, and flow rate. In this system, pressure and velocity are monitored up and downstream using Omega PX236 pressure transducers, Millar high-fidelity micromanometers, and hot film anemometers. Omega PX236 response is found comparable to the Millar high-fidelity micromanometers. Preliminary attempts to calibrate Doppler velocity crystals using a hot film anemometer were marginally successful. The two signals are qualitatively very similar but scaling problems prevent quantitative comparisons. Satisfactory responses are obtained in Doppler velocity crystal testing using 0.023" wall thickness plexiglas tubing with water seeded with 7.5 g of corn starch per liter.

## CIRCULATORY SHOCK DURING SUPERFICIAL HEATING WITH MILLIMETER WAVES

Sarah Miller, Research Associate

Ketamine-anesthetized Sprague-Dawley rats were exposed to 35 GHz continuous-wave radiofrequency radiation (RFR) in "E" orientation at an average specific absorption rate of 13 W/kg (power density=75 mW/cm<sup>2</sup>). During left lateral irradiation, colonic (T<sub>c</sub>), left subcutaneous (T<sub>s</sub>), tympanic, and tail temperatures, ECG, arterial blood pressure; respiratory rate; and superior mesenteric blood flow were continuously monitored by a PC computer-based system. Upon initiation of irradiation, the T<sub>s</sub> began to increase immediately, however, there was a 3-4 minute delay before T<sub>c</sub> began to increase, indicating that circulatory transfer of heat from the periphery was responsible for internal heating. During the course of exposure, the T<sub>s</sub> increase was significantly greater than the T<sub>c</sub> increase (36-50°C vs. 36-39°C, respectively). Heart rate increased monotonically during irradiation, while mean arterial blood pressure increased initially and then decreased dramatically. Also, splanchnic blood flow decreased during initial heating and then increased continuously until death. Simultaneously, blood pressure decreased at various rates until death. Such a reaction is characteristic of circulatory shock seen during heat stroke and terminal exposure to RFR. However, these reactions normally occur at colonic temperatures of 41.5°C or higher, while in the present study they occurred at less than 39°C. These results suggest that extreme peripheral heating, such as occurs during Millimeter Wave exposure, as well as core heating, can initiate circulatory shock, possibly by initiating splanchnic vasodilation.

Tod D. Romo  
Trinity University, Department of Biology

IMAGE ANALYSIS OF RAW 264.7 MACROPHAGES  
POPULATIONS

**Abstract**

Methodologies for quantitative analysis and the visualization were studied for cell growth and foci formation in mouse RAW 264.7 macrophage cultures using Apple Macintosh computers, flat-bed scanning, light and scanning electron microscopy. Correlation between scanned optical density and seed rates was examined. Natural cubic splines were used to interpolate between physical scans in time. Methods for extracting cell counts from SEM sample images, and for visualizing possible foci statistical estimators was also examined. Other methods of visualizing culture growth were studied including three dimensional color mapped isosurface renderings of OD scan data and derivative data between scans.

MODELLING HUMAN PERFORMANCE  
DURING SUSTAINED OPERATIONS

Anna L. Rowe-Hallbert, M.S.

Graduate Student-Rice University

ABSTRACT

Requiring people to make unusual shift changes or work for extended periods of time results in a disruption of natural bodily rhythms, and subsequently, their performance is degraded. A model which predicts performance degradations following the disruption of natural bodily rhythms would be useful as a decision making and staffing aid. Thus, two statistical models were developed to predict different facets of human performance during sustained operations: a reaction time model and an accuracy model. Both models utilize hours awake and melatonin levels as predictor variables. The predictor variables accounted for 33% the variance in reaction time performance and 18% of the variance in accuracy performance. Implications and future directions are discussed.

Sofia Ruiz

Not Available At This Time

**USE OF THE CARBOCYANINE DYE DiI FOR CORRELATION OF  
ANATOMICAL AND FUNCTIONAL PARAMETERS IN TWO  
EXPERIMENTS INVOLVING X-RAY INDUCED HYPOPLASIA**

**Marilu Vazquez**

**Summer Research Associate**

**ABSTRACT**

The purpose of the study was to complement and expand on two ongoing experiments involving neural grafts and the NMDA agonist, MK 801 and their association with x-ray induced hippocampal granule cell hypoplasia<sup>1,2</sup>. The primary goal being to investigate and develop the use of carbocyanine dyes, DiI and DiO, for labeling of neurones in fixed rat tissue obtained from the experiments mentioned. Specifically, the growth and arborization of neurons was analyzed and explored with the use of the neuronal marker. A technique was developed for the application of the dye, post injection clearing of the tissue, and for the viewing and photographing of the stained tissue. Preliminary results are positive and indicative of the various factors affecting DiI staining of fixed tissue, e.g., amount of dye needed and time required for diffusion. Using fixed tissue produced similar results to those observed when fresh tissue was used, but it required considerably more time for the dye to diffuse through the tissue. At the present rate of diffusion, final results will not be available for one to two months.

## **E-8. WILFORD HALL MEDICAL CENTER (WHMC)**

### **TEMPERATURE EFFECTS OF ESR, CELL VOLUMES AND VISCOSITIES: FINAL REPORT**

**Professor W. Drost-Hansen  
Richard R. McNeer**

#### **ABSTRACT**

Erythrocyte sedimentation rates and erythrocyte and platelet volumes of blood from 13 different species of mammals have been found to change abruptly near 46 - 46°C. The often dramatic drop in sed rates for temperatures above 45° reflect a histologically proven change in shape of the red cells from biconcave disks to nearly spherical. This change in morphology prevents rouleaux formation and thus lowers the sed rate. Furthermore, the viscosity of blood plasma increases rapidly and abruptly above the critical temperature of 45°C thus further lowering the sed rate. Finally, even resuspended erythrocytes in the absence of the plasma proteins show markedly reduced settling rates above 45°C. Abrupt changes are also seen in some parameters near 30°C; these and the 45°C anomalies reflect the effects of structural changes in the vicinal water associated with both the cells and the biopolymers in solution. This interpretation is further supported by notable thermal anomalies seen in the viscosities of a variety of polymers in aqueous solution, including both synthetic model polymers and naturally occurring biopolymers (such as BSA and fibrinogen.)

DIABETES, EXERCISE AND LIPID ABNORMALITIES:  
SELECTION OF A POPULATION FOR STUDY

ROBYN C. ROBINSON

ABSTRACT

Criteria for entrance into or exclusion from a study of aerobic capacity and exercise effects on lipids of diabetes patients is presented. Of 283 patients contacted by phone, 42 were accepted for study toward a goal of 110 patients. Baseline lipid studies for these patients is presented. Physicians recommend that their diabetes patients exercise. However, the most effective way of obtaining adherence with this recommendation is not known. The purpose of this investigation is to evaluate different of approaches for encouraging patients to consistently exercise and prevent complications of their disease.

## **E-9. ASTRONAUTICS LABORATORY (ASTRO)**

### **FINAL REPORT**

#### **RESEARCH IN VIBRATION IDENTIFICATION, ISOLATION, AND SUPPRESSION FOR LARGE SPACE STRUCTURES**

James Michael Argento  
Robert Alan Carlin  
Marco David D'Amore  
Ephraim Garcia, Ph.D.

### **I. INTRODUCTION**

The loads and vibrations that impinge upon a payload during launch have historically been the focus of structural and design engineers. My summer research focused on one particular Air Force satellite, and the possibility of reducing the loads from the two launch vehicles currently used: the Titan IV, and the Space Shuttle. The first step in this ongoing project was to learn about the structure of this satellite and perform an eigenanalysis using Nastran, NASA's Structural Analysis program. The next step involves a parametric study of the passive and/or active system that would be required to reduce said loads. It is assumed that this vibration isolator would be positioned between the satellite and the Inertial Upper Stage (IUS) upon which the satellite sits during launch in both vehicles.

Every satellite and its own substructures must be designed in such a way that they can withstand "launch cycle loads", and be able to perform their duties once they reach orbit. A considerable savings could be gained if these loads were reduced by some means. The savings are numerous and could include a decreased mass for the main load bearing members in the satellite, and in turn, an increased allowable mass for other components, such as electronics and propellant for attitude rockets. Another benefit is longer satellite life, since more propellant could mean a greater number of attitude adjustments while on orbit. The electronics on board might also exhibit longer life and have an even greater endurance, since the dynamic loading on the circuitry during launch would be reduced. With this in mind, the investigation into a vibration isolator for satellite systems has great potential.

# **XAFS Analysis of Propellant Materials**

## **RDL Final Report**

by  
Guy A. DeRose

### **ABSTRACT**

The technique of X-ray Absorption Fine Structure (XAFS) spectroscopy was used to determine local structure and short range order at the Cl K-edge in rocket fuel oxidizers - namely ammonium perchlorate (AP) - , oxidizer/binder systems, and new polymer materials of vital interest to the Air Force. Data was collected at the National Synchrotron Light Source, Brookhaven National Laboratory and analyzed at the Phillips Laboratory, Edwards Air Force Base. This Faculty/Graduate Student Summer research Project also resulted in the acquisition, by the Air Force, of state-of-the-art analysis programs for reducing EXAFS (Extended XAFS) data to a reportable form. Theory of XAFS and a detailed description of the analysis procedure is presented herein, along with limitations of the single-scattering formalism as applied to near-edge structure and suggestions for future work.

ALKALI METAL VAPOR SPECTROSCOPY  
AND  
SOLAR PLASMA PROPULSION

Paul S. Erdman  
Candidate  
Doctor of Philosophy  
University of Iowa

ABSTRACT

The solar plasma propulsion concept involves absorbing solar energy directly into the propellant of the rocket. Materials which would work well as solar absorbers and high specific impulse propellant would be alkali metals, particularly lithium, combined with hydrogen. To study the various  $\text{Li}_x\text{H}_y$  species which may be formed in the high temperature and pressure environment of the rocket, the Plasma Spectroscopy Cell (PSC) has been constructed. The PSC has been successfully tested and spectroscopic observations have been performed. There are indications that lithium hydrides have been formed, but wider spectral ranges and additional spectroscopic techniques will need to be employed in future experiments to fully study the  $\text{Li}_x\text{H}_y$  species.

## ABSTRACT

### A STUDY OF THE CATALYTIC GROWTH OF CARBON FILAMENTS

Patricia Meng-Fu Liu

In this project, the catalytic growth of carbon filaments on a graphite substrate was studied. To grow the filaments, gas mixtures of acetylene and hydrogen or propane and hydrogen were passed through the growth reactor at 950° C and angstrom sized iron oxide particles were used as catalysts. Experimental results indicate that carbon filament formation is inhibited when an acetylene-hydrogen gas mixture is used in the growth reactor at 950°C. However, when acetylene is replaced with propane what appeared to be carbon filaments with a hollow core and an approximate diameter size of 3 microns were grown. The hollow structure of the filaments are indicative of carbon filaments grown from catalyst particles.

# SYNTHESIS OF PHOTOCROSSLINKABLE POLYMER FILMS FOR INFLATABLE SOLAR COLLECTORS

RODNEY MASON

## INTRODUCTION

Phillips Laboratory Directorate of Rocket Propulsion has been interested in solar propulsion since 1956. By the end of 1963, the program was dropped due to the lack of interest in the scientific community. It wasn't until 1978 when the AFOSR funded an information gathering project with Rocketdyne that solar propulsion was again recognized as a viable alternative to chemical rocketery.

Rocketdyne determined that shuttle would be a good vehicle for getting solar experiments to low earth orbit. Since 1984, the AFRPL has redirected attention from earth based concentrator to space flight orientated inflatable reflector. The solar propulsion concept is the means by which solar powered propulsion can accomplish interorbital linear and interplanetary transfer missions. The main advantage of solar propulsion verses chemical propulsion is cost. The SPC is composed of three parts: the concentrators are inflatable and hollow, resembling large clam shells made of transparent films.

INCREASED DAMPING IN COMPOSITE TUBES THROUGH STRESS  
COUPLING AND CO-CURED DAMPING LAYERS:  
FORTRAN PROGRAM AND MEASUREMENTS

Dennis Duane Olcott  
Graduate Student, Brigham Young University

ABSTRACT

A unique tube design which uses the stress coupling properties of composite materials and the high loss factors of viscoelastics was studied. A computer program was written to solve previously derived equilibrium equations for the tube. The damping loss factor and resonant frequency of four tubes were measured. The measured values corresponded well with those from the computer program, indicating that this unique tube design has great potential for providing high stiffness, high damping, and low weight tubes for space structures.

## E-10. GEOPHYSICS LABORATORY (GEO)

# Developmental Research on Differential Inversion

Thomas W. Drueding

August 13, 1991

### Abstract

This report contains the progress of the summer research into the implementation of the differential inversion technique for temperature retrieval. The full derivations of the equations used are explored to determine what assumptions are involved in the initial implementation. The weakest assumption appears to be the representation of the weighting function as a convolution type kernel. Results from algorithms that account for the variation in the weighting function are reported and demonstrate a need for further research into the more general solution. A derivation of a differential inversion type solution to the more general weighting function is then shown. In addition the possible usefulness of a massively parallel machine for doing temperature retrieval is determined.

# LARGE SCALE STELLAR WINDS EFFECTS FROM A LUMINOUS EMBEDDED STAR

Kimberly A. Engle

## ABSTRACT

In order to obtain an infrared model of the celestial background that is applicable to Department of Defense goals, astronomical objects that emit infrared radiation must be well understood and modeled. This objective not only satisfies The United States Air Force's goals of obtaining an infrared model of the sky background, it also provides significant contributions to astronomy.

IRAS 05553+1631 was studied at many different wavelengths, including the four IRAS (Infrared Astronomical Satellite) of 12, 25, 60, and 100 microns. IRAS 05553+1631 is believed to be a deeply embedded young star with a bipolar outflow that heats the local molecular cloud. The outflow causes local heating that produces detectable emission in all four IRAS bands. This source is the second known object of this type, the first being well-studied L1551.

# INFRARED AND RADIO CORRELATIONS WITH GALACTIC H II REGIONS

Thomas A. Kuchar

Department of Astronomy

Boston University

## ABSTRACT

Infrared emission from galactic H II regions as revealed by IRAS (Infrared Astronomy Satellite) images was compared to radio continuum emission. H II regions are a major source of infrared emission in the Galactic plane, the brightest part of which is not yet well characterized. Three methods were employed to correlate IR with the radio. The most successful of these found a linear relation between each of the four IRAS wavebands and 11cm continuum flux. H II regions emit strongly in the infrared and thus provide background clutter for target detection and tracking in the infrared. The IR-radio correlations can be used to characterize this emission and thus improve celestial background models.

**1991 SUMMER RESEARCH PROGRAM  
FOR  
FACULTY AND GRADUATE STUDENTS**

Sponsored by the  
**UNITED STATES AIR FORCE OFFICE OF SCIENTIFIC RESEARCH**

Conducted by the  
**RESEARCH & DEVELOPMENT LABORATORIES**

**FINAL REPORT**

**STRUCTURAL AND VIBRATIONAL ANALYSES  
OF THE  
WAKE SIDE PLASMA SENSOR  
FOR THE  
WAKE SHIELD FACILITY**

Prepared by:

**Dr. Joseph J. Rencis, Associate Professor, P.E.  
Timothy J. Urekew, Ph.D. Candidate  
Christopher Scarpino, M.S. Student**

**This report serves as supporting documentation in certifying the Wake Side Plasma Sensor (WSPS) for flight as a secondary structure on the Wake Shield Facility. The WSPS is an experiment package that mounts on the free-flying Wake Shield Facility (WSF).**

## INFRARED EMISSION OF DIFFUSE HII REGIONS

Russell F. Shipman

### Abstract

A one grain infrared emission model was created to reproduce the IR emission of the Rosette Nebula. The temperature gradient, which reproduces the IRAS 60/100 ratio as well as the 60 and 100 micron surface brightnesses, cannot reproduce the 12 and 25 micron surface brightnesses. Therefore, more than one grain component is necessary to explain the 12 and 25 micron surface brightnesses. The temperature gradient, which reproduces the 60/100 ratio, has a very shallow slope suggesting that the dust is heated largely by the ionized gas.

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## **E-11. WEAPONS LABORATORY (WL)**

### **TWO-DIMENSIONAL FINITE ELEMENT SOURCE CODE USING**

**Four-Noded Quadrilateral Elements  
Truss Elements  
Frame Elements**

**Prepared by  
Richard C Castillo**

#### **ABSTRACT**

A finite element source code was written in response to a need for a method of numerical analysis which would enable an engineer to model both continuum and frame structures in conjunction with one another or separately. This source code contains the following three elements.

- 1) Four-noded Quadrilateral Elements
- 2) Truss Elements
- 3) Frame Elements

This program was written in the Fortran 77 language. The advantage of this source code is that it can handle both continuum and frame structures. The disadvantage, however, is that as the model becomes more complicated the creation of the input file becomes very cumbersome. A solution to this problem would be to marry this source code to an interactive - graphical - menu - driven program for rapid model definition and generation of the input - file. This would significantly reduce the time required to define a mathematical model of a structure.

**Assembly and Operation of the  
Working Fluid Experiment  
John F. Crawford, University of New Mexico**

**Abstract**

A 1-5 eV plasma is desired to be used as a working fluid for shockless compressions which have densities on the order of  $10^{19}/\text{cm}^3$ . This report describes the successful assembly and testing of the working fluid experiment (WFX).

**AN EXPERIMENT TO DETERMINE ANGULAR  
DISTRIBUTION OF BACKSCATTERED ELECTRONS  
AS A FUNCTION OF ENERGY & MATERIAL:  
A STATUS REPORT  
ROBERT DAVIES**

**1. Introduction**

Accumulation of electrical charge on orbiting spacecraft surfaces is a phenomenon receiving an increasing amount of attention. Such charge build-up is known to have produced operational anomalies of varying severity, ranging from insignificant to complete vehicle failure. Understanding the underlying mechanisms of this phenomena is logically the first step toward minimizing its effects.

Recent studies have revealed a strong link between the most significant charging events and precipitating high energy electrons originating in the earth's magnetotail. Additionally, a strong correlation exists between the energy of the incident electrons and the severity of the surface charging. Other variables, such as angle of incidence of the precipitating electrons and surface composition are less understood. This report summarizes progress of an on-going experiment probing the importance of these variables. Following a brief discussion of the project's goals and planned method, descriptions of experimental apparatus design, construction and testing are given.

**MITIGATION TECHNIQUES TO MINIMIZE  
DAMAGE RESULTING FROM EXPLOSIVE LOADING  
ON STRUCTURES FOUNDED ON PILES  
IN SATURATED SOILS**

Prepared by  
Nathan A. Dowden  
for  
Phillips Laboratory, USAF  
Kirtland AFB, NM

August 1991

**Abstract**

The Phillips Laboratory of the United States Air Force is currently examining the survivability of critical structures founded on piles in saturated soils subjected to explosive loading. The "typical" threat to structures has been established as a 500 Kg general purpose bomb of conventional munitions. The focus of this paper is to identify and investigate available methods of mitigating damage to the pile foundation in the event of an attack. Various methods, such as structural isolation, ground modification, and energy absorption/dissipation are reviewed within.

Stimulated Emission Pump Spectroscopy of Iodine

by

Shawn J. Gaffney

ABSTRACT

Work was completed on an experimental station, to perform stimulated emission pumping of ground state iodine and data was collected under a variety of conditions. Two optical tables were prepared with the proper optical equipment to simultaneously converge the beams of two pulse dye lasers and one argon ion laser onto a reaction point. The appropriate optics and monitoring equipment was added to observe the wavelength of all beams as well as beam absorption at the reaction site. The fabrication of a pressure controlled iodine cell allowed studies of relaxation rates in vacuum and partial pressures of various chosen ambients.

**FINITE-DIFFERENCE TIME-DOMAIN SOLUTIONS TO MAXWELL'S  
EQUATIONS FOR COMPLEX GEOMETRIES.**

**Michael C. Governale**

**Abstract**

The Finite-Difference Time-Domain (FD-TD) method for solving Maxwell's equations for complex geometry using the stair-step method at the boundary may be improved by using interpolative methods. It has been found that the interpolation method improves resolution at the boundary by closer approximations to the amplitude and frequency domains. Various solutions in 2-D using this technique are presented, including scattering and coupling of objects in the interior.

## **Parallelization of a Two Dimensional Vlasov code**

**James Koga**

**Graduate Student Research Associate**

### **Abstract**

A connection machine SIMD Vlasov code [4] is implemented on the MIMD Intel i860. Two versions of the code are implemented. A test problem is run and relative speed of the code is compared with the Cray YMP. A version of the code with 32 nodes achieves speeds faster than a comparable serial code on the Cray YMP. In this report the numerical scheme, timings, and test problem results will be presented.

ABSTRACT

TROUBLESHOOTING THE SPECTRA PHYSICS 5800 TUNABLE DIODE LASER

by

John E. McCord  
1991 RDL Graduate Summer Fellow

A Spectra Physics 5800 series high-resolution tunable lead-salt diode laser was reassembled and checked for proper operation as part of the introductory work for a planned transient study of NO ro-vibrational transfer with bromine radical. During this procedure, several technical problems and equipment failures were discovered on the laser system. The details of these problems and recommended steps for bringing the diode laser back to factory specifications are presented in this report.

Scott M. Peterson

Graduate Student, EECE Department  
University of New Mexico

## Introduction

The purpose of this report is to outline research conducted during the 1991 AFOSR Summer Research Program by Scott Peterson (associate number 434) at the LMI branch of the Phillips laboratory Kirtland AFB, New Mexico. During the course of this effort, Mr. Peterson was under the direction of Capt. Micheal Roggemann, Phillips Laboratory and Dr. Mohammed Jamshidi, professor of Electrical and Computer Engineering at the University of New Mexico.

The goal of the research activity was to formulate an understanding and investigate the problem of implementing a closed loop adaptive optics system using the phase reconstruction law known as minimum variance. The type of system that was considered is a general adaptive optics system consisting of a Hartmann type wavefront sensor and a continuous plate deformable mirror. The optical wavefront is propagated through the wavefront sensor where phase differences in the form of wavefront slopes across the telescope aperture are measured. These values are input to the minimum variance reconstructor matrix and the output of the reconstructor is a set of deformable mirror actuator commands that apply a conjugate phase correction to the wavefront.

Minimum variance is obtained by minimizing the mean-square residual phase error between the measured and actual wavefront. In this manner the reconstructor takes into account the correlation between atmospheric phase statistics and slope measurements from the wavefront sensor. The desired result is to design a deformable mirror controller using minimum variance reconstruction which is stable and highly responsive. Since there has been no previous work in which minimum variance has been applied to a closed loop system, it is hoped that this research and subsequent efforts can serve as the basis for a masters degree thesis and a technical article.

The first four weeks of this effort were used to investigate the dynamics and stability characteristics of a generic adaptive optics system under a closed loop (feedback) configuration and integrate a model of the dynamical system into an existing computer simulation. The results of this preliminary investigation and computer models are outlined in section 2.1. Three weeks were spent in an attempt to adapt the theoretical derivation of the minimum variance control law to the closed-loop configuration. The difficulties and restrictions encountered in this attempt are given in section 2.2. Further consideration indicated the need for a more detailed second order model which would account for interactuator coupling in the temporal response of the deformable mirror. Two weeks were used to develop the differential equations for the mirror dynamics, state space equation formulation and computer simulation of a decoupled second order system and the effort is outlined in section 2.3. The last week of the summer research effort was used to consider the effects of noise and model uncertainty on closed loop stability and is discussed in section 2.4.

SINGLE QUANTUM WELL, GRIN-SCH SEMICONDUCTOR OPTICAL AMPLIFIER  
GAIN CHARACTERIZATION

Keith W. Ver Steeg

Power gain measurements were made on a single quantum well (SQW) graded index - separate confinement heterostructure (GRIN-SCH) optical power amplifier (PA). At low input power, the amplifier exhibited better efficiency for vertically polarized input than for horizontal polarization, even though more power can be coupled into the cavity with horizontal polarization. Higher input powers damaged the amplifier, resulting in large leakage currents.

**NEURAL NETWORK PROGRAMS INSTALLED ON  
THE KHOROS ENVIRONMENT**

**Paul H. Wheeler**

**Abstract:** The Phillips Lab Neural Computation Research group developed a number of Neural Network programs for research into pattern recognition applications. These programs were written for a specific research topic, but were nearly useless for use for general research. These programs were revised so that they would operate on a visual processing environment called KHOROS, which is supported by the University of New Mexico. This paper describes in detail on how the neural network programs operate within KHOROS and how they were tested.

# INTEGRATING NEURAL NETWORK ALGORITHMS INTO THE KHOROS ENVIRONMENT

Carla S. Williams

## ABSTRACT

Many of the Air Force laboratories are interested in providing an environment supporting signal processing research using neural network algorithms for pattern recognition and classification that does not require domain expertise for the application engineer in neural computation. This paper presents the results of the Neural Computation Research Group's implementation of several generic neural network configurations, developed and tested on relatively large scale data, within the Khoros visual programming environment.

## E-12. ENGINEERING & SERVICES CENTER (E&SC)

### STRESS WAVE TRANSMISSION IN PARTIALLY SATURATED SOILS

Kara L. Olen  
Graduate Student  
Master of Science Program  
Virginia Polytechnic Institute and State University

#### ABSTRACT

Centrifuge testing was conducted at Tyndall Air Force Base to study stress wave transmission through partially saturated sands under blast loading conditions. A total of 24 tests were conducted in moist soil. Specimen saturation levels ranged from 17% to 70%. Charge weights of 220 mg, 440 mg, 660 mg, and 880 mg were utilized. The weight of the charge, depth of the explosion, and level of acceleration were varied for each test to model 1-g explosions ranging from 15 lbs. to 500 lbs. and occurring at a depth of 30 ft. Test results show that there is a definite correlation between the saturation level of the soil and the peak stress and velocity of the transmitted wave.

ESTIMATION OF CONTAMINANT TRANSPORT PARAMETERS FROM  
LABORATORY STUDIES: BATCH AND COLUMN TECHNIQUES  
WITH SORBING ORGANIC SOLUTES

William P. Ball  
Assistant Professor  
Dept. of Civil and Environmental Engineering  
Duke University  
Durham, NC 27706

Dirk F. Young  
Graduate Student  
Dept. of Civil and Environmental Engineering  
Duke University  
Durham, NC 27706

**ABSTRACT**

Batch and column experiments were performed with halogenated organic solutes and sandy aquifer solids. Column results were analyzed with two solute transport models that incorporated nonequilibrium sorption as a) first-order mass transfer and b) Fickian spherical diffusion. The diffusion model was able to predict the column results using input parameters from prior independent batch tests. On the other hand, the first-order model required 3 to 4 parameters to be varied for good simulation, and fitted parameters were often not in good agreement with the batch results.

E-13. ROME LABORATORY/GRIFFISS (RADC)

THE ROLE OF CUT-VERTEX SET ANALYSIS IN  
THE INTEGRATED COMMUNICATIONS NETWORK MANAGEMENT SYSTEM (IMS)

by

Benjamin W. Hoe

ABSTRACT

Rome Laboratory is currently developing the Integrated Communications Network Management System (IMS) prototype, and cut-vertex set analysis plays an important role in the IMS prototype development process. This paper discusses the role of cut-vertex sets in terms of network survivability and reliability. A computer program for generating cut-vertex sets was developed, and comprised the major effort of this research. It also presents the theory behind the operation of the cut-vertex set program, how the program can be applied to the analysis of network survivability and reliability and it concludes with a discussion of possible applications to the IMS prototype design.

Demonstration of a  
Low Energy Electron Diffraction  
System

Yolanda J. Kime

Abstract

The analysis of surface structure is a valuable contribution to studies of electromigration in thin metal films. Low energy electron diffraction (LEED) can be used to glean much structural information from periodic surfaces. A sample holder has been designed to accommodate electromigration studies while meeting the restrictions imposed by the required ultra-high vacuum. The LEED system was demonstrated by examining a Ag(100) surface.

# ANALYSIS OF THE ELECTROMIGRATION-INDUCED FAILURE IN THE VLSI INTERCONNECTION COMPONENTS AND THE MULTISECTION INTERCONNECTIONS

*Ashok K. Goel, Assistant Professor, and*

*Matthew M. Leipnitz*, Graduate Student

Department of Electrical Engineering  
Michigan Technological University

## ABSTRACT

We have carried out a first-order analysis of the electromigration induced failure effects in the various VLSI interconnection components including the multisection interconnections using the series model for failure mechanism. The Components include a straight interconnection segment, an interconnection bend, an interconnection step, an interconnection plug, an interconnection via, an interconnection overflow, a horizontal multisection interconnection, a vertical multisection interconnection, a mixed multisection interconnection, and a power/ground bus. First, by considering the effect of average flux density on the grain-boundary migration, we have reduced each interconnection component in to a series or series-parallel combination of straight segments. Then, for each of the components, we have investigated the dependence of the median-time-to-failure and the Log-normal standard deviation of the corresponding failure distribution on the various component parameters. The results can be utilized to choose optimum values of the component parameters for minimum probability of interconnection failure due to electromigration.

**WINDOWING COMPARISON PROJECT:  
THE EFFECT OF WINDOW SHAPE AND SIZE ON  
PHONEME IDENTIFIABILITY**

**Beth L. Losiewicz, MA**

**ABSTRACT**

A variety of window sizes (4, 8 and 16 ms) and shapes (Exponential, Gaussian, Hanning, Triangular, and Rectangular) were investigated for their effect on phoneme identifiability. FFT spectrograms were created with every window size/shape combination for fricatives, stops and vowels, to see what effect different windowing parameters had on the identifying characteristics of different phonemes. For vowels, the 8 ms Hanning did the best job. For fricatives the 8 and 16 ms Gaussian and Triangular windows were best. For stops, the 4 and 8 ms Hanning window did the best job.

# RTS Prototyper's Workbench:

A Tool for Rapid Prototyping Provably Correct Real-Time Systems

James F. Peters III

*Syracuse University  
School of Computer & Information Science*

*and  
Computer Science Department  
University of Arkansas--Fayetteville  
232 Science Engineering Building*

## Abstract

This paper reports work on a prototyper's workbench, which is a software tool for rapid prototyping provably correct real-time systems. A real-time system (rts) is conceptualized as plant || controller (read "cooperation between hardware and controller software used to control the operation of the hardware"). The principal aim of this workbench is to provide a formal basis for prototyping provably correct software for a real-time system. The workbench has three layers: visualization, specifier's assistant, and experimentation. It supports reusability of design concepts with libraries of existing visual representations and temporal specifications. The workbench can also be used to model the environment for an rts, which makes it possible to test the behavior of a prototype. The focus of this report is on the specification layer of the workbench. Specifications are written in Ada/TL<sub>rt</sub>, which is a language for specification of the behavior of real-time systems. It merges concepts of the specification part of Ada, VDM specification of packages, and temporal logic specification of task behavior. Ada/TL<sub>rt</sub> specifications utilize explicit clock temporal logic, which facilitates formulation of hard, real-time constraints with respect to an external clock. These specifications prescribe constraints on state transitions, properties of behaviors of individual tasks and properties of interacting tasks. A proof of a system specification consists of showing that the system property holds over all possible interleavings of the task behaviors. An example real-time system (traffic light controller) specified in Ada/TL<sub>rt</sub> along with a partial proof of its specification, is presented.

## EXPERIMENTAL EVALUATION OF OPTICAL SWITCHING TECHNOLOGIES

Dr. Dean Richardson

**Abstract:** During my 10-week tenure at the USAF Photonics Center, I was involved with two distinct though related projects. First, I helped align and optimize a mode-locked picosecond dye-laser system for use in studying cascability of Self-Electro-Optic-Effect Devices (SEEDs) on loan from Bell Laboratories. Second, I participated in experimental design, optical alignment, and data acquisition efforts aimed at characterizing the reflection-mode behavior of a novel class of tungsten-oxide thin-film optical switches. Since my previous "hands-on" experimental experience had been somewhat limited, both of these assignments enhanced my ability to perform confidently and capably in a laboratory environment.

**CLOCK SYNCHRONIZATION TECHNIQUES: A SURVEY**

**Final Report**

**AFOSR Summer Faculty Research Program**

**9 August 1991**

**Waleed Smari, Graduate Student**

**Department of Electrical & Computer Engineering**

**Syracuse University**

**121 Link Hall**

**Syracuse NY 13244 -1240**

**ABSTRACT:**

In this report we give a summary of the research that has been done on the problem of clock synchronization in distributed computing systems. After presenting the theoretical background, we introduce a brief description of the works which attempted to solve this problem. The report is a summary of a detailed technical report submitted to Rome Laboratories surveying over one hundred papers on clock synchronization techniques to date. The reader is referred to the technical report for further details.

## CHARACTERIZATION OF RADAR CLUTTER AS AN SIRP

CHARLES T. WIDENER and JAY K. LEE, Ph.D.

### ABSTRACT

It has been proposed that radar clutter can be modeled as a spherically invariant random process or SIRP. SIRPs seem well suited to this role since by variation of certain parameters the Weibull, K- or Rayleigh distributed clutter envelopes are obtained. These distributions are significant since they fit well with experimental radar clutter data under different circumstances. In this report, a radar clutter model based on rough surface scattering is developed to show that SIRP characterization can be based on electromagnetic principles. Small perturbation analysis of a two-scale randomly rough surface is chosen since the form for the backscattered field has the proper form for an SIRP, under certain conditions. This is an important step in being able to predict the proper statistical distribution of radar clutter based on surface geometry and electromagnetic properties.

## E-14. ROME LABORATORY/HANSCOM (RADCH)

Final Report

Summer Graduate Student Research

By

Kuang Z. Cheng

Direct Excitation of Microwave-Spin Dressed States  
using a Laser-Excited Resonance Raman Interaction

For the Optical Pumping experiment, we pre-pump the Sodium beam by laser going through the window of section A. Since the light irradiation is equivalent to a time-dependent stochastic process acting on the atoms, the excited Na atoms decay to level 2 with finite probability. Therefore, the fluorescence after laser going through window of section B will be reduced.

For the experiment of Excitation of Microwave-spin Dressed States, we pump the atoms in zone A into the trapped state, i.e. Raman excitation. These excited atoms interact with a microwave field in zone M. We measure the degree of this interaction in zone B by detecting the loss of the trapped state population, via the fluorescence detecting photodiode. We will also find out the phase effect between microwave field and optical difference frequency.

## MILLIMETER-WAVE NOISE MODELING INVESTIGATION

Lawrence P. Dunleavy, Asst. Professor

Steven M. Lardizabal

Department of Electrical Engineering

University of South Florida

### ABSTRACT

A new method is described that provides valid mm-wave noise models for field effect transistors, including MESFETs and HEMTs. This method avoids the complications of a variable impedance tuner, and requires only the knowledge of a small signal equivalent circuit, and noise figures measured across a range of frequencies for a single known source impedance. Noise parameters derived from this method are shown to agree well with those obtained from tuner based measurements. A review of previously reported noise modeling techniques, summarized here, reveals either their common dependence on tuner based measurements or the use of approximations that are not valid at mm-wave frequencies.

Thomas Lusby

Not Available At This Time

## **TESTINGS ON EFFECTS OF THERMAL TREATMENT ON GaAs (AND InP) SUBSTRATES AT MOCVD TEMPERATURE**

**Yonghuan Zhou**

In MOCVD processing, substrates are developed at about 650°C. To minimize the thermal degradation effects at this temperature is crucial for effective quality control. A Heat Cell was designed earlier for investigating the optimum processing conditions. In order to test the protecting function of the heat cell, surface degradations of GaAs and InP substrates first without protection while being thermal treated was studied by photoluminescence method. Various experiment conditions including chemical treatments were examined to develop a procedure of effective and accurate measurement.

## **E-15. ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC)**

NON-INTRUSIVE TESTING OF COMPOSITE

AIRCRAFT ENGINE COMPONENTS: II

James Abbey, Graduate Student

Engineering Science and Mechanics Program

Georgia Institute of Technology

### **ABSTRACT**

This paper is the result of a ten week research effort to study non-intrusive testing of composite aircraft engine components. A review of polymer, metallic/intermetallic, and ceramic matrix composites is presented of which polymer matrix composites is concluded to be the most likely candidate. Also, various nondestructive testing methods as applied to composites are reviewed as well as new signal analysis methods such as acousto-ultrasonics and the wavelet transform. Then, the generation process of the promising NDT technique of laser ultrasonics is discussed in detail.

## PARALLEL SIGNAL PROCESSING FOR TURBINE ENGINE TESTING

Prepared by: Theodore A. Bapty & Ben A. Abbott  
Academic Rank: Graduate Students  
Department: Department of Electrical Engineering  
University: Vanderbilt University

### ABSTRACT

Arnold Engineering Development is the preeminent facility for ground testing of turbine engines at simulated altitude. The AEDC test facilities can duplicate the conditions experienced by the engine during an actual flight in a controlled environment. Consequently, the testing process is much safer and less costly than the alternate method of flight testing.

In order to assess the performance of the engine, they are heavily instrumented with various sensors. The outputs of sensors are sampled at high rates to capture information about high frequency processes occurring inside the engine. These outputs must be processed further to reveal the information. These signal processing computations are typically computationally intensive. The Fast Fourier Transform, for instance, requires approximately 34 floating point computations per sample under normal conditions. Immediate feedback is beneficial to the engineers testing the mechanical system. Online results enable the engineers to make interactive decisions during the test, reducing the cost and/or improving the quality of the data. The combination of quick turnaround and high computation per channel impose large computational requirements on any system designed to solve these problems.

# WAKE AND PROJECTILE VELOCITY ESTIMATION

D. Mitchell Wilkes & Georges Badih Aboutanos

Vanderbilt University

Department of Electrical Engineering

Nashville, TN 37235

## 1 Abstract

Digital signal processing techniques were used to estimate the velocity of a projectile and its wake. The observed data was collected by one or multiple doppler radars in an underground ballistic range.

A classical FFT-based spectral estimation approach was used to identify the frequency characteristics of the data. These frequencies were later translated into velocities leading to accurate velocity profiles of the projectile and of the wake.

A C program was also developed to implement the spectral estimation approach and to provide an automated analysis of the data with extensive graphical display of the results. These graphical presentations include velocity profiles, 3-D surface plots, and contour plots.

# AN EXTENDED KALMAN FILTER OBSERVER FOR AN ALTITUDE TEST CELL

D. Mitchell Wilkes and W. Brian Ball  
Vanderbilt University  
Department of Electrical Engineering  
Nashville, TN 37235

## Abstract:

New control techniques are needed to keep pace with the development of technology in altitude test cells. A recently proposed technique for these controls is a model-following controller using an inverse-process model, but there may be room for improvement in the accuracy of the inverse-process model. During this effort, an extended Kalman filter was developed to reduce errors in the inverse-process model.

## PARALLEL SIGNAL PROCESSING FOR TURBINE ENGINE TESTING

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Academic Rank: Graduate Students  
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**DEVELOPMENT OF A COMPUTATIONAL MODEL OF THE  
LASER-INDUCED FLUORESCENCE (LIF) OF HYDROGEN (H<sub>2</sub>) WITH  
EXCITATION AT 193 NANOMETERS**

**Clinton Daniel Benefield  
Graduate Student  
U.T. Space Institute, Tullahoma, TN**

**Abstract**

**The development and application of LIF diagnostics for O<sub>2</sub> and NO using excimer lasers is in progress at AEDC. The potential exists for LIF of H<sub>2</sub> using 193 nm. excitation. A theoretical/computational model is needed to accurately predict locations and structure of absorption and emission transitions.**

## PLIF DEVELOPMENT FOR WAKE PHYSICS ANALYSIS

John V. Dempsey, Jr.

### ABSTRACT

The following report describes the author's assignment at Arnold Engineering Development Center, Arnold Air Force Base, Tullahoma, Tennessee under the AFOSR Summer Research Program. The author participated in an active Air Force sponsored technology project titled, "PLIF Feasibility for Wake Physics". The project is being performed by Calspan Corporation/AEDC Division, operating contractor for aerospace flight dynamics testing at AEDC. The project is being conducted to investigate the feasibility of exploiting laser induced fluorescence to indicate the presence of selected gas molecules in the wake of a hypervelocity projectile in the hypervelocity gun range at AEDC. A Nd:YAG Pulsed Dye Laser and a CCD array camera produce an image of the downstream wake of the hypersonic upper atmospheric vehicle to provide data for development of mathematical models.

PARAMETRIC EVALUATION OF FINITE ELEMENT  
MODELING TECHNIQUES

by

Dollena S. Hawkins

ABSTRACT

Algor's finite element analysis software was used to model basic structural geometries. Parametric evaluation of finite element modeling techniques was achieved by generating models with different element and mesh densities and comparing the model generated data to theoretical or experimental results to determine model accuracy.

# THE EFFECT OF DOPPLER SHIFT ON THE APPARENT PLUME INFRARED SIGNATURES OF GAS TURBINE ENGINES

Charles R. Hewitt, Jr.

## Abstract

Aircraft engine exhaust plumes are important contributors to the total aircraft infrared (IR) signature. Accurate prediction of the plume infrared signature is therefore important in determination of an aircraft's detectability by infrared seekers. Current prediction techniques for plume IR signatures neglect Doppler shifts which arise from the high relative speed of the exhaust gases in relation to the atmosphere. The purpose of this study was to determine what the effect of including the Doppler shift in signature predictions was on the apparent plume IR signature of gas turbine powered aircraft. Results to date indicate that within the range of altitude and velocity at which current aircraft operate, the Doppler shift effects are small for IR seekers working in the 4 to 5 micron waveband. The results do indicate the potential for large effects under special circumstances.

**RECOMMENDATIONS REPORT ON WATER TUNNEL ANALYSIS  
OF ASTF C1 PLENUM SECTION**

**Stephen D. Howard  
AFOSR Summer Research Student**

**Abstract**

The basics of water tunnels are examined in terms of theory and design. The practicality of using a water tunnel model to determine the inlet/plenum design of the C1 test cell of ASTF is examined. A recommendation is made on using a water tunnel approach to the design.

## **CALIBRATION TECHNIQUE FOR COCODEC**

**Emily G. Joy  
Graduate Research Associate  
Arnold Engineering Development Center**

### **ABSTRACT**

**This paper presents a calibration procedure for a compressor flow code called COCODEC. The technique involves adjusting relative inlet dynamic head loss coefficient and relative exit angle deviation within the code to match calculated values of overall pressure ratio and efficiency with experimental results for a single rotor and a three stage transonic fan. A method of correlating the data from the calibration of each machine is discussed. Performance correlations for each machine are formulated for intended implementation into a three-dimensional flow code.**

## **DYNAMIC MODELING OF A DUAL FLOW PATH COMPRESSION SYSTEM**

Jules W. Lindau V

### **ABSTRACT**

A dynamic, stage-by-stage, post-stall compression system model intended for multiple flow path systems such as turbofans was investigated. Accurate results have been obtained with single flow path systems. However, the model exhibits numerical failure during deep surge in multiple flow path systems. Several deficiencies were identified which contribute to numerical failure: interpretation of stage characteristics at choked flow, an improperly imposed Mach number boundary condition, and a critical algorithm modeling flow at the splitter joining core and bypass flows to upstream flow. The stage characteristic interpretation and the improperly imposed boundary condition were corrected. The investigation suggested that the flow at the splitter region cannot be dynamically captured with a one-dimensional algorithm.

## Multigraph Implementation of Image Morphology

by

Michael S. Moore

### ABSTRACT

Morphological operators have been shown to be useful for image analysis and enhancement. Image morphology, though, is computationally expensive due to the amount of data, the complexity of data flow, and large required processing time. Multigraph, a system integration tool developed at Vanderbilt University, allows the building of complex algorithms from precoded modules (sub-algorithms). Multigraph will automatically schedule, execute, and control data flow between the steps of an algorithm. Multigraph is also capable of distributed processing using transputers, P.C.s, or workstations. This capability promises to make the morphological operations considerably faster. This report presents a multigraph implementation of a morphological algorithm for image enhancement. We will show that Alfa, a Multigraph graphics interface environment, allows the algorithm to be executed with ease and speed. Finally, we show a multigraph implementation of the algorithm that uses distributed processing between several workstations and give resulting speedup figures.

An Approximate Method for the Prediction of Underexpanded  
Rectangular Nozzle Exhaust Plume Boundaries

by

Kyle L. Nash

ABSTRACT

An existing simple modeling technique is proposed for the prediction of underexpanded exhaust plume boundaries. This technique transforms axisymmetric plume boundary coordinates to the respective rectangular nozzle coordinates by using a simple model for the plume cross-section. The method employs a scaling factor to account for mixing rate differences between axisymmetric and rectangular nozzle exhaust plumes. Studies indicate that the technique shows promise as a preliminary design and analysis tool.

# A Local Lagrangian Finite Volume Model for the Infinite Domain Shock Tube Problem

Blair H. Rollin

July 16, 1991

**Abstract:** An infinite domain shock tube model was constructed using the Local Lagrangian Finite Volume Method introduced to the author by K. C. Reddy <sup>1</sup>. For comparison purposes, two sets of initial conditions were chosen as test cases. These were the cases which Hirsch <sup>2</sup> used as standard tests in order to compare the performance of various schemes. Several parameters were changed, and modifications were made to the basic scheme. The results indicate that the scheme has a large amount of numerical diffusion as well as a Courant-Friedrichs-Lewy (CFL) number restriction. Nevertheless, the method produced results comparable to many popular first-order methods. With a minor modification, the results were even more favorable.

## COMPUTER MODEL FOR CAVITY OSCILLATIONS

Daniel Schatt

### **ABSTRACT**

A computer model for flow over a cavity was developed to estimate the frequencies and magnitudes of the pressure oscillations that occur. The computer model can be used to estimate the maximum dynamic loads that will act on a store located in the cavity, and to help design small scale experiments that simulate full scale phenomena.

**Monitoring an Axial Flow Compressor  
for Rotating Stall and Surge**

by

John M. Sebghati

**ABSTRACT**

Rotating stall and surge in an axial flow compressor are unsteady phenomena, which if left unattended could prove disastrous for the compressor and possibly the entire wind tunnel. Detecting the onset of these phenomena can, at times, prove to be difficult and requires constant monitoring.

Therefore, a study of the methods for monitoring the axial flow compressors in the 16 ft. transonic and the 16 ft. supersonic wind tunnels located at the Arnold Engineering Development Center (AEDC), Arnold Air Force Base was conducted for the detection of these unsteady phenomena. A method to complement or replace the existing use of strain gages mounted on a select number of rotor blades in each stage of the axial compressor was desired because of its slow response time. A variety of techniques were found, these include hot-wire, thermocouples, pressure transducers, acoustic sensors, and optical sensors. The use of high response static pressure transducers was found to be the most promising method but in light that it is still a new technology, this is not the time for its full implementation. A neural network based expert system tied into the current system would, for the time being, be the best possible solution and would provide a method for distinguishing between rotating stall, surge, and any other abnormalities, at a variety of operating conditions.

## **DEMONSTRATION OF A NEW FINITE-RATE CHEMISTRY CFD CODE**

**Paul Vitt  
Graduate Student Research Assistant  
Arnold Engineering Development Center**

### **Abstract**

This paper presents the procedure and test problem results for the initial demonstration of the GASP computational fluid dynamics code at AEDC. The code was converted to run on a Silicon Graphics IRIS workstation, and solve test cases and current problems of interest. These problems, a high back pressure nozzle and a high area ratio nozzle, were used to demonstrate the abilities of GASP. Some difficulties were encountered with convergence and small upper CFL number limits.

**BOUNDARY ELEMENT ACOUSTIC ANALYSIS OF THE EXHAUST GAS  
MANAGEMENT SYSTEM IN THE ARNOLD ENGINEERING DEVELOPMENT  
CENTER AEROPROPULSION SYSTEMS TEST FACILITY**

Michael A. Weaver, MSAE  
School of Aerospace Engineering  
Georgia Institute of Technology

**Abstract**

The boundary element method was used to numerically determine the acoustic response of cylindrical models approximating the Exhaust Gas Management System in the Aeropropulsion Systems Test Facility at the Arnold Engineering Development Center. Longitudinal, tangential, and radial mode responses were calculated using two different model resolutions.

**THE INFLUENCE OF MATERIAL PROPERTIES AND SHAPE ON THE  
MEASURED HEAT-FLUX DISTRIBUTION USING A HEMISPHERICAL  
COAXIAL THERMAL COUPLE TEMPERATURE PROBE**

William Glenn Wilk  
Graduate Student, The University of Alabama

**ABSTRACT**

The primary objective of the project was to evaluate the effect of varying materials, their properties, and the hemispherical shape on a coaxial surface thermocouple heat flux probe. The results of the evaluation were used to develop a more precise heat flux reduction scheme. The present data reduction program to calculate the heat flux of a flow field assumes the probe behaves as a semi-infinite body of a single material at standard temperatures. Using the temperature time histories of a probe passing through the field under these assumptions results in an unsymmetrical heat-flux distribution whose magnitude is too low. A finite-element model of the probe was used with the computer code, TRAX, to perform this evaluation. After thorough investigation, the reduction procedure, COAXVP, was modified to include material property effects for the complete temperature range. Further improvements could be achieved by modifying future probe's shape (increasing nose radii) to closely match the semi-infinite body.

## E-16. FRANK J. SEILER RESEARCH LABORATORY (FJSRL)

### The Effects of a Passive Porous Surface on Flow Field Development Under both Static and Dynamic Conditions

Gregory A. Addington  
Master Degree Candidate  
University of Colorado at Boulder

#### Abstract

A passive porous suction surface was added to a NACA 0015 wing of otherwise conventional construction. Static surface pressure measurements indicate that the adverse pressure gradient usually present over the aft portions of such a wing were attenuated by the addition of this porous surface. Pressure gradients near the leading edge, however, are maintained in magnitude although local  $C_p$  magnitudes are generally less than those collected for non-porous wing configurations. When this pressure data is combined with flow visualization, a separated region is evident over the wing's aft portions even low angles of attack. Flow visualization taken during constant rate ramp motions in pitch indicate that no clearly evident and repeatable dynamic stall vortex is produced over the porous surface at low pitch rates, whereas one is evident for the non-porous and solid surface wings. As non-dimensional pitch rates are increased, a dynamic stall vortex becomes evident, although initiating earlier in the pitch motion than for non-porous or solid wings.

**ACTIVE/PASSIVE CONTROL SYNERGISM  
FOR A PLANAR TWO-DIMENSIONAL TRUSS**

**Jeffrey D. Curtis  
Graduate Research Fellow  
State University of New York at Buffalo**

**Abstract**

**An experimental example of active/passive control synergism was accomplished for a planar truss system using visco-elastic struts and air-jet thrusters. It was shown that the passive dampers can eliminate a third mode instability and increase the structural damping with only a relatively small loss in stiffness.**

## OPTIMAL PLACEMENT OF PASSIVE DAMPERS VIA SIMULATED ANNEALING

Tami A. Hamernik  
Graduate Research Assistant  
State University of New York at Buffalo

### Abstract

The study of placing a finite number of viscoelastic members in a large structure to provide damping for selected modes of vibration was examined. When the locations available in the structure for placement of these passive members are spacially discrete, the problem becomes a combinatorial optimization, much like the classic traveling salesman problem. For this case study, a simulated annealing algorithm was used where the cost function was the energy dissipation rate generated by a random placement of the viscoelastic members. Near optimal solutions were found and presented for the third mode of vibration in a twenty-bay planar truss structure.

## SECOND HARMONIC GENERATION IN POLED AMORPHOUS QUARTZ

Mr. Karl E. Kauffmann

### Abstract

In this paper the observance of second harmonic generation from poled amorphous quartz is reported. Samples are heated and then poled under high field strengths. These field strengths are maintained upon subsequent cooling, and the second harmonic signal of incident 1064 nm light is observed using the Maker fringe technique. The dependence of field strength on the magnitude of the second harmonic is explored. The temperature dependence on the poling process as well as that upon subsequent heating of the poled samples is studied. The observed second harmonic is shown to be relatively stable for several months at room temperature. ESR studies have been performed to determine the role of paramagnetic centers in the generation of the second harmonic signal. The nature of the dipoles aligned in the poling process has not been determined.

## THREE-DIMENSIONAL FLOW STRUCTURE DEVELOPMENT AND EFFECT NEAR THE ROOT OF AN OSCILLATING WING

John D. Klinge

### Abstract

Forced unsteady separated flows were studied near the root of a NACA 0015 wing undergoing sinusoidal pitch oscillations at low Reynolds numbers for various reduced frequencies and mean pitch angles. Vortex initiation, development and aerodynamic influences were characterized using hot-wire anemometry, surface static pressure measurements, and force balance measurements. The structure and development of a leading edge vortex on the wing upper surface varied temporally and spatially with different parameter combinations. Peak suction forces produced by the leading edge vortex on the wing surface were closely tied to convection and dissipation mechanisms. Forces measured on the splitter plate mounted at the root of the wing configuration were a result of the periodic vortex formation on the upper wing surface and the flow stagnation that occurred at high instantaneous angles of attack on the lower wing surface.

# AN INVESTIGATION OF ACTIVELY CONTROLLED STATIC AND DYNAMIC AIRFOILS

Julie A. Lovato, PhD Candidate  
Washington State University

## ABSTRACT

This research investigation evaluates the use of internal tangential pulsed air forcing as a means of steady and unsteady separation control on a NACA-0015 airfoil. Control frequencies are related to the natural vortex passage frequency associated with a separating static airfoil flow. Results show promise in reducing the separation region on both the static and dynamic airfoil flows. The static airfoil shows two distinct phenomena caused by the pulsed air forcing, a leading edge reattachment region and a clockwise vortex downstream of the leading edge. Both phenomena appear to be frequency dependent. The dynamic stall vortex on an unsteady airfoil is eliminated or reduced for certain forcing frequencies. The control effects involve interactions between pulse-generated vortices and the dynamic stall vortex generated by the unsteady flow.

## Relaxation Studies of Molten Salts

Maureen Parrish

### ABSTRACT

The combination of 1-methyl-3-ethylimidazolium chloride, MEICl, with aluminum chloride,  $\text{AlCl}_3$ , produces a molten salt that has the possibility of being used as a battery electrolyte. In recent years this melt has been used in studying organic solutes.<sup>1,2</sup> In the present work, ethyl aluminum dichloride,  $\text{EtAlCl}_2$ , is being added to the melts for the purpose of using the ethyl group as a "environmental NMR probe". The movement of the ethyl group relative to the other melt components will provide useful information and give a better understanding of molten salts as electrochemical and solvent support systems.  $^{13}\text{C}$  NMR relaxation studies have been done on the seven carbon peaks of these melts. Correlation studies with  $^{27}\text{Al}$  NMR are being done to determine the quadrupole coupling constants.

# DOWNWASH FLOW MECHANISMS ON A PITCHING CANARD/WING CONFIGURATION

Graduate Research Assistant

Dennis J. Strickland Jr.

## Abstract

In recent years, much attention has been given to enhancing the maneuverability of fighter aircraft. The understanding of the unsteady flow fields in which these fighter aircraft operate is the key to this enhancement. The primary concern of the present investigation was to correlate flow visualization data with existing unsteady quantitative data for a canard/wing configuration. Using a smoke-wire flow visualization technique, the flow mechanisms which cause downwash were identified. From this analysis, it was determined that a forward canard at positive angles of attack can produce an upwash on an aft located wing. This lift enhancing property was due to the location of shed vortices with respect to the aft wing and the circulation lag associated with pitching airfoils. The flow mechanisms associated with the circulation lag were identified, but the results were inconclusive.

**AN AB INITIO STUDY OF THE ADDUCTS OF ALUMINUM HYDRIDES,  
HALIDES, HYDROXIDES, AND OXIDES WITH HF AND HCL**

Mr. Marty Wilson

**ABSTRACT**

The adducts of HF and HCl with aluminum hydrides, aluminum halides, aluminum hydrohalides, aluminum hydroxides, and aluminum oxides have been studied using ab initio molecular orbital methods. When the electron rich region of HF or HCl is placed between 2.0 and 3.5 angstroms above the aluminum atom, Lewis Acid/Base adducts are generally found. In a few cases, the starting geometry rearranged to give a hydrogen bonded structure. In fewer cases, chemical reactions were observed. The structures observed are reported and briefly discussed.

**THE USE OF THERMOGRAPHIC PHOSPHORS FOR  
SURFACE TEMPERATURE MEASUREMENT**

David J. Bizzak  
Department of Mechanical Engineering  
Carnegie Mellon University  
Pittsburgh, Pennsylvania 15213

**ABSTRACT**

The efficacy of a nonintrusive, optical technique for surface temperature measurement based on the temperature sensitivity of the fluorescent emission spectrum of rare-earth ion doped phosphors (i.e., thermographic phosphors) is demonstrated in an experiment with a heated circular cylinder in cross flow. In this experiment the cylinder is heated by a constant surface heat flux, which is provided by applying a voltage across the foil surface of the cylinder. To allow surface temperature measurement, a thin coating of a thermographic phosphor is applied to the foil. The phosphor fluoresces when excited by ultraviolet (UV) illumination provided by a mercury vapor lamp. The fluorescent emission at two different wavelengths are captured by a charge coupled device (CCD) video camera. The analog output of the CCD camera is digitized and stored using PC-based hardware. These thermographic phosphor image data provide the means to calculate discrete circumferential surface temperatures, while thermocouples attached to the inner surface of the foil cylinder provide collaborating measurements. Comparison of circumferential surface temperatures obtained using the thermographic phosphor with those recorded from the surface-mounted thermocouples indicate that the accuracy of the present technique is  $\pm 2$  °F, but future technique improvements promise to significantly increase the accuracy of thermographic phosphor temperature measurements.

# Experimental and Analytical Investigation of Effects of Noncondensable Gases On On-Axis Rotating Heat Pipes

**Kaveh A. Tugavi & Bryan T. Martin**  
Department of Mechanical Engineering  
University of Kentucky

## ABSTRACT

During the ten week summer appointment, we conducted an investigation of the effects of noncondensable gases on the performance of on-axis rotating heat pipes. Our efforts are divided in two fronts: experimental and analytical.

On the experimental front we designed and manufactured a rotating heat pipe made principally of oxygen-free-hard-copper with water as the working fluid. The assembly was isolated from the working table and electrical motor by using two air bearings. To study the effects of noncondensable gases some predetermined amount of nitrogen will be added to the working liquid. The heat pipe's inner wall was tapered at about two degree slope so that the centrifugal force would help the transfer of the working liquid from the condenser end to the evaporator end. Several thermocouples were installed both throughout the vapor passage and at the inner and outer sides of the heat pipe's wall. This will facilitate the measurement of temperatures of the heat pipe wall and the vapor inside. Accordingly, heat flux through the wall and the amount of noncondensable gases may be calculated from the temperature measurements. The thermocouples are connected to a data acquisition system by a slip-ring. The condenser end, which is covered by radial fins, is cooled by the aid of a Vortex tube while the evaporator end is heated radiantly via a set of element heaters.

Although no systematic set of experiments was performed during this period, several sets of experiments are planned for the follow-up study during the next academic year.

# A TWO-WIRE THERMOCOUPLE TECHNIQUE FOR DYNAMIC TEMPERATURE MEASUREMENT IN REACTING FLOWS

by

Thomas R. Scattergood

## ABSTRACT

A new method of determining the instantaneous thermocouple time constant is examined using two thermocouple junctions of similar composition but differing diameters placed in essentially the same environment. This method is found to work well in theory but is somewhat more complicated in practice due to a strong sensitivity of the technique on the ratio of junction sizes and on the nature of the response signal. A probe calibration technique is recommended and discussed for use with this method. Also, the effect of probe geometry on the flowfield was examined using an LDV in a simple dump combustor and it was determined that there were no significant effects caused by any of the three geometries studied

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Conducted by the  
Research Development Laboratories, Inc.

FINAL REPORT

Investigation of the Combustion Characteristics of Swirled Injectors in a  
Confined Coannular System with a Sudden Expansion

Prepared by:

Paul O. Hedman, Professor  
David L. Warren, Master Candidate

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." The burner, referred to as the Pratt & Whitney Task 150 Combustor, uses a swirling fuel injector from an actual Pratt & Whitney turbojet engine installed in a sudden expansion combustor that closely simulates the geometry of a combustor from an actual jet engine. The Task 150 configuration has been configured so that the geometry around the injector is nearly axi-symmetric, but the combustor incorporates quartz windows so that optical (laser based) instruments can be used to make measurements in the flame. The Task 150 configuration uses a swirling injector similar to those used in the Task 200 combustor, and the inlet diffuser sections and Inconel chimney of the Pratt & Whitney Task 100 burner. This unique configuration allows complex diagnostic measurements to be measured in a simpler geometry than the Task 200 combustor, but embodies most of the features of an actual jet engine combustor in an axi-symmetric configuration that is easier to mathematically model.

Mark Williams

Not Available At This Time

## E-18. ARMAMENT LABORATORY (ATL)

### TWO DIMENSIONAL SIMULATION OF RAILGUN PLASMA ARMATURES

by

Dr. Manuel A. Huerta, Professor of Physics and Mr. George C. Boynton

#### ABSTRACT

Our code uses the equations of two-dimensional resistive MHD with Ohmic heating and radiation heat transport to simulate the internal dynamics of a railgun plasma armature. All quantities are advanced in time using an explicit Flux Corrected Transport scheme. We have done some theory to describe the initial fuse explosion and have modified the simulation to have a more realistic initial state. We now allow the driving current to be input from a data file. We also have developed a version that computes only one half of the rail to rail distance and forces mirror symmetry for the other half to save running time. We have done the background work to use an electrical conductivity that accounts for nonideal effects and to include turbulent viscous drag. We also studied the problem of the lubrication and drag of the projectile against the rail walls and found that it could be made to have little effect. A good deal time was spent doing a review of a new scheme for pulse radiation.

## SETUP OF MULTISPECTRAL RADIOMETER SYSTEM

Laurence Flath

### ABSTRACT

Recent studies<sup>1</sup> have found that state-of-the-art electronic video technology is superior to film-based high-speed imaging of in-flight events (missile releases, reconnaissance, etc.) in many respects, including greater amounts of useful data and shorter time from capture to data analysis. As a first step in constructing a high-resolution, high-speed video system, quantities like the nominal scene radiance of such events need to be found. A multispectral radiometer was constructed over the past year for just this purpose at the University of Arizona's Optical Sciences Center, with funding by USAF WL/MNGI. With the basic radiometer completed and returned to Eglin AFB, the setup of data collection equipment and calibration of the system remained and has thus constituted the main focus of this summer project. In addition, analysis of current video-camera technologies was also carried out as part of further research on the high-speed video project.

# LASER POLARIMETRY

Graduate Student Researcher

Randy Gove

## Abstract

Research in the field of Mueller matrix polarimetry was furthered with improvements in the data reduction and calibration technique, and construction of a visible light polarimeter. The data reduction and calibration technique was improved by implementing Mueller matrix equations which compensate for element orientational errors and nonideal retardances. These equations improved the accuracy of measurements made on the polarimeters. Infrared Mueller matrix measurements were made on a sample of cadmium telluride (CdTe) as a function of voltage applied across the crystal. The linear retardance for CdTe was found to increase linearly with voltage from 100 to 2400 volts. The electrooptic tensor coefficient was determined to be  $6.10 \times 10^{-12}$ . Measurements were made on a silicon wafer by rotating it between two polarizers. The linear retardance was determined to be 3.5 degrees and the linear diattenuation was determined to be less than 1%. A spectrum analyzer was used to find the power output for each of the infrared Edinburgh lasers tunable wavelengths. A Mueller matrix polarimeter operating at  $632\text{nm}$  was constructed and calibrated.

MATERIAL CHARACTERIZATION AND EVALUATION FOR  
PENETRATOR APPLICATIONS

Graduate Student Steve Hatfield

As a participant in the Air Force Office of Scientific Research (AFOSR) Summer Research Program for graduate students, I learned the importance of material selection for dynamic penetration mechanics. The selection process to determine the optimum material involved the operation and interpretation of several precise tests. These tests consist of the Hydraulic Tension Test, the Hopkinson Bar Test and the Rod Impact Test, most commonly known as the Classic Taylor Test. In addition to operating these test the lab was also evaluating material properties for other clientele. I was also involved in upgrading the computer program that the Hydraulic Tension Test used to achieve useable data and produce stress-strain plots. I am hoping to continue the research this summer at the University of Kentucky.

## TWO-DIMENSIONAL WAVEGUIDE SIMULATION

Christopher P. Hussell

### ABSTRACT

A program was developed to implement the spectral index technique for calculating the mode indices and field profiles of rib waveguide structures and the results were compared to those previously published. The method was extended for the case of dual rib waveguiding structures and a new program written. Since accurate data on structures of this type are scarce, an attempt was made to develop a finite element solution to the waveguide structure using a full vector field. This would be used to verify the accuracy of the extensions made to the spectral index technique. This remains to be completed.

## MATERIALS FOR INFRARED MODULATOR TECHNOLOGY

Annette M. Marsh

Graduate Student

### Abstract

Modulators play a very powerful role in many military applications. A list of possible electrooptic modulator materials was compiled from a literature search. A good modulator material has the characteristic quality of a large electro-optic coefficient or a large Verdet constant. One method of determining the new indices of refraction after an electric field is applied, and the indices are rotated, is by using laser polarimetry. Laser polarimetry at Eglin Air Force Base uses the polarimeter data to form a Mueller matrix. By knowing the crystal structure of the sample and the crystal plane the electric field is applied across, the electrooptic coefficient can easily be calculated. This was demonstrated by measuring the electrooptic coefficient found to be  $5.8 \times 10^{12}$  m/V, for a cadmium telluride sample. It was determined from a survey of material properties that lithium tantalate show great promise for a modulator operating in the infrared wavelength region.

MATERIAL CHARACTERIZATION AND EVALUATION FOR  
PENETRATOR APPLICATIONS

Graduate Student Jessica L. Mayes

As an AFOSR summer research graduate student, I was involved in several aspects of engineering research. In addition to assisting with various projects in the lab, my main focus was dynamic penetration mechanics relating to the advancement of weapons, specifically warheads. With the aid of good technical equipment and proficient research engineers, significant advancements were made that can be continued upon return to the University of Kentucky's research environment.

FULL REYNOLDS-AVERAGED NAVIER-STOKES SIMULATION  
OF TURBULENT TRANSONIC FLOW PAST  
A WRAP-AROUND FIN PROJECTILE

Juan B. Ordonez  
RDL Research Associate  
University of Florida

ABSTRACT

An algebraic grid network has been generated for the numerical solution of the turbulent transonic flow past a wrap-around fin projectile. This network is comprised of four 103x31x55 blocks, with the proper clustering needed to resolve viscous effects at all solid surfaces. The blocks are being solved using a full Reynolds-averaged Navier-Stokes code with the Baldwin and Lomax turbulence model, at a Mach number of 0.95 and an angle of attack of zero degrees. This investigation has not been completed due to errors encountered during preliminary runs. However, intermediate results suggest that the code is robust enough to model the flow in the high curvature regions near the fins.

# **IMPLEMENTATION OF A SYSTEM FOR EVALUATING THE MODULATION TRANSFER FUNCTION OF CCDS USING LASER SPECKLE**

**Martin Sensiper - Graduate Research Assistant  
(University of Central Florida)**

## **ABSTRACT:**

Many contemporary optical imaging systems contain a focal plane at which the continuous input signal is discretely sampled. In the past, accurately measuring the MTF of such systems has been difficult because the accepted techniques were not designed for the unique problems inherent with sampling. This paper presents a method for establishing the MTF of a sampling array from low frequency to twice Nyquist frequency. The use of random phased laser speckle circumvents the problems inherent with traditional methods of MTF testing where the phase of the test target with respect to the sampling grid affects observed contrast. Another advantage is the simplicity of the equipment and ease with which a test system can be assembled. In this report an aperture is presented which limits the speckle power spectrum to a narrow band, allowing the system response to be evaluated at specific frequencies. The algorithm for extracting the MTF from the data set is described. Sample MTFs are shown using this method and compared with the theoretical MTF and MTFs measured with sine targets.

**E-19. AVIONICS LABORATORY (AVION)**

**A NOTE ON PRONY'S METHOD**

David B. Choate, Associate Professor, and Wendy Barkman

**ABSTRACT-** Prony's method can be used to compute the frequencies of two signals using four receivers. It is shown in this note that this can be done with only three receivers.

# APPLYING CASCADE CORRELATION TO THE EXTRAPOLATION OF CHAOTIC TIME SERIES

David Ensley  
Department of Electrical Engineering  
Auburn University  
September 1991

## Abstract

Attempting to find near-optimal architectures, ontogenic neural networks develop their own architectures as they train. As part of a project entitled "Ontogenic Neural Networks for the Prediction of Chaotic Time Series," this paper presents findings of a ten-week research period on using the Cascade Correlation ontogenic neural network to extrapolate (predict) a chaotic time series generated from the Mackey-Glass equation. Truer, more informative measures of extrapolation accuracy than currently popular measures are presented. The effects of some network parameters on extrapolation accuracy were investigated. Sinusoidal activation functions turned out to be best for our data set. The best range for sigmoidal activation functions was  $[-1, +1]$ . One experiment demonstrates that extrapolation accuracy can be maximized by selecting the proper number of training exemplars. Though surprisingly good extrapolations have been obtained, there remain pitfalls. These pitfalls are discussed along with possible methods for avoiding them.

# COMPUTER AIDED ANALYSIS OF LPI SIGNAL DETECTABILITY

Scott P. Francis

Graduate Student, University of Kansas

## Abstract

A low probability of intercept signal detectability analysis program is described which calculates the detectability of certain spread spectrum signals by radiometric detection systems and feature detectors. LPI/SDA is a PC-based computer aided analysis system which expresses the detectability of a signal in terms of the signal carrier power to one-sided noise power spectral density  $C/N_0$  required at the input to a radiometer or feature detector to achieve user-specified detection and false alarm probabilities. LPI/SDA also has the ability to calculate LPI system Quality Factors, which describe the detectability of a signal separately in terms of scenario dependent and scenario independent factors. Sample detectability calculations are illustrated, and performance curves are provided. This program was initially developed at the Telecommunication and Information Sciences Laboratory (TISL) at the University of Kansas, and was modified and enhanced at the Avionics Laboratory at Wright-Patterson AFB during the 1991 AFOSR Summer Research Program.

**MINIMUM RESOLVABLE TEMPERATURE MEASUREMENTS OF THE MITSUBISHI  
THERMAL IMAGER IR 5210C**

**Daxron D. Lockett, Research Associate  
Electro-Optical Sensor Evaluation/Analysis Group  
Wright Patterson Air Force Base, Ohio**

**ABSTRACT**

The Electro-Optical Sensor Evaluation/Analysis Group of Wright Patterson Air Force Base has been involved in extensive modeling of mid-wave infrared sensor systems. One study that is of particular interest is the characterization of sensor performance. The Minimum Resolvable Temperature (MRT) test is used as a figure of merit upon which to judge imaging infrared performance. In this report MRT's of the prototype Mitsubishi Thermal Imager IR 5210C are measured. The result of this test is a plot of the minimum target to background temperature differences that allow humans to resolve a series of varying spatial frequency targets. These measurements may be used as inputs for the Mid-Wave Infrared Sensor Model developed by the Group.

# Performance Evaluation of Rule Grouping Algorithm Running on the Activation Framework Architecture

Ing-Ray Chen and Bryant Poole

## Abstract

The objective of this research is to design and develop rule grouping algorithms for maximizing the performance of real-time rule-based systems running on the Activation Framework (AF) architecture [GRE 87]. This research involved the development of a formal theory for quantifying the estimation of performance metrics based on probabilistic parameter modeling and the design of a rule grouping algorithm based on Kernighan-Lin (KL) heuristic graph-partitioning for a single processor system. A demonstration system based on the theory and algorithm has been developed and tested on a portion of Advanced GPS Receiver (AGR) and Manned Maneuvering Unit (MMU) knowledge bases.

## HIGH TEMPERATURE OHMIC CONTACTS FOR GaAs

David W. Moss  
Graduate Student of Physics  
Wilkes University, Wilkes-Barre, PA. 18766

Fabrication of electrical contacts to n+ and p+ GaAs were studied using GeMoW as the refractory ohmic metal and TiPtAu, TiPtAlTiPtAu, and Al were used as the different Schottky metals. The transmission line model (TLM) was used to determine the contact resistance at room temperature. The contacts were annealed with As and InAs over pressure. The samples were annealed at increasing temperatures, then the contact resistance was measured after each anneal. Plots of average contact resistance versus annealing temperature were created to help understand the relation between the two parameters. A GeMoW/TiPtAu contact on p+ GaAs had the lowest average minimum contact resistance of 0.14  $\Omega$ -mm after 550 °Celsius anneal and remained as an ohmic contact until 650 degrees. A GeMoW/Al contact on p+ GaAs remained ohmic from 300 ° C to 550 ° C with an average minimum contact resistance of less than 0.4  $\Omega$ -mm. The goal of this work was to increase the operating temperature of GaAs-based HBTs and MESFET devices by eliminating ohmic contact as an impediment.

## **E-21. FLIGHT DYNAMICS LABORATORY (FDL)**

**AIR FORCE OFFICE OF SCIENTIFIC RESEARCH**

**THE RESEARCH & DEVELOPMENT LABORATORIES**

**FINAL REPORT**

**ACOUSTIC EMISSION BEHAVIOR AND DAMAGE ACCUMULATION**

**MONITORING OF CORD-RUBBER COMPOSITE MATERIALS**

**Prepared by: Pat K. Hippo**  
**Academic Rank: Graduate Student**

### **ABSTRACT**

**Relying on coupon representations simulating the aircraft tire carcass region, this study investigated the key parameters that control damage accumulation in cord-rubber composite materials. Acoustic emission (AE) behavior of these specimens was monitored as well and the relationship between damage accumulation and AE was assessed for static and cyclic loadings. The results showed that the overriding factor controlling damage accumulation was stress amplitude rather than mean stress. In addition, strain dependence of AE under static loading was clearly established. The results were not as clear under cyclic loading conditions as the relationship seems dependent on selective minimum loads. However, AE potential as a predictor of imminent failure of aircraft tires still has some merit as refined procedures and improved instrumentation may eventually prove.**

Deply of Laminated Panels with Perforation due to Impact

by

John Lair and David Hui

ABSTRACT

Deply techniques were used in composite material laminated plates where no perforation occurs. Some preliminary data were obtained by Foss (1989). Such deply technique by pyrolysis (heat it in an oven at approx 800 deg F for about 40 min and then separate the plies with a scalpel) has not been commonly applied on perforated plates. Such deply technique will give more accurate delaminated areas and hole sizes than C-Scan techniques. Further, matrix cracks were observed in deply laminates which cannot be observed by C-Scan. Six panels from previous composite panels perforated by spherical projectiles (Altamirano 1991) are used for deply and the separated plies are analyzed in an image processing machine. The delaminated areas are seen quite clearly since they were pre-soaked in gold chloride prior to heating in an oven.

**ACTUATOR LOCATION  
AND  
OPTIMAL CONTROL DESIGN  
FOR  
FLEXIBLE STRUCTURES**

**John A. Mitchell  
Research Associate**

**ABSTRACT**

The optimal placement of one actuator and design of the associated optimal feedback control law is discussed and analyzed for flexible structures using the linear quadratic regulator formulation. This approach is then used to place multiple actuators sub-optimally. An iterative optimization scheme finds the global solution to this problem, and is based upon the theory and algorithm put forth by (Geromel,1989). Application of the algorithm to a small sample problem is presented.

**FINITE ELEMENT NON-LINEAR MULTIMODE RANDOM  
RESPONSE OF COMPLEX PANELS**

**USER'S GUIDE**

**RUSSELL A. MORRIS  
AFOSR SUMMER GRADUATE RESEARCH PROGRAM  
VIRGINIA POLYTECHNIC INSTITUTE  
SUMMER, 1991**

**ABSTRACT**

An analytical method has been developed for predicting root-mean-squared (RMS) maximum strain and displacements for isotropic and composite plates under random acoustic excitation. Eventually, data from this prediction method may aid in the prediction of sonic fatigue lifetimes of structures such as the National Aerospace Plane (NASP). Work done during the summer has included debugging and updating an already existing finite element code (RBUP2.FOR), generalizing the method of data input to allow for a much broader range of conditions, verifying results with other analytical solutions, performing mesh convergence studies, and developing a method of plotting linear mode shapes for rectangular plates. This paper is intended to serve as a user's guide, discussing in detail changes that were made during the summer.

**EVALUATION OF THE ANALYTICAL DESIGN PACKAGE (ADP)  
FOR FRAMELESS TRANSPARENCY PROGRAM**

David M. Russell, Ph.D. Student  
Joe Chow, Assistant Professor  
Clarkson University, Potsdam, New York

**Abstract**

The increasing demand for more efficient transparency design, low cost manufacturing, and longer service life has lead to the concept of frameless transparencies for high performance fighter and trainer type aircraft. The frameless transparency program investigates the use of a transparent panel which directly interfaces with the aircraft structure without using a frame. Computer programs, such as Patran, MAGNA, STAPAT, and C-Mold, have been used to create, assess and optimize traditional transparency designs. However, these stand alone programs can be difficult to run, as the user is expected to be quite proficient with all procedures for running these programs. To aid in the transparency design procedure, an Analytical Design Package, ADP, is being developed by General Dynamics (GD), which integrates these computer programs into one module. The main

# EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF CONSTRAINED-LAYER DAMPING TREATMENT ON PARAMETRIC AND AUTOPARAMETRIC RESONANCES IN NONLINEAR STRUCTURAL SYSTEMS

Lawrence D. Zavodney  
Assistant Professor

Joseph A. Schudt  
Graduate Research Assistant

Department of Engineering Mechanics  
The Ohio State University  
209 Boyd Laboratory  
155 West Woodruff Ave  
Columbus, Ohio 43210

## ABSTRACT

The influence of viscoelastic constrained-layer damping treatment on parametric resonances of single-degree-of-freedom (SDOF) systems and autoparametric resonances of multiple-degree-of-freedom (MDOF) nonlinear systems possessing internal resonance was investigated. The results show that commercially available aluminium-backed treatment is effective in suppressing parametric resonances of a particular mode; it essentially adds linear viscous damping to the system and moves the regions of parametric resonance away from the frequency axis. In the MDOF systems the damping affects the nonlinear coupling between modes and can suppress the modulation between modes. In general, its effect is to reduce the regions of nonlinear modal interaction and, in some cases, actually suppress it entirely with a sufficient amount of damping treatment. Experimental results include slow swept-sine excitations at constant amplitude and slow swept-amplitude excitations at constant frequency. Particular attention was paid to the nonlinear resonances and the modal interaction regions bounded by the Hopf bifurcation.

APPLICATION OF COMPUTATIONAL FLUID DYNAMICS FOR OPTIMAL  
STRUCTURAL DESIGN OF FLIGHT VEHICLES

Anne M. Stephenson  
Graduate Student

ABSTRACT

This investigation concentrates on the use of both linear and non-linear aeroelastic models for the structural weight optimized design of a fighter-type vehicle. ASTROS produces the optimized weight redesign of a finite element model of the wing and determines a flutter boundary using both subsonic and supersonic aerodynamic theories. The flutter phenomenon is recreated by the non-linear transonic code XTRAN3S. Once a critical flutter point is identified, one of two approaches can be taken to correct the problem. Either a control system is devised to suppress flutter, or the structure is redesigned to preclude flutter. In either case, a linear transonic aerodynamic model greatly facilitates the design process. The purpose of this study is to extract the linear transonic aerodynamic model.

# BALLISTIC IMPACT TEST OF GRAPHITE/EPOXY (COMPOSITE MATERIAL)

BY: AZIZ TADAYON

## ABSTRACT

This paper is explaining the experimental work of 1/2 in. diameter steel ball impacting a graphite/epoxy panel (composite materials) with two different velocities:

a.) low velocity (400 ft/sec), is done under atmospheric pressure 14.7 psi or 760 Hg.

b.) high velocity (3200 ft/sec), is done under vacuum conditions to eliminate the air resistance factor.

Two different types of powder were used:

1. unique, which is ideal for low velocity.
2. red dot which burns much better under vacuum conditions and is suitable for high velocity.

The study and analysis of fragments (image processing size and shape distribution) under SEM and C-Scan machines are the main goals of this scientific phenomena.

**HYPERSONIC VEHICLE CONTROL STRATEGIES:  
PRELIMINARY CONSIDERATIONS**

**Dr. Daniel J. Blezad  
AFOSR 1991 Faculty Research Program**

**Mr. Phuong Vu  
AFOSR 1991 Graduate Student Research Program**

**Aeronautical Engineering Department  
Cal Poly State University  
San Luis Obispo, CA 93407**

**presented to**

**Mr. Chuck Suchomel  
AFOSR Research Focal Point  
WL/FIGC  
WPAFB, Ohio 45433-6553**

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## E-22. MATERIALS LABORATORY (MAT)

### A STUDY ON THE EFFECTS OF TEMPERATURE AND GAS COMPOSITION ON THE MICROSTRUCTURE/MORPHOLOGY OF CVD SiC IN THE MTS/H<sub>2</sub> SYSTEM

Peter Brown  
Graduate Research Associate

#### Abstract

Silicon carbide was deposited onto graphite substrates in a vertically-oriented hot-walled reactor using a processing technique known as chemical vapor deposition (CVD). The precursor gas used in this study was methyltrichlorosilane ( $\text{CH}_3\text{SiCl}_3 = \text{MTS}$ ). Hydrogen gas acted as the carrier gas. Experiments were conducted to study the effects of temperature and inlet composition on the morphology of the deposited coating. It was shown that the microstructure and morphology of the coating do depend heavily on the temperature and the composition of the inlet gas stream. Further experimentation should be done to understand these dependencies more thoroughly, as well as the silicon carbide's dependence on the total system pressure and the mass flow rate into the reactor.

**THERMAL DEGRADATION OF PERFLUOROPOLYALKYLETHER FLUIDS IN THE PRESENCE OF VARIOUS METALS**

**DAVID DRAKE**

**ABSTRACT:** The thermal stability of Perfluoropolyalkylether (PFPAE) fluids (Krytox, Aflunox, Demnum, Perfluoropolydioxolane and perfluoropolyethylene oxides) has been investigated at different temperatures in the presence of three metals, 1018 steel, M-50 steel and M-50NIL steel. The preliminary results found 1018 steel to be much more reactive towards the PFPAE fluids in comparison to both M-50 and M-50NIL steel. It was also determined that, out of the fluids looked at Perfluoropolydioxolane was the most reactive in the presence of 1018 steel. The reactivity of the fluids was found to be as follows:  
Perfluoropolydioxolane > Krytox > Perfluoropolyethylene oxides > Demnum > Aflunox.

**NUMERICAL SIMULATION OF PHOTOREFLECTANCE FROM  
TWO-DIMENSIONAL ELECTRON GAS IN A GaAs/AlGaAs  
HETEROJUNCTION**

by  
James R. Enholm  
Physics Dept.  
University of Minnesota, Duluth  
RDL Summer Graduate Student Research Program  
ID#301, for Dr. William Mitchel  
at MLPO/WPAFB  
Summer 1991

**ABSTRACT:** We present a first principles calculation of the photoreflectance lineshape originating from the quantum well region of a GaAs/Al<sub>x</sub>Ga<sub>1-x</sub>As heterojunction.

## **PULSED LASER DEPOSITION AND NEAR OPTIMAL FORGING ACCOMPLISHMENTS**

**Pulsed Laser Deposition and  
Near Optimal Forging Accomplishments  
By: Douglas C. Moore**

### **ABSTRACT**

Accomplishments this Summer have been two fold. First, the pulsed laser deposition process presently being used by Wright Laboratories tribology group is being aided by the manufacturing research group in order to optimize the process. This optimization effort was advanced by software developments using the LabVIEW data acquisition and processing package from National Instruments. Also, preliminary investigation of possible quality improvements of the near-optimal-forging process were completed. Second, the near-optimal-forging program underway at Wright Laboratories seeks to use advanced computer modeling and insitu control parameter sensing to decrease forged-part variability while increasing product performance. The forging of high performance alloys has historically been difficult to control. With the use of insitu temperature measurements combined with advanced computer modeling, precise process paths can be generated and executed in order to produce consistently good product. This effort is being assisted by the manufacturing research group by investigating various methods of insitu process sensors. Particularly eddy-current and ultrasonic techniques have been researched for the purpose of noncontact temperature sensing of the preformed billet.

Decomposition Pathways for Model Fluorinated Ether Lubricants  
on Iron, Chromium and Nickel Surfaces

Mary E. Napier  
AFOSR Summer Research Fellow  
Summer, 1991

Introduction

Perfluoropolyalkylethers (PFPE) possess several unique characteristics, thermal and chemical oxidative stability, wide liquid range, good temperature-viscosity character, chemical inertness and nonflammability, which make them attractive for use as high temperature lubricants.<sup>1,4</sup> However, iron and titanium alloys, commonly found in the operating environments of the PFPE fluids, catalytically decompose these materials.<sup>2,8</sup> With no metal present, the PFPE are stable up to 410°C in an inert environment and 316°C in an oxidizing environment.<sup>2,7</sup> In the presence of metals, the thermal stability decreases dramatically in both environments.<sup>2,7</sup> If these materials are to be used as proposed, it is extremely important to understand the nature of the catalytic degradation, so that structural modifications of the PFPE or surface modifications can be implemented to increase the working temperature range of the fluids, in the presence of metals.

ULTRASONIC BEAM PROPAGATION: DIFFRACTIONLESS BEAMS AND  
BEAMS IN ANISOTROPIC MEDIA

Byron Newberry, Assistant Professor  
Mark Preischel, Graduate Student  
University of Cincinnati

ABSTRACT

Two problems were addressed during the summer research activity, both dealing with the propagation of ultrasonic beams as used in the nondestructive evaluation of materials. First, the possibility of making a transducer which produces an ultrasonic beam that does not diffract, or spread, as it propagates was explored. As a result of the work, such a beam was produced and a proposal for the construction of a practical device was developed. The second topic concerned the modeling of ultrasonic transducer beam propagation through anisotropic materials, such as fiber reinforced composites. As a result, simple formulas which predict the on-axis field profiles of beams in such materials were derived and validated through comparison with more complex models.

## POLYMER CONDUCTIVITY AND OPTICS

Joanne Promislow

### ABSTRACT

Using a Model 110 Keithley Hall Effect Measurement System and a Model LTS-22 RMC cryogenic refrigeration system, preliminary photoconductivity data were obtained for a thin film sample of Kr implanted BBL. The cryogenic unit was upgraded to include a more evenly spaced heater coil and more accurate temperature sensors. Much effort was put into and some progress was made on optimizing the sample mounting procedure, so that valid conductivity research can be performed in the future. A new technique for determining the sample thickness and index of refraction of polymeric thin films from the reflectivity pattern of a P-wave was tested and found to be valid for isotropic thin films.

## MATHEMATICAL MODELING OF CARBON/CARBON PROCESSING

Jennifer Reid

### ABSTRACT

An integral part of expert model development for intelligent processing of composite materials is process modeling. The objective of my summer research was to determine the state-of-the-art development in process modeling of the processing of carbon-carbon composites. With knowledge about the current trends in process modeling and carbon-carbon processing, I was able to evaluate existing models according to their accuracy, capabilities, ease of use, transportability, and the types of principles used to base the models on.

## **PROCESSING OF MONOLITHIC $Ti_5Si_3$**

**Andrew Thom  
Ames Laboratory  
iowa State University  
Ames, IA**

### **ABSTRACT**

The processing of  $Ti_5Si_3$  to produce a fully dense monolith is investigated. The effect of hot consolidation technique and parameters are considered. The resulting monolith is sufficiently brittle at room temperature to cause pullout of grains during preparation of metallographic samples. Thermal expansion anisotropy, elastic anisotropy, and impurity effects are suspected of causing this behavior.

## **AUTOMATED INSPECTION CODE GENERATION**

**Steven M. Ruegsegger  
Graduate Student - Electrical Engineering**

### **ABSTRACT**

**This paper describes the summer research done at the Manufacturing Research group at Wright Patterson Air Force Base (WL/MLIM) through a contract from Research & Development Laboratories (RDL). After some background knowledge is introduced, a discussion of the process leading to code-generated automated inspection plans is developed. An example of a manually produced inspection process plan for an actual part, started from an engineering drawing through to CMM code using the Rapid Design System (RDS), is given for clarity.**

## APPENDIX F. HSAP REPORT ABSTRACTS

### F-1. ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY (AAMRL)

#### A STUDY ON HUMAN RESPONSE TO DYNAMIC IMPACT DURING FLIGHT

High School Research Apprentice  
Caroline Christine Chuang

#### ABSTRACT

This summer, I had the opportunity to return to the Biodynamics/Bioengineering Division of the Harry G. Armstrong Aerospace Medical Research Laboratory to work on a research project measuring human response to dynamic impact during flight. Over the course of this summer, I completed various test equipment designs and computer programming tasks for my mentor Mr. Joe Strzelecki and his associates. Most of the test equipment designs dealt with a chair with variable back recline angles designed to simulate pilot seat positions and to measure human response to flight impact. The bulk of my work was designing parts of the seat, drafting assembly drawings, and overseeing the construction of the chair components. As part of the designing process, I learned how to select materials for the test equipment, to calculate the conditions on seat pan loading, to operate the AutoCAD (Computer-Aided Design) system, to run a finite element structural analysis, and to prepare a suborder to begin the construction of parts at the machine shop. In addition to these tasks, I also expanded a Randomized Block Design computer program I wrote for the lab during the previous summer so that it can handle a matrix with more test cells.

IMPLEMENTATION OF THE CLEAN AIR ACT  
RELATIVE TO TOXICOLOGICAL RESEARCH

D. Joshua Finch

During my summer term at the Toxic Hazards Division of Wright Patterson Air Force Base I encountered many new opportunities for learning. I worked with two new computer programs; Autocad and Word Perfect 5.1. I also worked in the labs with various scientists. My main research project was to describe how the Clean Air Act Amendments of 1990 relate to toxicological research. This paragraph is followed by the report which was submitted to my focal point, Dr. Jeffery Fisher.

The Clean Air Act Amendments of 1990 were signed into law by President Bush on November 15, 1990. The poor condition of the nation's air and the diminishing ozone above the country's larger metropolitan areas has called for these revisions to be conceived. Many major reductions of automotive and industrial emissions are to be achieved over the next twenty years. Much information about the chemicals and compounds involved in these reductions must be obtained through research. This opens up many possibilities for toxicology research labs.

## RDL SUMMER APPRENTICESHIP FINAL REPORT

Brian Gose

During my apprenticeship, I worked on a couple of different projects. The first of which was to write a program in C++ designed to create an output file to be used later next year with a B-52 flight simulator. The project itself was confidential, and hence, I don't know all of the specifics, but the output file I created is to be used as information coming in from the B-52's scanners. The second task I performed was to interview people. During the interview I was required to draw a concept map while the subject brainstormed about the essentials of driving. After this, the subject then designed a storyboard of a car's dashboard. Not only was this task an experiment in how people organize thoughts, but it also prepared a method for the real experiment intended to design a heads-up display for fighter planes.

## COOPERATIVE LEARNING AND PROBLEM SOLVING

Claire Grazier

The objective of the study was to determine how the cooperative problem-solving processes of a group affected the learning effectiveness of each individual at a later time. The fifty-six subjects were either placed in a group of two members or else they worked individually to solve an ill-defined nature story problem. After they finished that problem and a brief filler task, each subject individually solved a second similar problem to see what knowledge had been transferred. Texts of their verbalized thought processes were analyzed and coded to determine metacognitive strategies. The subjects were also given recall tests to determine memory performance.

More and more people are working in a group setting to accomplish certain tasks, such as are in research and education. There is still, however, a question of what counts as successful cooperative learning. This study is attempting to determine how the cooperative learning processes of a group compare to those of an individual, and also how those processes affect the later learning recognition of each individual member. The effectiveness of the cooperative learning is then evaluated as the group-to-individual learning is compared with that of the individual-to-individual.

Deanna Jende

Not Available At This Time

## COMPARISON OF 3-D NOISE HEADTRACKERS

Miss Jennifer M. Kim

My work at Wright Patterson Air Force Base consisted of research in the area of Bioacoustics. After performing a study to become familiar with the various pieces of equipment and types of noise and pure tones, I began work comparing two 3-D noise headtracker systems to discover the more efficient one. The two systems, the Polyhemus 3SPACE and the Ascension Technologies BIRD, were set in a lab testing environment and the same test was done on each. The collected data was compared for speed of transmission and for accuracy. I also spent time working in an anechoic chamber, calibrating speakers within an auditory localization facility, which was a sphere containing 272 speakers at 15 degree spacings. This sphere was used to collect data to synthetically test 3-D sound over headphones.

## F-2. OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (OEHL)

### TERATOGENICITY OF D-LIMONENE TO XENOPUS EMBRYOS

Rosalie D. Hemeyer

#### ABSTRACT

d-Limonene is a naturally occurring compound found in several new aircraft cleaners. Although considered relatively non-toxic, the exposure potential for Air Force workers and limited chronic health effect data made it desirable to determine the teratogenicity of d-limonene. The FETAX teratogen assay was selected for this purpose. Much information was collected on the proper operation of the FETAX assay, and limited data collected showed some teratogenic effect from d-limonene exposure. Further studies will be carried out to confirm or deny these initial observations.

## THE USE OF SPECTROPHOTOMETERS IN METALS ANALYSIS

Physical Science Technician  
Marsha Gayle Henke

This summer I worked as a physical science technician analyzing water and soil samples for the presence of metals. Though no research was involved, these analyses are important in determining possible environmental and/or occupational hazards in United States military bases throughout the world. To test for metals including copper, iron, manganese, nickel, zinc, magnesium, potassium, calcium, sodium, chromium, cadmium, silver, lead, beryllium, and barium, a Flame Atomic Absorption Spectrophotometer was utilized. My time was spent working this spectrophotometer along with a Hydride Generator to test these samples for mercury. In addition, I aided in general and preventive maintenance of the flame spectrophotometer, logged out results to be sent to customers, kept statistics on the percision and accuracy of both spectrophotometers, and spent two weeks training a new technician to run the flame. The experience of working as a laboratory technician has enhanced my knowledge of chemistry and laboratory work in general, and I hope to continue my learning next summer.

## ADVENTURES IN PROGRAMMING

High School Apprentice Nathan Pritchard

My apprenticeship for the Air Force Offices of Scientific Research during the summer of 1991 consisted less of research and more of the application of previously gained knowledge. I have obtained an extensive background in computer programming: five years of BASIC, two years of Pascal, and several months of C. Upon the discovery of my computer-oriented skills, my supervisor, Dr. George Lee, assigned several programming tasks to me. I began the software development with the approval of my mentor, Maj. Ed Brown. The first project involved the alteration of data files produced by the laboratory's software system. The second began as a complex calculator program designed to compute concentrations and volumes.

## F-3. SCHOOL OF AEROSPACE MEDICINE (SAM)

### THE DEVELOPMENT OF A FIXATION MONITOR

Mireille Bean

#### Abstract:

The ophthalmology laboratory is an important part of the Aerospace Medical Division. The work done at the ophthalmology laboratory ranges from research to the designing of new equipment to be used in the lab and exam room. My work at the laboratory included the gathering of information from the medical files to be used in a contact lens study, and the use of a computer and the OSDP program for lens design. The objective of the main project with which I was involved was to develop a fixation monitor, which would aid in testing for glaucoma. Though these projects were not closely related, each of them both required and provided information for the growing technology in optics. Research such as this contributes to the need for high-tech optical care that is so important to the Air Force.

# Comparison of Perceived Breathing Resistance in Four Mask Configurations

Whitney Brandt  
High School Apprenticeship Program

## Introduction

Because of the possible threat of chemical warfare, aircrew members and pilots wear protective respiratory devices to prevent the inhalation of poisonous vapors. Because of the exposure to hazardous chemicals, these devices include a full face mask to provide eye and respiratory protection. According to Epstein et al. "The use of respiratory devices produce a deterioration in pulmonary ventilation, lengthening and shallowing of the respiratory wave, increase in functional residual capacity, accumulation of CO<sub>2</sub> in the alveolar air and excessive respiratory work" (1). Work performance is significantly decreased because of these problems during submaximal exercise.

# **NMDA induces light phase shifts of the circadian activity rhythm and c-fos expression in the hamster suprachiasmatic nuclei.**

Eduardo Carrillo  
Sustained Operations Branch  
Armstrong Laboratory

## **ABSTRACT**

The suprachiasmatic nuclei (SCN) have been identified as a pacemaker for many circadian rhythms in mammals. Entrainment of circadian rhythms to the environmental light-dark cycle is mediated by the direct retinohypothalamic tract (RHT). Recent findings suggest that excitatory amino acids (EAA) could be involved in the transmission of photic information to the SCN via the RHT. Exposure of rodents to light can induce expression of a number of immediate-early genes, including c-fos, in cells of the SCN. This paper describes whether injections of EAA agonist into the SCN could mimic the effects of light pulses in inducing c-fos expression, and phase shifting of the circadian pacemaker.

MILLIMETER WAVE RADIATION

RESEARCH APPRENTICE: JOHN CERDA

BROOKS AFB SUMMER 1991

As an apprentice for research at Brooks AFB in San Antonio, Texas, I have achieved knowledge that is beyond what I have expected from this summer program. The work that I have undertaken and have accomplished here are the studies of The Physiological Effects of Whole-Body Exposure to Millimeter Waves. My duties as an Apprentice were to show proper care and handling of the experimental rats.

## A Comparison of Sweat Rates and Mean Skin Temperatures in the CDE+BDU and CWU-77P Chemical Defense Ensembles

Rebekah Drezek

### **ABSTRACT**

To compare how proposed chemical defense ensembles (CDEs) would perform in desert conditions, subjects wearing different protective suits walked briskly on a treadmill in a climate-controlled chamber ( $T_{\text{db}} = 40^{\circ}\text{C}$ ) until their body's core temperature rose  $1.5^{\circ}\text{C}$ . The two CDEs studied each consisted of a charcoal-foam layer, shielding chemical agents, encased within an insulated cloth garment. The CWU-77P, weighing 4.5 kg, is worn alone, while the CDE+BDU, combined with its additional required clothing layer, weighs 6.5 kg. The CDEs were evaluated by measuring the quantity of sweat a person exercising in the suit produced, what percent of this sweat evaporated, the subject's mean skin temperature throughout the trial, and the duration of work performed before core temperature elevated  $1.5^{\circ}\text{C}$ . Subjects wearing the CWU-77P produced 26.25 ml/min of sweat, evaporated 12.91 ml/min (46.9% of production), and had a mean skin temperature of  $37.3^{\circ}\text{C}$  after completing 52.77 minutes of work. For these same subjects wearing the CDE+BDU, production rose to 30.63 ml/min, evaporation fell to 9.34 ml/min (30.6% of production), and the mean skin temperature recorded was  $38.0^{\circ}\text{C}$  following only 31.32 minutes of work. The CWU-77P ensemble kept the subjects significantly cooler than the CDE+BDU probably because of its light weight, single layer, and permeability to sweat. However, these same factors may cause the CWU-77P to provide less protection from chemical agents.

RELATIVISTIC AND CLASSICAL  
CATEGORIZATION OF ATOMIC ORBITS

BY:Mark Eslinger

The purpose of this research is to simulate the orbital path of an electron at one standard Bohr radius from a proton and, subsequently, perturb these orbits using radiation. The first step of this research is to categorize and understand classical orbits for an electrostatic potential active at atomic or molecular distances. Once the classical orbits are categorized, relativistic effects will be added to the equations, and all departures from the classical orbits will be recorded. With a clear picture of undisturbed orbits, it will be possible for researchers to determine if electron and nuclear movement can generate enough radiation to influence the orbits. The final phase of the research will simulate different types of external radiation impacting the atom, and investigate the radiation's affect on the electron orbits.

RELIABILITY OF THE CONDUCTANCE CATHETERS FOR  
MEASUREMENT OF LEFT VENTRICULAR VOLUME  
AND  
AFFECTS OF ANTI-G STRAINING MANEUVERS ON BLOOD  
PRESSURES IN MAN

Mr. Matthew Felder

My accomplishments during the 1991 summer term were multifold. I contributed much effort in many small projects, but I had two primary projects. The first was to further the data collection for my research last year, 'Affects of Anti-G Straining Maneuvers on Blood Pressures in Man.' The second subject was to research and test the reliability of a series of conductance catheters.

## RESEARCH SUPPORT ACTIVITIES AT THE ARMSTRONG LABORATORY

Julie Grinde

This past summer I had the privilege to participate in helping with and learning from several of the research projects under Dr. John Fanton's supervision in the Research Support Systems Division of the Brooks Air Force Base in San Antonio, Texas. While everything was new and strange to me, I learned a great deal- from the elementary basics to some of the more difficult procedures- until I believe I was able to be of service to the persons with whom I was working. While some of my personal accomplishments were learning the basic operating room procedures, it was imperative that these be learned well before any real work could be done with any of the many types of animals that they work with there. I will attempt to relate some of these exciting aspects, from the ordinary to the unique.

## Exercise and Health

Kathryn Kawazoe  
High School Apprentice

### ABSTRACT

My main project this summer was in aiding Dr. Larry Krock with his study of nervous system signals that control heart function. Male subjects were observed at given speeds and levels on a stationary bicycle and on a treadmill to determine their  $\text{VO}_2$  max, possibly the most valuable measure of physical fitness obtainable by our standards. Significant differences were found between the high fit subjects' and low fit subjects' percent body fat, body densities,  $\text{VO}_2$  maxes, heart rates before, during, and after exercise, blood pressure, and levels of performance. Through other various lectures and observations, I also became more familiar with the effects of exercise, both good and bad, but mainly how exercise drastically improves overall physical fitness.

# PROTOCOL TO DETERMINE THE BIOEFFECTS OF 5.6 GHz RADIATION

KRISTIN E. KLATT

AFOSR  
RDL SUMMER RESEARCH STUDENT

## ABSTRACT

In order to discover the bioeffects of electromagnetic radiation, neurochemical studies were conducted by exposing rats to an electromagnetic field. Rats were surgically implanted with a microdialysis probe into either the lateral hypothalamus or preoptic area. The rats were then exposed to a 5.6 GHz field and neurochemical samples were collected. These samples were assayed by high pressure liquid chromatography. In addition, neural tissue was stained for c-fos, an intermediary gene.

RESEARCH PAPER

NATASHA LINDSAY

Abstract:

My main function at the Tyndall Air Force Base, Engineering and Services Center, would consist of a few different things. I would be working with a variety of computer programs, which included; Harvard Graphics, Database III, Database IV, and Word Perfect. All of these I would be using at some time or another while I was here at the center. I would also be working in the laboratory with Doug Klarup. He is working on a project that involves trying to find a more productive and cost effective way of salvaging pleating baths. This plays a major part in trying to prevent the contamination of the environment, which inevitably happens every time one of the waste hazardous baths is disposed of. I will be working with him on this project, and hopefully we will be successful in our endeavors.

# Neurophysiology Research Assistant Job / 1991 Sonya Longbothan

## Acknowledgements and Introduction

During the course of my work experience I was able to perform a task most beneficial for LTC Mickley's study with the hippocampal cells of the experimental animals. Because LTC Mickley's goal was to expose only the hippocampal cells to radiation and not other areas of the brain, the need arose to check on the success of what was intended. In performing these cell counts I counted a set area of cells from different parts of the brain, namely the olfactory bulb, cerebellum, and dentate gyrus. (The results of these counts are shown in the included supplement.)

## **A Subjective Evaluation of the Effects of Cockpit Instrumentation on Spatial Disorientation and Workload**

Virginia Amalia Miksch

Information needed to be obtained concerning cockpit displays and their effectiveness in reducing spatial disorientation and workload. A questionnaire was developed for this purpose. It was separated into two sections -- a rating scale and a suggested improvements section. It was divided into five phases of a sortie and five displays were listed. Twenty questionnaires were distributed at Randolph AFB. Fifteen were returned and the ratings were averaged and the suggested improvements were sorted and studied. The attitude indicator was the most efficient according to the pilots ratings. The pilots mentioned using color to indicate changes on displays. They also mentioned creating warnings that would indicate when a pilot is not paying attention to his aircraft instruments. These suggested improvements will be investigated in further research of cockpit displays.

CALCULATING CREW REST INTERVALS FOR ACCELERATED  
MAC MISSIONS:  
LESSONS FROM DESERT STORM.

*Lori Reneé Olenick  
McCollum High School*

ABSTRACT

Four mathematical models are compared which attempt to predict adequate rest periods following a commercial airline flight. The accuracy of these models as predictors of fatigue in military pilots is described. Subjective fatigue scores were obtained from five MAC air crew every four waking hours for thirty days as they flew operational AF missions during the Persian Gulf crisis. These crews were part of a larger experiment attempting to determine fatigue levels and the safety of flying 150 hours per month during wartime conditions.

Greater fatigue was associated with larger fatigue scores throughout the 30 day study. Fatigue scores were graphed against the predicted rest periods from the models. It was assumed that the longer the predicted rest period was, the more fatigue was implied by the models.

The models were found to be inadequate to predict the level of fatigue experienced by MAC crews flying resupply missions during Desert Storm. One model, Gerathewohl's, was preferred because it allowed for longer crew rest periods in all cases and considered the most causes of fatigue in the equation. However, there were serious deficiencies in all models in predicting military air crew rest periods. Therefore, a new model, developed by Armstrong Labs is described which includes many factors relative to fatigue generation in MAC air crew.

# AIR CREW DIETS DURING DESERT STORM

by

*Carol Salinas  
Incarnate Word School*

## ABSTRACT

This study evaluated the nutritional components of boxed lunches collected from MAC air crew at the end of Desert Storm. A thirty day field experiment was conducted by Armstrong Labs/CFTO to evaluate fatigue data in MAC air crew. Additionally, boxed lunch information was collected from one crew of five subjects during the study as they flew on operational AF missions. Nutritional analysis was conducted on these lunches for kilocalories, proteins, carbohydrates, fat, cholesterol, sodium, potassium, and saturated fats. The means for these components were 1758.07 Kcal, 53.75 g, 233.50 g, 66.75 g, 136.94 mg, 3240.05 mg, 1551.20 mg, and 20.87 g, respectively. It was found these components were about half of the minimum daily requirements for key nutritional components for air crew and, by themselves, would not constitute an adequate day's nutrition. Although boxed lunches were not intended to be the sole source of daily nutrient intake, often, particularly during long duty days, they became the most important source of nutrition. However, the lunches were prepared by MAC kitchens as carefully and as thoroughly as resources permitted. It is recommended that a daily vitamin supplement pill be added to each boxed lunch.

# PROFILE OF MOODS DURING MAC FLIGHTS IN DESERT STORM.

Summer High School Apprenticeship Program  
Armstrong Labs /CFTO  
Brooks AFB, TX

by

*Paul Salinas*  
*Taft High School*

## ABSTRACT

During Desert Storm, the coalition forces allied against the invading armies of Iraq depended on a 6,000 mile air bridge created by the USAF MAC for food and supplies. MAC's effort started with the buildup of forces in August of 1990 and continued until the end of hostilities in March of 1991. In an effort to monitor the safety of flight generated by the demands of such a sustained re-supply effort the MAC surgeon general requested that Armstrong Lab evaluate 5 representative air crews for fatigue during the closing days of Desert Storm. Like they had done so often during the campaign, these crews were required to fly the maximum number of hours per month (150 hours) and get the minimum amount of crew rest (12 hrs) during duty days that often extended to 20 hours. This report describes the profile of mood survey (POMS) scores that were collected as one of the instruments used to evaluate fatigue during the 30 day field study. POMS were taken when the crews were legal for alert (LFA) during the start of their duty day and right before crew rest (CR) during the end of their duty day. It was found that fatigue, confusion, anger and tension POMS scores were greater and vigor scores were lower during CR than during LFA as crews built up to 150 hours of cumulative flight time. No effect was found for depression POMS scores.

# COMPARISON OF CHEMICAL WARFARE SUITS DURING HOT PHYSICAL WORK SESSIONS

High School Apprentice Program

Patrick Sharkey

## ABSTRACT

This summer I kept busy helping out around the laboratories and gaining a working knowledge of how scientific experimentation really works. Most of my time was spent with the ongoing experiments being conducted in the physiology division. My focal point was the work with the chemical warfare suits, which I have documented in this paper. These experiments dealt with testing the physiological effects of physical work, more specifically walking, in a hot environment. Another experiment I helped out in was the testing of various filters in chemical defense masks. This also involved having the subjects walk in a controlled, but cooler, environment. Finally, I helped with the data processing and general work around the laboratories.

I thoroughly enjoyed the program this summer and thank all who made it possible. The knowledge I gained was priceless and will help me throughout my life. This program gave me a great opportunity to learn how things really work in the world and how I can help make things safer for all beings.

## CALCULATION OF THE FRACTAL DIMENSION OF GRAPHICAL DATA

Paul D. Shocklee  
High School Apprentice

### Abstract

An investigation was made into the construction of recursive fractals and the determination of the fractal dimension of time-series data. The fractal dimension is a quantitative measure of the complexity of the data. Two methods of determining this dimension, the "compass" method and the grid method were tested on objects of known fractal dimension and compared. It was discovered that, while both methods produced dimension estimates accurate to within one decimal place, the compass method was inefficient when a small compass radius was used, and the grid method was inefficient when presented with a large number of data points. It was also found that the grid method is capable of distinguishing between patterned and random data.

## OBJECT ORIENTED SIMULATION

Mr. Brandon S. Wadsworth

### Abstract

This research has been directed at developing a simplified method for constructing computer simulation models. Normally, a researcher developing a computer simulation model needs to possess an in-depth knowledge of computer programming, graphics techniques, and complex mathematics. This knowledge however is not completely necessary. It is the intent of this research to simplify the construction of simulation models by removing the need for knowledge in areas other than the model at hand.

## INDEXING SCIENTIFIC REFERENCE DATABASES

Lelsha Eileen Wood

### ABSTRACT

My summer project dealt with library research rather than experimental research. My task was to sort through twenty-five boxes of scientific article reprints (approx. 2000 reprints) and organize them according to subject areas. To do this, I had to first learn a few basic DOS commands so that I could work with a new personal computer (PC) program called "Pro-Cite." The purpose of this program is to make it easy to manage a bibliographic database and to create and maintain properly formatted bibliographies. The reprints I was working with were located in boxes with their bibliographies and key reference words or phrases and were stored on five data disks. With the search and merge functions within the Pro-Cite program and the five data disks, I was able to sort the reprints into ten specific topic areas.

## F-4. ASTRONAUTICS LABORATORY (ASTRO)

### NITINOL, SHAPE MEMORY, AND SPACE APPLICATIONS

Jessica Gardner

#### ABSTRACT

Shape memory describes the ability of certain metal alloys to be deformed at low temperatures and return to their original shapes upon heating. This phenomenon is not a new technology, however, since its discovery in 1962 by scientists at the Naval Ordnance Research Laboratory, applications have not yet reached their full potential. To date, the nickel-titanium alloy, which best demonstrates shape memory, has been used in eyeglass frames, as an implant material in orthopedics, and in the brackets used for orthodontic therapy. Missile guiding systems and airplane systems have also utilized the shape memory effect.

Because of their unique properties, amazing strengths, and extremely light weights, shape memory alloys also have many applications in space. These include a ball and socket system to assemble composite tubing and a latching system for assembling cross-types of structures in composite tubing. Shape memory alloys can also be used as actuators to erect folding protective shells. This paper describes a novel application of nitinol, a shape memory alloy, as the primary power source in a direct current motor.

Specific Impulse Calculations For Clean Solution Propellant  
Compositions  
Jacqualynn L. Hearne

**ABSTRACT**

During my work at Phillips Laboratory, I examined theoretical specific impulses of potential clean solution propellant compositions. The data that I came up with, would help to determine which oxidizer and polymer/matrix would work best to make a good, clean solution propellant.

## 1991 SUMMER RESEARCH PROJECT AT PHILLIPS LABORATORY

Debra Meyer

### SUMMARY

over the past eight weeks, I have been studying the synthesis of aminopropyltriethoxysilane-terminated poly imides. This had two parts. First, a simple monomeric model compound was synthesized to test the synthetic methods planned to use for the polymer synthesis. Secondly, a small molecular weight polymer was synthesized to further investigate these synthetic methods and characterization parameters. In order to characterize the compounds synthesized, I learned to operate the fourier-transform nuclear magnetic resonance spectrometer (FT-NMR) and fourier-transform infrared spectrophotometer (FTIR).

## LEAP INTO ENGINEERING

LEAP into Engineering by Diane Monaghan

This summer I worked on writing procedures to fill the LEAP (Lightweight Exo-Atmospheric Projectile) vehicle with oxidizer (NTO) and fuel (Hydrazine). This vehicle will eventually be flown in space as part of the Strategic Defense Initiative Operation (SDIO), but for the time being the vehicle is undergoing a series of simulation tests on computer and hover tests here in the facility.

The LEAP Program itself is very complex. The basic idea of this program is to develop a reliable vehicle having the capability to intercept an unfriendly target in the upper atmosphere without leaving debris behind. This was basically a safer, and more accurate way to intercept a target. As Werner von Braun said, "The object of the missile business is to make the target site more hazardous than the launch site." In order to eliminate the debris the vehicle was designed to intercept the target using kinetic energy at high velocities, causing the debris to be very tiny, and virtuously harmless if it should so happen to fall back to the earth. In order to do this the vehicle was designed with a propulsion system, to position the vehicle, and a seeker, which has the capability of tracking a heat source and finding the body from which the heat is emerging.

## USING THE I-DEAS' AUTOMATIC MESHER

S. Olkowski, Engineer Technician  
Research & Development Laboratories  
Under Contract Number F49620-90-C-0076 For AFOSR

### ABSTRACT

This report takes a look at the I-DEAS' automatic mesher. Models were created using the automatic mesher and then solved, so they could be compared to a hand-meshed model made in PATRAN by PDA, and which was solved using the P/STRESS Linear solver also by PDA. In this comparison, the three things looked at were the accuracy of the results, the time it took for the model to be meshed, and the cpu time to solve each model.

WLF SHIFT PROGRAMS

Engineering Apprentice  
Joseph Padilla

ABSTRACT

During my eight week apprenticeship at the Phillips Laboratory in Edwards Air Force Base, I worked under the auspices of Mr. Durwood Thrasher, converting HP BASIC code on the HP 85/87 computers to AMIGA BASIC code on the Commodore Amiga 2000 computers. The codes which I translated were one in a series of Engineering Analysis Programs which needed to be translated from the HP 85/87 computers to the Amiga or VAX computer systems.

**Jason Phillips  
OLAC/RCC  
Phillips Laboratory**

I worked on a project that involved work on Liquid Crystal Polymers (LCPs). LCPs are the future of the space program, they are light weight, with a high strength to weight ratio, and possess an even greater strength in colder environments. LCPs are highly anisotropic fluids that exist between the boundaries of solid and conventional isotropic liquid phase.

These LCPs are to be used sometime in the future in a turbopump that will be used later in space related activities. The ideal material would be extremely strong and light, yet capable of withstanding cryogenic temperatures. Other factors like compatibility with various chemicals have been taken into account before any actual materials for testing were decided upon.

## Final Report

Tracy Reed

I had two main tasks to accomplish at Phillips Laboratory over the summer. I had to do an annealing study on IIX-4000, and the tensile testing of several liquid crystal polymers. The object of the annealing study was to find the optimum time and temperature for annealing, find the effects of annealing on IIX-4000, and to confirm the already known melting point of the polymer. The object of the tensile testing was to discover the tensile properties of the liquid crystal polymers.

## F-5. GEOPHYSICS LABORATORY (GEO)

### ANALYSIS OF MODEL OUTPUT STATISTICS THUNDERSTORM PREDICTION MODEL

High School Apprentice GL/LYS Hanscom AFB

Frank A. Lasley

#### Abstract

Model Output Statistics (MOS) Thunderstorm prediction information and Service A weather observations collected for the past two years were studied in an effort to validate the predictions generated by MOS. Predictions from the same three month period from 1990 and 1991 were analyzed. The major conclusion was that MOS overestimated the majority of the thunderstorm probabilities for 1991.

## EQUATORWARD BOUNDARIES OF NIGHTSIDE AURORAE

Jeremy Liebowitz

Finding the equatorward boundary of auroral image data recorded by the Polar Bear satellite can help determine the approximate southern edge of aurorae and where aurorae will appear as a function of solar activity. I have used the current image processing software to locate exact boundaries for specific aurorae and then compared these radii of the auroral oval to the  $K_p$  index in order to find an algorithm which can relate  $K_p$  to the location of the aurora.

## SOLAR TERRESTRIAL INTERACTIONS

GALEN MCKINLEY

This summer, I worked on an ongoing project to produce a database of all the data collected by neutron monitors at stations all over the world during solar Ground Level Events (GLE's).

A GLE is often the result of a powerful solar flare that greatly increases the number of solar protons hitting the surface of the Earth. There have been 52 such events between February 1942 (Event #1) and June 1991 (Event #52) which have been recorded by 122 various stations. The ways in which the stations have recorded these data and the entirety of their reports vary widely. Therefore, it is important to establish a computerized database that is in a standard format, that is easy to understand, and that is quick to access via electronic mail and by computer programs for analysis.

# TEMPERATURE, KINETIC ENERGY, AND INTERNAL ENERGY DEPENDENCES AND ISOTOPIC EFFECT FOR THE REACTION OF $\text{Cl}^-$ WITH $\text{CH}_3\text{Br}$

John S. Paschkewitz, High School Apprentice Program  
A. A. Viggiano, R. A. Morris, Mentors  
*Phillips Laboratory, Geophysics Directorate, Ionospheric Effects Division (LID),  
Hanscom AFB, MA 01731*

## Abstract

Rate constants for the reactions of  $\text{Cl}^-$  with  $\text{CH}_3\text{Br}$  and  $\text{CD}_3\text{Br}$  have been measured as a function of reactant ion/neutral average center-of-mass kinetic energy ( $\langle \text{K.E.}_{\text{c.m.}} \rangle$ ) at several temperatures using the Variable Temperature Selected Ion Flow Drift Tube (VT-SIFDT) apparatus. Rate constants were found to show identical negative temperature and kinetic energy dependences ( $T^{-0.8}$  and  $\langle \text{K.E.}_{\text{c.m.}} \rangle^{-0.8}$  for the  $\text{Cl}^- + \text{CH}_3\text{Br}$  reaction,  $T^{-0.9}$  and  $\langle \text{K.E.}_{\text{c.m.}} \rangle^{-0.9}$  for  $\text{Cl}^- + \text{CD}_3\text{Br}$ ) and showed little if any internal energy dependence. Rate constants for  $\text{Cl}^- + \text{CD}_3\text{Br}$  were slightly greater than those for  $\text{CH}_3\text{Br}$  at low  $\langle \text{K.E.}_{\text{c.m.}} \rangle$ , but at high  $\langle \text{K.E.}_{\text{c.m.}} \rangle$ , there was no isotope effect within experimental uncertainty.

RESEARCH & DEVELOPMENT LABORATORIES  
1991 HIGH SCHOOL APPRENTICESHIP PROGRAM  
RESEARCH PAPER: FINAL REPORT

IONOSPHERIC EFFECTS ON RADIO SIGNALS

JEFFREY M. ROTH

Abstract

My work term this summer has been at the Ionospheric Applications Branch of the Geophysics Laboratory on Hanscom AFB, Massachusetts. The work I have completed in the eight weeks has dealt mostly with the use of computers. This has included processing and analyzing ionospheric data, modifying and debugging system software, and producing various plots of ionospheric conditions.

FINAL REPORT 1991

BY: Paul K. Swietek

This summer I spent my time working in Atmospheric Sciences Division at the Air Force Geophysics Laboratory located at Hanscom A.F.B, Massachusetts. I performed what could be called odd jobs than doing any kind of research. These tasks included computer observations of weather stations across the country; updating fax weather charts and copying HIRAS data on magnetic tape to optical disks.

## **F-6. WEAPONS LABORATORY (WL)**

### **POLARIZATION OF LASER LIGHT IN A DOUBLE PHASE CONJUGATE MIRROR EXPERIMENT**

**Mara L. Collins**

*Phillips Laboratory, Nonlinear Optics Center of Technology, PL/LTN,  
Kirtland Air Force Base, New Mexico 87117-6008*

The project I was involved with was in a lab working with ways to enhance output power from a laser and to synergistically combine beams from two or more lasers. In an experiment involving varying angles to optimize power from phase conjugation two beams of horizontally polarized laser light are required. Using two lasers and various optical equipment including Faraday optical isolators, a broadband polarizing beamsplitter cube and a retardation plate, we achieved two beams of horizontally polarized light crossing in a crystal of barium titanite conducive to phase conjugation.

HSAP FINAL REPORT

Eric Eidson

ABSTRACT:

*This paper is an outline of the eight week High School Apprenticeship Program (HASP) and the steps taken to interface Neural Network programs into the University of New Mexico's KHOROS Graphical Signal Processing environment. I also discuss my experiences in installing a Logitech Hand-Held scanner and Microsoft Windows 3.0 on a PC.*

FINAL REPORT FOR THE HIGH SCHOOL APPRENTICESHIP PROGRAM

EXPERIMENTING WITH FRACTALS AND CAREERS

Eric L. Engberg

Apprentice # 725

Abstract

My work at Kirtland Air Force Base was multileveled, as were the benefits. Throughout my work period I made a point of being curious about what people did for their living, if they could tell me. My goal in this was to gain an understanding of what a broad range of careers in the scientific field entailed. This experience was unique to working in the laboratory. On a more specific level I wanted to learn as much as I could about fractals, and how this new area could be utilized to have real world applications, especially for the Air Force.

**SUMMER APPRENTICESHIP IN THE CHIEF GEOLOGIC RESPONSE SECTION, KAFB**

**Matthew Firstenburg - Civil Engineering Assistant**

The eight week High School Apprenticeship Program was spent at Kirtland AFB in Albuquerque, New Mexico. These eight weeks were spent obtaining data to be used in testing designed to formulate a theory on the microstructural properties of soil. This data was obtained using the Cue-2 image processing system. This system was used to view individual particles to determine their areas, perimeters, aspect ratios, and compactness. These four properties will later be used to formulate the theory on their microstructural properties. Another project worked on during the summer involved use of the Movias motion analysis system. This system is used in the analysis of subterranean detonations in a division wide project, Halfspace. Movias allows for manipulation of films taken of subterranean detonations to create graphic representations of the displacement of the soil and rock used. These graphs include values of velocity, displacement, energy, and momentum, and are used by geologic analysts to develop theories on effects of subterranean detonations on underground structures, wiring, and shelters.

## TEM STAGE COLLECTORS, LDEF SAMPLES, AND A SUMMER AT KIRTLAND AIR FORCE BASE

Russell Grubbs, High School Apprentice

Abstract - My high school apprenticeship was very successful. The design for the TEM (transmission electron microscope) was completed and its construction is in progress. The objective of the TEM Stage collectors will be to collect vaporized space craft materials. We will then be able to know how space craft material changes over time and distance. The actual experiment will be performed in October, most likely at Los Alamos National Laboratories. The one problem with the design is that it will have to be rescaled. This is because the dimensions are too large for the vacuum chamber. In order for the experiment to be accurate it requires a smaller device. Robert Roybal's original draft was drawn to a certain scale and he wanted to continue using the same measurements. The gearing system still needs to be developed. The LDEF (Long Duration Effects Facility) samples were partially characterized and the lab recently purchased a camera which will finish the job and check the work that has already been completed. This summer I increased my knowledge of computers because I had access to them daily. Finally, I learned how to perform most of the tests described in the Introduction.

## ADVENTURES IN HIGH ENERGY

by Brad L. Karmiol     Apprentice

### ABSTRACT

This summer I worked on various projects, and rarely by myself. On the first day I discovered that there was another high school student working in the same building as I was, and our mentors decided that it would be easier for them if he and I worked together. Brian Rizzoli and I spent the rest of the summer working together on projects ranging from upkeep of laboratory equipment to acquisition of data captured on film. Our biggest project, however, was the development of a program that would digitize these data images from the film, and then the actual digitization of many data images using this program.

COMPARISON OF SEISMIC REFRACTION AND BOREHOLE DATA WITH DIFFERENT COMPUTER INTERPRETATION PROGRAMS TO DETERMINE A SUITABLE SITE FOR PILE TESTING.

Kerim Martinez

ABSTRACT

The Hayman Igloo test site at UTTR in Utah was characterized to determine if the area was suitable for pile testing. The subsurface was investigated for two geological parameters. The site was determined to have an adequate water table for testing (10 - 15 ft depth). The bedrock layer was investigated for the presence of the second parameter, a 30 to 70 ft depth. Before a site could be determined the best possible data interpretation method had to be found. Geophysical and geological subsurface investigation techniques were compared. Refraction interpretation and graphic interpolation computer programs were also compared. Two refraction programs, Seisview and SIPT, and a Surfer mapping program with a kriging interpolation technique were utilized. Each method provided a different view of the data. Two suitable test sites were determined by combining the topographic and 3-D results. The subsurface investigation and computer programming techniques were combined to produce the best possible interpretation and representation of data for studies with near-surface parameters.

A Final Report Presented to  
AFOSR Summer Research Program  
Research and Development Laboratories

EXPERIMENT VERSUS THEORY - MARAUDER AND MACH 2

by

Brian D. Rizzoli

General Description of Project

Working at the High Energy Plasma Division I was exposed to two different types of research - experimental and theoretical. I was given tasks that involved the testing and cleaning of the Marauder components as well as collecting data in a control room. I was also given the project of writing a program that would allow the numerical digitizations of Marauder oscilloscope photographs. The oscilloscope data would be stored in a computer to compare with the theoretical data being simulated.

## HOLOGRAPHY

Dawn Vernoooy

The purpose of this summer research project was to construct a quality hologram. By building several holographic set ups, and using interferometric and holographic theory, fringe patterns are created and then "photographed" to form a hologram. The included paper provides an historical background of holography, a theoretical background , a geometrical description, and the experimental account of my project.

SURFACE QUENCHING OF SINGLET DELTA OXYGEN ON A  
90% NICKEL/10% COPPER ALLOY

Evan Werkema

**ABSTRACT:**

Data are presented which represent the  $O_2(^1\Delta)$  quenching rates and deactivation efficiencies for samples of 90% nickel / 10% copper alloy demonstrating varying degrees of aging.

## F-7. ENGINEERING & SERVICES CENTER (E&SC)

### KINETICS OF HYDROXYL RADICAL PHOTODEGRADATION OF 2-BUTANONE (METHYL ETHYL KETONE) UNDER SIMULATED ATMOSPHERIC CONDITIONS

Jennifer Brewer

#### Abstract

The relative OH reaction rate from the simulated atmospheric oxidation of 2-Butanone has been measured. Reactions were carried out at  $297 \pm 2\text{K}$  in a 100-liter FEP Teflon<sup>®</sup> film bags. Hydroxyl radicals were generated in the bag by the photolysis of ethyl nitrite in zero-air. The rate constant measured for 2-Butanone was  $2.8 \pm 10^{-11} \text{ cm}^3 \text{ molecule}^{-1} \text{ sec}^{-1}$ . The rate constant obtained for 2-Butanone was placed on absolute basis with the absolute rate constant of  $2.56 \times 10^{-11} \text{ cm}^3 \text{ molecule}^{-1} \text{ sec}^{-1}$  for propene, the reference organic used.

## Working at Tyndall Air Force Base

Nirmala Darmarajah

The work I did this summer (1991) at Tyndall Air Force Base, Panama City, Florida, had a great deal of responsibility associated with it. I worked at the Technical Information Center (TIC) in the Air Force Science and Engineering Services Center (AFESC). My mentor was Mr. Andrew Poulis. He showed me the importance and the impact of my work. My job was to enter, in to the TIC's cataloguing system, certain records containing Bird Air Strike Hazard (BASH) information. The BASH Team is a group of researchers who monitors and experiments with ways to control bird strikes to airplanes.

# COMPUGRAPHIC INTEGRATOR'S ABILITY

C.I.A.

PHILIP C. DORCH

## General Description

A series of tests were conducted on a Compugraphic Integrator in order to find out it's ability at processing top value documents. Each test was conducted under close supervision. The tests consisted of three stages: Draft and Transfer, Typography and Design, Review and Revise. To be able to conduct these experiments, I had to be educated in the proper testing and research procedures required of a personage in my position. I obtained hands-on training for all the equipment which I was to use and spent numerous hours in training. After that, I felt confident that I could perform to the highest of RAXI's standards. We conducted tests and researched this project for about seven weeks. The results of our experiments proved to be important for the Air Force and informative to the public.

## HSAP FINAL REPORT

Richard C. Hartzler

This summer, my task as a high school apprentice was to design a program that would use DBase IV databases to print out a list of overdue DTIC summaries. This list will be used to contact the various project officers and inform them of their outstanding summaries. After I finished this program, I worked with Brent Miller barcoding books. With a combined effort, we completed approximately three hundred books.

Long Range Agent Delivery System:  
Summer 1991 Development

Prepared By: Thor Johnson (712)

The Long-Range Agent Delivery System was designed to launch agent canisters up to 1200 feet in order to extinguish hazardous/inaccessible fires. New Mexico Engineering Research Institute (NMERI) was given the tasks of design, validation, and construction of the prototype.

NMERI's design/validation program was composed of three distinct phases. The Phase I prototype used an air-piston to launch the canisters (Fig. 1). The air piston could launch a fully loaded canister (approx. 15 lbs) 1200 feet when driven by 110 psi. It was found that the air pressure must be increased when using the larger projectile (45 lbs). Beyond 110 psi, the air piston contacted the projectile, resulting in severe damage to both the shell and the launcher. Because this pressure could not fulfill the range requirements, another system was designed.

# PLASMIDS

JEROME ALLEN

Plasmids are small circular DNA molecules found inside bacterial cells. Plasmids reproduce every time the bacterial cell reproduces. Once infected, the bacteria will always contain a plasmid. Like all natural DNA plasmids contain a special region in their DNA called an origin of replication. This origin of replication ensures that the plasmid DNA will be replicated by the host cell. One important thing plasmids do is that they often contain genes that make their host bacterial cell resistant to antibiotics which can be extremely useful in genetic engineering.

## HSAP FINAL REPORT

Brent Miller

This summer, my job was in the Technical Information Center, at the Air Force Civil Engineering Support Agency (formerly known as the Air Force Engineering and Services Center). My task included helping Mr. Andrew Poulis compile statistics for the Center's budget. This was accomplished with the help of the Supercalc V Spreadsheet Program. I used the spreadsheet to calculate money spent on different on-line services, books, periodicals, and subscriptions. After my part in this project was finished, I helped to convert part of the library's inventory of books over to a system of computerized "barcodes". This was necessary in order to simplify the checkout and return process of the library. Because of these two tasks, there were few times during this work period that I had nothing to do.

# FINITE ELEMENT PRE-PROCESSING, ANALYSIS, AND POST-PROCESSING ON A 3-DIMENSIONAL GRAPHICS WORKSTATION

Jonathan M. Protz

## ABSTRACT

This project uses a Silicon Graphics Personal Iris 4D/35 three-dimensional graphics workstation for finite element analysis by HQAFESC/RDCM at Tyndall AFB, Florida. The project attempts to use the Personal Iris for graphic pre- and post-processing of finite element data. The ADINA series of finite element analysis programs were used. The source code for the software was downloaded from a Cyber mainframe using Kermit protocol and was modified for use on the Personal Iris. The end result was a system which was capable of doing pre- and post-processing. However, there were software conversion problems which prevented using ADINA on the Personal Iris for actual finite element analysis. Also, the ADINA-IN is command based rather than graphic based. There were also major limitations on the ability of the Personal Iris and Cray to communicate. As the project proceeds, these difficulties will be ironed out. One promising option lies in IRIS Explorer graphic-based program development software which could be used to write graphic-based pre-processing and analysis programs that are compatible with ADINA. As these setbacks are overcome, the Personal Iris will become a valuable tool for finite element analysis.

# HIGH HEAT EFFECTS RESULTING FROM AUXILIARY PROPULSION UNIT

Chip Summey

## SUMMER RESEARCH ESSAY

This summer was my first experience working with the Air Force Research and Development Laboratories. I was stationed at Tyndall Air Force Base in Panama City, Florida. Captain Charles Manzione was my head mentor, although my direct mentor who signed my time sheets was Mr. Jim Murfee. The first three or four weeks I was there, I worked with Bill Dass in ARA (Applied Research Associates). There I worked directly in the lab under the supervision of Avery Adcock, the lab manager. While working in the lab, I learned basic civil engineering techniques like sieve analysis and gyratory analysis. I even had the opportunity to run a few triaxial compression tests in Tyndall's materials testing room.

During the fourth week of my employment, I moved to a different branch, working directly for Mr. Murfee. Dr. Michael McVay, a civil engineering professor from the University of Florida, was working on a summer project dealing with the high heat effects resulting from Auxiliary Propulsion Unit (APU) engines operating on jet aircraft concrete parking aprons. An APU engine is the small jet engine (mounted perpendicular to the concrete) used to start the main jet engine. The APU engine runs for five minutes or more. The heat from this engine turns the water in the concrete into superheated steam which cannot escape, thus, causing the concrete to spall like popcorn. My job in this assignment was to assist Captain Sean Childress in modeling this effect on an SGI Iris Workstation. To accomplish this I learned to use both Fortran and the "IDEAS" modeling software.

Participating in this summer research program was probably as beneficial to my education as the whole previous year at high school. Thank you for the opportunity you gave me through this program.

Amy Thomas

Not Available At This Time

# **Pre-Commissioning and Capabilities of the Workhorse Scatterometer**

Daniel J. Abbis

## **ABSTRACT**

The OSEL Scatter Lab, performs research work in the field of stray light, or scatter, from optical surfaces. The scatter equipment consists of a Complete Angle Scatter Instrument (CASI).

This report describes capabilities, operation, and initial setup (precommissioning) of the CASI scatterometer. The types of samples that can be measured will be discussed along with a description and examples showing the various types of data output and the formats in which the data may be presented.

# INTEGRATED SERVICES DIGITAL NETWORK AND ITS IMPACT ON DEPARTMENT OF DEFENSE COMMUNICATIONS SYSTEMS

Matthew Bauder

## ABSTRACT

Integrated Services Digital Network (ISDN) will produce major changes in the way people communicate, provide and receive services, and purchase merchandise. Business management will also see a major improvement with implementation of ISDN. The Department of Defense (DoD) can use ISDN services for military programs and for the improvement of Command, Control, Communications, and Intelligence (C<sup>3</sup>I) functions. This paper will discuss ISDN concepts and applications, and how the DoD can take advantage of this technology.

## THE DETECTION OF LASING IN A DIODE CAVITY

Mr. Andrew Gerrard

This paper reports the spectral measurements performed on an external cavity diode laser with a Princeton Instrument's Optical Spectrometric Multichannel Analyzer. The ultimate result of the measurements being the detection of "lasing" within the cavity. The Analyzer was run with the Princeton Instrument's MSMA software package. The package contained the MSMA main program, the FSMA data-processor, and the SSMA step motor. The preliminary problems encountered with the setup and initiation of the project were the use of the program(s) and equipment, and the actual search for lasing within the cavity. Although no true lasing was discovered at the time of the writing of this report, great steps were being taken to improve the likelihood of observing lasing in the cavity.

# C-ing The SUN

*by Todd Gleason*

## **Abstract**

This summer I worked not on the Digital Analysis System (DAS) testing A/D converters but instead wrote C programs to automate various functions. As I had no knowledge whatsoever of C, most of my time was spent learning it and writing very simple programs in C. A great deal of debugging was required, as C has a very strict syntax which is not easy for novices to work with. I wrote a fair game program to generate a pseudo-random number and let the player guess it. The second (and perhaps the one I liked the most for its simplicity and possible use) was a sort of screen saver which leaves a message on the terminal when run. The third and final program, which I was unable to finish, was a menu interface complete with windows which allows the user to receive files from the DAS using Kermit as well as letting the user convert and merge those files to a format whereby FFT's (Fast Fourier Transforms) can be run on them. I used our Sun workstation to write the C programs, with the Open Windows and SunView programs. In addition, I interfaced with the Sun workstation via the LONEX terminals, and edited files from there using the VI program.

AUGER STANDARDS FOR THE  
SCANNING AUGER MULTIPROBE PHI 600

by

Julie A. Gopsill

Abstract

This document presents standards for certain elements and compounds commonly found in microelectronics as well as basic properties of all samples to help with the identification and quantification of elements and compounds with the Scanning Auger Multiprobe (PHI 600).

These standards were acquired using the Scanning Auger Multiprobe (PHI 600) and samples of known composition (Standards for Auger Electron Spectroscopy, registered standard no. 2128). The Auger electron is a result of an electron beam interacting with a sample. Each element (except hydrogen and helium) has an unique Auger electron pattern and, therefore, can be identified by matching the unknown spectra with the spectra of a known element. Some of the spectra characteristics are determined by the analyzer used in the acquisition process. Therefore, to calculate atomic concentrations from spectra and depth profiles, the beam sensitivities for each element must be determined for each instrument. The graphs of the standards in this document are derivatives of the intensity versus energy spectra with electron beam voltages varying between 3KV, 5KV, 10KV, or 15KV. In some instances, the samples were ion beam sputtered to remove surface layers. Sensitivities of each element to each beam voltage were determined and recorded on the table of properties noting differences between the calculated and published values.

## RDL SUMMER RESEARCH PROGRAM

Jason D. Kowalczyk

My summer research project entailed many small projects of different types. The major function of my apprenticeship was programming in 'C'. I also worked on the support of the ELINT Developmental Facility by doing computer maintenance and testing new hardware and software that the lab would be using in the coming months. Most of the testing was done on a IBM<sup>TM</sup> Compatible Personal Computer platform but some was using SPARCstation 1+<sup>TM</sup>, Macintosh<sup>TM</sup>, and DEC<sup>TM</sup> Products.

The main project was Hexdump Utility to validate that the network inside the lab was working properly and the large data files still had data integrity. One of the major problems with the "C" code was the input and the output of the program to and from the hard disk without using ANY DOS function calls or any IBM-PC function calls. This is to keep the Brian W. Kerighan and Dennis M. Ritchie standard. To have total code portability throughout the lab.

## GEMACS REVISIONS AND UTILIZATION

Jason C. Lenio

This report describes the work done by the High School Apprentice in ERPT during the summer of 1991. This work was primarily concerned with the revision and utilization of the Electromagnetic Environmental Effects (E3) program, General Electromagnetic Model for the Analysis of Complex Systems (GEMACS). The tasks regarding the GEMACS program consisted of generating a release version of the program, debugging the code, the validation of test cases, and producing simulation models for GEMACS analyses using the Graphical Aids for the Users of GEMACS (GAUGE) tool.

## ABSTRACT

### Artificial Neural Networks

Sean Menge

Research was performed over eight weeks to assess the use of artificial neural networks for computing versus using Conventional computers. Neural networks or neural "nets" are modeled after the human brain. The human brain contains billions of neurons which are connected to thousands of other neurons. The neural net contains many simple units called neurons, because of the way they function similar to the brain. Conventional computers, such as personal computers, mainframes ect., operate by changing numbers, symbols, and letters in a uniformed manner. Conventional computers can do many things such as add large numbers quickly or balance a persons budget. Although these computers can do work with little effort and time put into, conventional computers cannot do human-like functions. These functions include associative memory, vision, pattern recognition, and speech. For example, a conventional computer can add very large numbers in under one second but cannot identify a person from a photograph. In using PDP programs it was noticed that the answers were picked much like our own human brain would do it. Although the answer was not always right ninety percent of the time it was. With conventional computers the answer was right all the time but the neural net system was more efficient. Artificial neural networks are still in infancy meaning not too much is known on how they work. Programs were run on the ZENITH DATA SYSTEM using PDP software. The future for neural networks is very bright as commercial and military applications are starting to be seen.

CORRECTING A PHONE LOG PROGRAM  
FOR USE WITH MICROSOFT EXCEL  
*Christopher Moylan*

My summer work was done at Griffiss Air Force Base in Rome, N.Y. While at Griffiss I was assigned to fix a program for keeping track of commercial long distance phone calls. Since I had never used a Macintosh or Microsoft Excel before I came to Griffiss, and the program I was assigned to fix was written for these two, I had to learn how to use them before I could begin fixing the program. Once I was adept at using these, I began to try to find and eliminate the errors. These errors were causing data to be lost and the program to run very slowly.

# AN INTRODUCTION TO SOFTWARE ENGINEERING AND PARALLEL PROCESSING

Debra A. Panck

## **Abstract**

The main purpose of my summer was to gain a basic understanding of software engineering, its concepts and environments, and to interact with software engineers and their efforts to advance their field. I have been exposed to new computer systems, their hardware, software and software design, and to high-level languages for coding. I was also introduced to the concepts of parallel computers and transputer communication, and I observed experimentation with their efficiency. Of great personal importance was the opportunity to apply this new technical knowledge and experience to the medical field, where lie my main interests. Thus, I was able to combine computer usage, observation, and literature into a productive summer of research and education.

## DATABASE MANIPULATION APPLICATION FOR USE WITH PARADOX

Thatcher J. Pospiech

Over the summer I spent my apprenticeship at Rome Laboratory at Griffiss AFB and was assigned to a project called "Database Manipulation Application for use with Paradox". On this project I came in contact with numerous different programs, several different programming languages, and multiple computer devices.

The final goal of the project was to develop an application that would allow data to be downloaded from a from a centralized database VAX computer and imported into an environment on a PC in which it could be manipulated. The application had to allow any user, even one unfamiliar in the environment used, to easily manipulate and add data to the records downloaded.

## SECOND-GENERATION SOCC

Jason M. Riordan

### **Abstract**

This paper presents an general overview of the second-generation SOCC. Topics given special attention are the software configuration and internal and external SOCC communications. The possibility of implementing FDDI as an internal data network for the SOCC is examined and current FDDI is found to be inadequate for this purpose. Future applications of this technology are discussed, and its application to multi-media integration should create a more secure environment.

## AFOSR High School Apprenticeship Program

Gene Salerno

### Filter/Graphing Program

Much of my time at Rome Labs was spent writing programs for Mr. Smith's use. The following program is an example of my work. I was asked to use the C programming language to write a program that would create wave-shaping filters. Given an input wavelet and a desired wavelet, the program uses a method of convolutions, as described by R. F. Mereu, to create a series of filters, which evolve with every iteration. Each new filter produces a cleaner output than the one before. The program also plots the inputs, filters, and output.

# **PROTOTYPING ON SUPERCARD**

**By  
JOE SENUS**

## **OBJECTIVE**

-Try to learn and comprehend the application on the Macintosh, and the Sun/Sparc Workstation in order to be able to utilize them for rapid prototyping visualization methodology.

-Be able to visualize and prototype. Be able to capture the methodology and prototype a part of the MAXI application on the latest workstation environments.

## **F-9. ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC)**

**KEN BARNES**

### **MODIFICATION OF COST ESTIMATION PROGRAMS**

#### **ABSTRACT**

The budget for each wind tunnel project conducted in the Propulsion Wind Tunnel (PWT) facility is estimated by computer programs. The 4 foot transonic (4T) wind tunnel needed an estimation program like the 16 foot transonic and supersonic (16T/S) wind tunnels. The assignment over this eight weeks of the apprenticeship program was to create a cost estimate program for the 4T tunnel. The project was divided into two phases. First, completed 4T tunnel tests were researched and cost rates were derived from them. Then, a 4T program was derived from an existing 16T/S program. The result was a new estimate program for the 4T tunnel.

1991 AIR FORCE OFFICE OF SCIENTIFIC RESEARCH  
(AFOSR)  
HIGH SCHOOL APPRENTICESHIP PROGRAM

## **Direct Write Scene Generator Laser-Beam Mode Analysis**

Kevin Belew

Mentor: Sid Steely, Calspan

### **ABSTRACT**

This research was conducted in relation to the Direct Write Scene Generator method of testing. The objective of the research was to illustrate that the laser beam size can be determined from the classical limits of the corresponding isotropic two-dimensional quantum mechanical harmonic oscillator. In particular the laser beam spot size can be determined from the corresponding harmonic oscillator's classical limits. In addition it is shown that the fraction of the laser beam energy contained within the classical limits approaches unity in agreement with the correspondence principle.

# ***RTR TRAILER CABLE SPOOLING SYSTEM***

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***MARK COLEMAN  
TULLAHOMA HIGH SCHOOL  
VANDERBILT UNIVERSITY***

## **ABSTRACT**

This project was designated to provide an efficient means of storing and deploying the twenty-five cables used by the <sup>Sverdrup Technology</sup> Real Time Radiography (RTR) team at <sup>Arnold Engineering</sup> ~~Sverdrup~~ <sup>Development Center</sup> Technology. These cables are an integral part of the RTR mobile x-ray lab facilities. These cables range from 150 feet to 300 feet in length and from 0.1575 inches to 1.2525 inches in diameter. Rolled and unrolled by hand, the RTR trailer cables take approximately one working day for two craftsman to either deploy for use or store after use. Many man-hours have been expended in the past to take care of the cables necessary to take data at an engine firing away from Arnold Engineering Development Center (AEDC). The spool described in this report is designed to greatly reduce the time, labor, and cost of any trip where the RTR trailer's cables would be utilized. It is estimated that this system would save twenty man-hours per test installation. The design work for the spool system was completed as well as a resources chart, man-hour list, and a project schedule.

MENU-DRIVEN GRAPHICAL CONTROL  
INPUT SOFTWARE

Genetta Gibson

**Abstract**

A menu-driven program to create or modify an input file for the Graphic Interactive Analysis Techniques (GIANT) program was created. GIANT is a graphics program used to plot steady-state data for turbine engine testing on a graphics terminal or a graphics workstation. GIANT Initialize (GIANT Init) defines the parameters to be plotted by the GIANT program. The source code was written in the FORTRAN language with the use of the Plot 10 graphics library subroutines to perform input and output of the GIANT Init information. These graphics routines allow for a more user-friendly program than using standard FORTRAN code but still maintain a desired portability of the source code among the various computer systems. The program, which is called MIRAGE (Modify Input Record to Access Giant Effectively), was developed on the Apollo workstation, which runs under the Aegis operating system. MIRAGE provides on-line help for the user and input validation to help prevent GIANT from aborting during execution.

## REMOTE ACCESS TO INSTRUMENT BOOK INFORMATION

Kenneth Harwell

### ABSTRACT

The purpose of the Remote Access to Instrument Book Information Project was to develop a computer generated instrument book for the instrument technicians at the Data Input Center (DIC). This database will replace the old bulky instrument book. The technicians needed a way to refer to the information about the parameters and be able to make comments about a certain parameter of choice. This display of information will improve the method of communication between the Data Input Center (DIC) and the EAF building. Updating the computerized instrument book will be quicker and more efficient. This improved instrument book used by the technicians will help in the time of preparation before testing which leads to improved testing at Arnold Engineering and Development Center(AEDC).

Appendix A contains example program output screens and selected programs.

## POWER COORDINATION STUDY

Heather B. Hopwood

The Power Coordination Study updates information on the protective function that a relay performs. Specifically the study provides information concerning the effectiveness of the protective devices. If a fault is found in the protection, modifications are recommended. A database filled with information about the relays, joined with Electrical Distribution System Analysis program (EDSA) will be able to display which relay at what facility is working ineffectively.

## DEVELOPMENT OF FINITE ELEMENT MODELING PROCEDURES

Kevin L. Johnson

### Abstract

The objectives of this research were to 1) develop and demonstrate finite element modeling procedures and 2) evaluate a recently acquired personal computer based finite element program called Algor. After learning the modeling procedures, the engine component was modeled. After defining the geometry and simulating component interfaces a stress analysis was performed. Results of this effort include evaluation of Algor program specific features and initiation of the analysis of the selected engine component. These results will eventually help to define finite element modeling procedures.

## PLUME CHEMISTRY DIAGNOSTICS

Lisa G. Lewis

### ABSTRACT

The testing was divided into two phases in which the writer participated. The first phase, computed tomography, was a diagnostic, nonintrusive technique which can be used to scan turbine/rocket plumes to measure the concentrations of species that determine the performance of the turbine/rocket. The second phase, ultraviolet mechanisms, was the actual test which combined with phase one. The author's involvement in the Ultraviolet Mechanism experiment was to determine whether or not a plasma could be generated in an atomic oxygen generator during a simulated combustion test.

**ANALYSIS OF PROBLEMS IDENTIFIED IN PROJECT ENGINEER'S  
NOTEBOOKS**

Mr. John-Paul Motley

**ABSTRACT**

Data was collected from project engineer's notes on problems that occurred in the VKF wind tunnels ABC before, during, and after testing during the 1990 and 1991 fiscal years. Many types of problems were identified, but one particular problem showed up in the majority of data. The computer communications network which links MACS, RADS, and the printers caused multiple delays which increased the total cost of the projects. Further investigation is needed on this data to acquire closer estimations on the magnitude of impact and the cost of the problem.

**A THEORETIC TECHNIQUE FOR ASSESSING COMBUSTION  
INSTABILITY OF A LIQUID ROCKET ENGINE**

Julie Reece

Mentor: Max Roler, Sverdrup Technology, Inc.

AEDC

August 9, 1991

**ABSTRACT**

The objective of this study is to determine the sensitivity of liquid rocket engine combustion instability to injector spray characteristics and combustor performance. A newly developed computer code, ROCCID, was applied to a specified test article and parametric variations were performed. This determination would lead to minimizing the probability of combustion instability in liquid rocket engines. Droplet size model, propellant supply temperature, and mixing efficiency concluded to have the greatest effect on combustion instabilities. Future studies to determine the sensitivity of injector type and damping devices to combustion stability should be performed.

## TUNNEL 4T DATA TABULATION AND GRAPHS

JONATHAN ROBERT SANDERS

ARNOLD ENGINEERING DEVELOPMENT CENTER

My job was to write a software program which could access Tunnel 4T event data and convert this data into a usable spreadsheet format. The final part of the job was to produce tabulated and graphical results. The Tunnel 4T event data consisted of such parameters as Mach number, start-ups, shutdowns, air on test condition time and energy, and valve positions from twenty-six different tests over the last year. Each test was run individually, and the spreadsheet formatted data was then downloaded onto a Zenith 248 personal computer for presentational purposes. The Tunnel 4T event data will be used to establish operational norms and indicate potential improvement areas.

1991 USAF-RDL SUMMER HIGH SCHOOL APPRENTICESHIP  
PROGRAM FINAL REPORT

Prepared by:                    Jason M. Scott  
Mentor:                            Lt. Greg Nordstrom  
Research Location:            AEDC - DOTP

ABSTRACT

My work this summer in the High School Apprenticeship Program was centered around the CADDMAS Project. The project is planned to be used for engine testing at AEDC. The CADDMAS system will have the ability to process all data from the various sensors in an engine test. My focus this summer was the user interface and graphics software of this system. The user interface is important because it is one of the most visible parts of the system. There are many features which must be incorporated and yet it should stay easy to use. The graphics software should produce displays with many features but stay easy to comprehend.

# HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

JENNIFER M. TRENT

## Abstract.

This document presents standards for certain elements and compounds commonly found in microelectronics as well as basic properties of all samples to help with the identification and quantification of elements and compounds with the Scanning Auger Multiprobe (PHI 600).

These standards were acquired using the Scanning Auger Multiprobe (PHI 600) and samples of known composition (Standards for Auger Electron Spectroscopy, registered standard no. 2128). The Auger electron is a result of an electron beam interacting with a sample. Each element (except hydrogen and helium) has a unique Auger electron pattern and, therefore, can be identified by matching the unknown spectra with the spectra of a known element. Some of the spectra characteristics are determined by the analyzer used in the acquisition process. Therefore, to calculate atomic concentrations from spectra and depth profiles, the beam sensitivities for each element must be determined for each instrument. The graphs of the standards in this document are derivatives of the intensity versus energy spectra with electron beam voltages varying between 3KV, 5KV, 10KV, or 15KV. In some instances, the samples were ion beam sputtered to remove surface layers. Sensitivities of each element to each beam voltage were determined and recorded on the table of properties noting differences between the calculated and published values.

## **F-10. AERO PROPULSION & POWER LABORATORY (PROP)**

### **EQUAL DISTRIBUTION OF PRESSURE IN A FACILITY CONTAINING UNEQUAL FLOW VELOCITIES**

Tecumseh High School Senior Student, Lee Bunch

#### **Abstract**

In gaseous two-dimensional shear-layer flows from a splitter plate, it is observed in a wind chimney containing unequal flow velocities that the shear-layer tends to slant toward the low velocity side. This occurs due to unlike pressure distributions along the low velocity (right) and high velocity (left) walls of the containment chimney. A pivotal wall on the low velocity side of the chimney is proposed as a solution to the pressure distribution problem. Pressure taps are located in the left and right walls in order to help in positioning the right wall to where the pressure distribution is equal on both sides of the splitter plate, and the vortices formed do not collide with the chimney walls. Based on previous experiments and data, it is predicted that the procedure mentioned keeps the shear-layer from slanting to the low pressure side of the flow and equalizes the influence of the walls on the vortices formed.

**THE PRODUCING AND TESTING  
OF SINGLE CELL  
THERMAL BATTERIES**

**HIGH SCHOOL SUMMER APPRENTICE  
TINA M. CHILCOAT**

**ABSTRACT**

The testing of single cell thermal batteries provides information about larger scale batteries. Numerous Differential Scanning Calorimeter tests were performed to ensure that the materials used were well characterized. The testing of the vanadium glass showed that although the results were encouraging, more research and testing must be done in the future in order to find a lightweight, long lasting, high voltage thermal battery.

## A STUDY IN SOLID AND LIQUID LUBRICANTS

Jeffrey S. Cropp

For my summer apprenticeship, I worked at the Aero Propulsion and Power Directorate at Wright-Patterson Air Force Base, in the Lubrication Branch of the Fuels and Lubrication Division. The work I completed occurred in two sections. The first section lasted for one week and involved a study of the change in an oil's acidity and viscosity relative to a certain period of use in an engine. The second section, which consumed the following seven weeks, dealt with changes occurring in solid lubricants heated to various temperatures in both air and nitrogen atmospheres. The research into the solid lubricants was classified as Military Critical Technology, and therefore cannot be discussed in as much depth as I wished.

## FUEL RESEARCH

FUEL RESEARCH Matt Grider

The time period that this paper covers is from June 17 to August 9, 1991. During this period I have worked in the fuels branch of the fuels and lubrication division of Wright Laboratories at Wright Patterson AFB. I have been exposed to experimental techniques and equipment as well as the atmosphere of a research and development oriented workplace. The research I did was concentrated in the area of the thermal stability of jet fuel.

**Project: Static Wicking**

Mark Hansell  
August 9, 1991  
MENTOR: DR. JERRY BEAM

Heat pipes are able to cool things efficiently because they take advantage of two natural properties: evaporation and condensation. A heat pipe consists of a closed system, usually a pipe as its name indicates, with a working fluid and its vapor at equilibrium. A porous wick structure, to which the liquid is attracted to or wets, separates the liquid from the vapor within the system. Heat enters one end, called the evaporator, and causes the liquid to evaporate. The vapor, then, leaves the liquid and joins other vapor in the adiabatic region. Here the vapor travels to the opposite end of the system called the condenser. At this point it loses its latent heat of vaporization and condenses onto the wick or other liquid. From here, the liquid is pumped back to the evaporator for another cycle. This pumping, called capillary pumping, is caused by the pressure difference between the liquid and the vapor across the wick structure.

FINAL REPORT, SUMMER 1991

Christopher O'Dell

Throughout this past summer I learned much and did valuable work, both for myself and others. I worked mostly with computers, starting off the summer by learning the C++ programming language (one I had never worked with before). I contributed in my division by helping people with their computers, and my main project was writing a short but very complex program for a Ph.D. physicist. I also worked on smaller projects, such as the FTEPS (Fault Tolerant Electrical Power System) project. The accomplishment I am most happy with is that I used the opportunity of this employment to teach myself much and work with others.

FINAL REPORT TO RDL  
COMPRESSOR RESEARCH FACILITY TEST GROUP

JENNIFER L. POLLOCK

This summer I was placed in the Aero Propulsion and Power Laboratory, assigned to the Compressor Research Facility Test Group. My mentor and the Technical Area Manager of the Test Group was Norman D. Poti. The assignment I was given for my summer research included producing a form of plot called a Campbell Diagram, forming tables from these diagrams, and analyzing the diagrams.

## **F-11. ARMAMENT LABORATORY (ATL)**

### **SPACE BASED INTERCEPTOR STAR TRACKER ANALYSIS**

**High School Apprentice: Eric Apfel**

As a high school apprentice working to learn the various tools and skills required in the fields of science and engineering, most of my gained knowledge came from writing computer programs. These programs were designed to perform functions ranging from plotting the history of a gyro trajectory over a certain interval of time to determining how many stars a given orbiting telescope can no longer see due to various sources of noise. Writing each program and sorting out its bugs was a task that varied in time according to complexity (some programs took me under a day, while others lasted me over a week!). I feel proud of the work I achieved, however, and I will discuss in detail each of the programs (excluding the ones which were simply fruitless attempts to improve accuracy) after an explanation as to why I wrote these programs.

PREPARATION AND CHARACTERIZATION

OF

3-PICRYLAMINO-1,2,4-TRIAZOLE

Kathryn Diane Deibler  
Mr. Stephen A. Aubert, Mentor

3-picrylamino-1,2,4-triazole (PATO) is a heterocycle under investigation as a possible high energy insensitive explosive. PATO has been synthesized in small quantities and characterized (reference 10). As a continued study of the preparation of PATO, a 796 gram scale synthesis was conducted. The synthesis was verified using instrumental analyses. PATO's solubility was tested in organic solvents. To increase the particle size, recrystallization was investigated using precipitation, evaporation, and Soxhlet extraction methods. Density, heat of formation, and heat of combustion of PATO were determined. Calculations were conducted to estimate performance parameters including detonation velocity, detonation pressure, and Gurney energy, using Becker Kistiakowsky Wilson (BKW), Jones Wilkins Lee (JWL), Kamlet Finger, and Gurney methods.

Mercury-Indium-Silver Alloys for Joining Copper  
and Aluminum Striplines  
by Lesha Denega

August 1991

This summer, I worked as a high school apprentice under the direction of Dr. Duane Finello at the Fuzes Branch of Wright Laboratories' Armament Directorate at Eglin Air Force Base. As a high school apprentice, I had the opportunity to learn valuable, hands-on information in the engineering and science fields. As the weeks progressed, I was able to put this information to valuable use. The project to which I directed the bulk of my time dealt with metallurgy and alloys. The goal of this project was to recreate a paint-like solder paste called alloy 232. I was to use X-Ray fluorescence (XRF) spectroscopy<sup>1,2</sup> to perform a complete chemical analysis of this unusual solder using quantitative comparisons with a series of standards of known composition that I would prepare.

Brian Eplett

Using the IEEE-488 General Purpose Interface Bus  
for Device Integration

My project for this summer centered around developing software necessary to operate three devices from the computer. This was a challenge of understanding the hardware and applying this knowledge to the software. The hardware knowledge was knowing the National Instrument's GPIB card, the bus, the instruments connected to the card. Lacking experience with remote operations or communications and only limited programming experience, I was to create a program which could run in the MicroSoft Windows environment. Ultimately, my own software would be integrated into to lab work for test and development purposes.

# Hydrocode Animation

## Thomas J. Fraites, Jr.

The High School Apprenticeship Program at the Wright Laboratory has many purposes and goals. One of the fundamental aspects of the program is that it enables qualified high school students to perform tasks and conduct research that their mentors do not have time to complete. This mission, I think, has been the basic motivation for my summer research project at WL/MNSA, the Technology Assessment Branch. The animation services that I provided this summer could have been accomplished by any other member of the branch, but no one could spare the time or effort to concentrate on this project. It is for this reason that I have experienced great satisfaction in completing my appointed task. I hope that my work this summer will prove to be beneficial to WL/MNSA for years to come. I myself have gained invaluable academic and practical experience that will definitely benefit me in the future. I feel that this summer I have been given a real taste of life in the science and engineering world.

## STRESS SENSOR EXPERIMENTATION, ANALYSIS, AND EVALUATION

Daniel R. Grayson

The main focus of my summer work project this year in the MNGI branch was centered around shock stress sensors. Shock stress sensors measure the force pressure of conventional munitions such as explosives and projectiles. Under the High Explosive Munitions Instrumentation program we are validating the accuracy of these gages. Projects stemming from this program include some data analysis and manipulation, development of software in support of the program, and assistance in actual range tests conducted on those gages and sensors. Two major components are encompassed within the experimentation process. Thin film stress gages utilizing special electrical properties are being compared to a newer sensor technology utilizing fiber optics to measure and determine the explosive potential and effectiveness of developmental weaponry.

1991 HIGH SCHOOL APPRENTICESHIP PROGRAM  
FINAL REPORT: TRANSFORMS, IMAGE COMPRESSION

Derek Holland, WL/MNSI

**ABSTRACT:**

This summer I participated in a variety of different projects, all 'housed' under the giant arms of Signal Processing. Working in the Guided Interceptor Technology Branch, Strategic Defense Division, I wrote several series of programs with varied applications and uses for my office, working generally with my fellow apprentice and colleague, Troy Urquhart, and the established computer guru of our office, Capt. Allen Andrews. My mentor, Paul McCarley, helped in teaching me of the 'real world,' some bizarre place he says exists beyond college (I think he's a bit crazy). This year the majority of my work can be categorized as dealing generally with transformations of images - thus the reference in my title. It was then a refreshing discovery to realize that this newly-acquired knowledge of image frequency spectra (used primarily for signal processing operations) could be used to shrink the storage size of image data - the Discrete Cosine Transform and Wavelet (fractal) Transform Compression schemes.

# VISIBLE LASER POLARIMETRY

by:

**Chad Houghton**

## INTRODUCTION

During my first summer in the HSAP program, I worked in the field of laser polarimetry. Research in laser polarimetry has progressed from the early stages of development to advanced measurement and collection used to test various samples. The infrared laser polarimeter was first assembled by Dr. Goldstein and Mr. David Chenault. The first measurements and a description of the polarimeter can be found in Mr. Chenault's final report.<sup>1</sup> Mr. Randall Hodgson did additional work on the polarimeter which included steps to reduce measurement and data processing errors; his work is documented in his final report.<sup>2</sup> Follow up research, data collection and calibration of the polarimeter was completed and compiled by Mr. Randy Gove and documented in his final report.<sup>3</sup> Additional information on polarimetry or electrooptic modulator materials can be found in Dr. Goldstein's dissertation.<sup>4</sup>

## MEASUREMENTS TO DETERMINE MECHANICAL CHARACTERISTICS OF MATERIALS

High School Apprentice: Jason A. Kitchen

My summer work assignment was in the Warheads Branch of the Armament Directorate at Eglin Air Force Base. The work involved the use of physical measurement techniques to determine mechanical characteristics of various materials. This research included microhardness testing of impact specimens and high-speed film data analysis. Both tasks were related to material science, a field in which my interest has increased as a result of this summer's work. This research answered some original questions and raised new questions to be examined during future research.

# NEURAL NETWORK IMPLEMENTATION OF AN EXTENDED KALMAN FILTER

HIGH SCHOOL APPRENTICE:DARAN MASON

## Abstract

Neural network simulation software was used to apply neural networks to the problem of an Extended Kalman Filter. Three different networks were used in training. The first was a direct replica of an Extended Kalman Filter, five inputs and nine outputs with a hidden layer of nine added. This network failed to learn thoroughly. In the second network a sliding window was added to take the time dependent nature of the problem into account. This changed the input layer to twenty-five with two hidden layers of twenty-five and an output layer of nine. Although this network learned, when tested it failed. The last network divided the nine nodes in the output layer into three groups of three. One group was associated with the parameters for each direction (x,y,z). Each one of these networks had an input layer of two,output layer of three, and a hidden layer of eight. These networks failed to learn. Future work should involve experimentation with the back-propagation network or a new type of network such as a time dependent network.

# QUICK-LOOK, VIDEO-BASED SCORING FOR CAPTIVE FLIGHT TESTING OF ASARG

CHRISTINE D. RIENDEAU  
JOHN WOLVERTON, MENTOR

The summer of 1991 was my second summer in the high school apprenticeship program at Eglin Air Force Base. During this summer, captive flight tests were conducted of the Autonomous Synthetic Aperture Radar Guidance (ASARG) program, and I was privileged to be part of the team. My project this summer was to develop image processing techniques to accomplish quick-look analyses of the data collected during the missions, and I was also asked to help with much of the set up for the captive flight tests. I worked in WL/MNGA, advanced guidance division, advanced development section, under the mentorship of John Wolverton and the guidance of Captain Jeffery L. Owen and Air Force Academy Cadet Anne Clark.

## LOW-COST COHERENT-ON-RECEIVE MISSILE RADAR

Dennis W. Scott, Jr.

The project assigned to me this summer dealt with the real time, real world testing, research, and development of low-cost coherent-on-receive missile radar. The greater portion of the project was aimed at the use of a Recirculating Optic Delay Link (RODL) in a radar system to act as frequency reference unit. The RODL is a relatively new and untested concept which has received little attention since its conception and development because of a lack of personnel and priority. This summer it was reinstated for the cause of the High School Apprenticeship Program and the need to develop the project. My job was to advance the project to a stage where it may later be resumed for further development by the faculty of Wright Laboratory. A partner was assigned to work and learn with me in this task so that we would be able to help each other through this relatively difficult project. Ultimately, the project involved devising a simple pulsed generating radar system, implementing the recirculating optic delay link in the system, and evaluating/testing the system. By summer's end the system was progressed from nonexistence to a working setup which could determine targets and their ranges through the implementation of this hardly used concept.

## DIGITAL SIGNAL PROCESSING

TROY URQUHART, WL/MNSI

During the summer of 1991, I worked in the signal processing section of the Guided Interceptor Technology Branch in the Wright Laboratory Armament Directorate on Eglin Air Force Base (WL/MNSI) under contract of Research and Development Laboratories, Inc. (RDL). Working with mentor Captain Allen Andrews and colleague Derek Holland, I was involved in a variety of projects, a summary of which follows.

# Interior Ballistics Applications in Aerospace Research

WL/MNAA

Gregory D. VanWiggeren

Before attempting to explain my summer research project, some background should be provided about the Aerodynamics Branch and, in particular, the Aeroballistics Section. The Aerodynamics Branch of the Armament Directorate consists of two sections, the Computational Fluid Dynamics Section, and the Aeroballistics Section. The CFD branch calculates fluid flow predictions for various missile shapes and configurations using a CRAY Y-MP super computer and various other high-power scientific computers. The CFD branch offered me a chance to model a test case using simple prediction techniques, but unfortunately, my early departure date does not leave me enough time to undertake the project. The pictures in attachment one provide examples of the type of work the CFD section does. The computer-simulated paths of trillions of different particles are traced over the missile's surface according to equations for fluid flow. The particles are called floating points and the calculated paths are called floating point operations, abbreviated as "flops". The images shown in attachment one required 5-15 trillion flops. The results of these flops are compiled and graphically represented in images like these. The ribbon-like structures represent vortices. The projectile shown has a simulated pitch of thirty-eight degrees.

# RANDOMLY GENERATED SYNTHETIC BACKGROUND DATA USING ITERATIVE FRACTAL TECHNIQUES

Eric P. White, WL/MNGA HSAP 1991

## INTRODUCTION

Working in such an educational and constructive environment as the Eglin Armament Directorate of Wright Laboratories leads to mental growth beyond anything taught in any school. The research that takes place and the facilities that it uses are on the leading edge of technology. No other work experience could possibly rival that of the programs of the Air Force laboratories.

This is my second year to participate in the High School Apprenticeship Program. Last summer I researched the feasibility of using fractals to generate realistic background terrain for simulation purposes. I also wrote an example program under the Turbo C programming language on the IBM compatible personal computer in our office.

This year I worked in the Advanced Guidance Division under the same mentor as last summer, Mr. Lee Prestwood. My assignment was to move my project to the Image Processing Laboratory which my division supports. Here the program would become a utility available to any program supported by the IPL.

SOFTWARE DEVELOPMENT FOR THE AEROSOL TEST CHAMBER  
AND A CODE CONVERSION FOR A DATA RETRIEVAL SYSTEM

James E. Youngblood

During this summer I had an opportunity to work on two projects. The first, SOFTWARE DEVELOPMENT FOR THE AEROSOL TEST CHAMBER, took up the majority of my time. I was told that I would write some software in C for the embedded system that will control the chamber. I didn't even know what an embedded system was! I eventually learned a lot about the Aerosol Project and how much time and effort goes into a project like this.

My second project, PASCAL TO C CODE CONVERSION FOR A DATA RETRIEVAL SYSTEM, was given to me a few weeks before I would leave in order to present me with some idea of what program maintenance is all about and why commenting your code is important.

## F-12. AVIONICS LABORATORY (AVION)

### FINAL REPORT

Lori L. Anderson

#### ABSTRACT

The following report is a description of the work I performed during my participation in the Air Force Office of Scientific Research (AFOSR) High School Apprenticeship Program. At Wright-Patterson Air Force Base, I worked with a number of software packages, including word processors, spreadsheets and graphics packages. These software packages were hosted on an IBM compatible Z-248 microcomputer. As another part of my work experience, I learned how to write software in the Ada programming language. The Ada compiler I used for this effort was the Digital Equipment Corporation (DEC) Ada Compiler, hosted on a DEC VAX computer. The Ada programming comprised the majority of my work experience and the applications that I developed implemented numerous scientific and mathematical functions.

## Communication, Navigation, Identification Laboratory Research

Mr. Barry J. Koestler

### Abstract

This project entailed the conversion of the User Defined Operations and interactive Testing (UDOIT) system from use with a Hewlett Packard HP 8566B Spectrum Analyzer to use with a Hewlett Packard HP 8563A Spectrum Analyzer. Included in converting the system to use the new analyzer was reprogramming the FORTRAN codes and programs to enable them to work with the new machine. Also, the Device Descriptor Files (DDFs) were translated into useable commands for the new equipment, and new menus were set up according to the new routing of data. This portion of the project was necessary as the new machine needed different commands for its different functions and operating procedures. Also, the new machine had some functions that were not implemented in the other analyzer and thus needed to have those new functions linked to the system. Also included in this project was work in the Analysis and Evaluation Group office. This consisted of familiarization with and work on Zenith, Unisys, and Macintosh computer systems. The work included the transfer of circuit designs from their rough draft on graph paper to a finalized printout that made them easier to use, understand, and update; the creation of spreadsheets to corrolate data pertinent to office operations; and also the wiping and reformatting of disks that were no longer needed in their present form.

FINAL REPORT ON THE USE OF PROLOG AND RULE BASED SYSTEMS IN  
ARTIFICIAL INTELLIGENCE

Research Apprentice, Allen L. Lefkowitz

My position this summer in the Artificial Intelligence Division of Wright Laboratories, at Wright-Patterson Air Force Base has presented me with many of the basics and uses of Artificial Intelligence (AI). My research this summer consisted of three areas: basic hierarchy, creating an expert system using a rule based shell program, and programming with Prolog. While the first four weeks of my job involved learning the purposes and concepts of both basic hierarchy using Procedure Consultant and rule based systems using Personal Consultant Plus, the last four weeks were devoted to programming with Arity Prolog. The first two areas of study were basically the ideas that are combined and utilized in Arity Prolog. In working with basic hierarchy, I created a consultation program involving choosing the right college. My work with a rule based shell program involved drug interactions with medicine for diabetes. In Arity Prolog, I dealt with the enhancement of a demonstration program involving a mechanical gripper arm that can pick up blocks and stack them according to the program user's commands, typed in plain English.

## **SUMMARY OF RESEARCH ON A NEW RADAR SCENARIO**

**Meredith A. Lewis**

**The research that was done in the term of eight weeks consisted of a brief report on the history of airborne radar and an in depth research and development of a new radar scenario and simulation. The task was to design and simulate a passive radar scenario from very little prior knowledge of radar.**

**The research program began with a one week period of time to produce a report on the history of radar ( a sampling of this 15 page report can be seen on the next page). This task was beneficial because it required the use of the MacIntosh computer, which was useful in the larger project. In the following six and a half weeks, work time was devoted to the project of designing a passive doppler radar design. The task was to evolve various geometries for a variety of scenarios and to produce numerous original equations from basic knowledge of the doppler shift.**

## **RADAR STUDY**

**Eric Powers**

Radar has many applications that have not been touched upon. I wrote a C++ program that demonstrated a new kind of radar. The group in which I worked was composed of myself, Meredith Lewis, and Greg Power. All of our efforts contributed to the end demo program.

The concept of radar was introduced to me in my first week by means of a report. I searched through the WPAFB Technical Library and found pictures of major accomplishments in radar history. I then scanned these images into a Macintosh computer and captioned these images. Thirty pictures made up the content of the report.

**COMMUNICATION, NAVIGATION, IDENTIFICATION LABORATORY  
RESEARCH**

**MS. KAREN THOMAS**

**ABSTRACT**

The tasks that I encountered as a research apprentice were varied because of the nature of the organization I worked under, which was the Analysis and Evaluation Group. I had numerous opportunities to interface with engineers, scientists, managers, and electronic technicians. My assignments centered around work being done in the Communications Systems Evaluation Laboratory, (CSEL), and a smaller in-house laboratory. While in CSEL, my work revolved around the Spectrum Analyzer. In the smaller in-house laboratory my work dealt with creating designs for engineers on the Super Macintosh Computer. Along with working on the Macintosh, I used a Zenith computer system to convert documents from the WordStar Program to the Word Perfect Program.

# PT 2 Memo: Chaotic Functions Experiment

Christine Yoon

July 29, 1991

## 1 Introduction

This memo documents the results of PT 2 Task Order 3. The objective for this task was to decompose a series of logistic functions (part of a class of functions known as Chaotic) in order to demonstrate the generality of function decomposition in measuring complexity. It was our intent to discover whether or not a correlation existed between the DFC values for these functions and the Lyapunov Exponent for the portion of the Logistic Map from which these functions were taken. All the planned data we set out to be tested were generated and thus produced the results reported in this memo.

## F-13. ELECTRONIC TECHNOLOGY LABORATORY (ETL)

### Monte Carlo Simulation of 50-keV Electrons in Various Resists

Mark Buxton (610)

Wright-Patterson Air Force Base is currently committed to research in the fields of microelectronics. This research includes designing new devices, testing manufacturing schemes and acquiring working processes, testing finished devices, and working with the materials from which the devices are manufactured. One of the goals of this research is to provide information in high-risk areas or areas with only long-term economic benefit. One area the Electronics Research Division is currently exploring is the construction of ever smaller devices by using electron beam technology.

**FINAL REPORT**

Wright Laboratory  
Solid State Electronics Directorate  
Microelectronics Division

Helen Chou  
Mentor: Luis Concha

This summer I worked in the Microelectronics Division of the Solid State Electronics Directorate. My summer apprenticeship was aimed at learning computer operating systems. This was accomplished through several tasks chosen to compliment the ongoing work in the Microelectronics Division. I was tasked with becoming proficient with MS-DOS, the Unix operating system, and running a series of software benchmarking tests.

## WHAT I DID FOR MY SUMMER VACATION

Mr. Alan M. Page

In this summer's apprenticeship program, R.D.L. conjectured that all the students would be involved in a typical research environment, with each student assigned a task and a date for completion. Instead, I learned some of the basics of electrical engineering; circuit theory, circuit design, and fabrication for both digital and analog circuits, as well as various technical skills such as bread boarding, soldering, component wiring, and circuit diagramming. I even received some background in optics by building a laser. I feel that this was a more fruitful direction to take. Not only has this apprenticeship given me a broad exposure to all facets of electrical engineering and thus a solid experience base to build career decisions upon, it has provided a good foundation for my educational future. This foundation is the product of Mr. James Grote (with whom I spent most of the summer working), and includes some engineering nomenclature applicable in all fields, an information base for better comprehension of discussions at college, and a working knowledge of the skills necessary to be an engineer. The other method of apprenticeship with one assigned task leads to only esoteric facts about one particular discipline. Because I was not assigned a major task but many small ones, this paper will not be in the standard research format, but instead shall be presented as a synopsis of my achievements on a day to day basis.

## THE THIRD-ORDER INTERCEPT POINT IN MICROWAVE CIRCUITS

Suzette Yu, High School Apprentice

In order to improve efficiency and productivity, a program to pinpoint and plot the third-order intercept point was written. Among other tasks, this entailed computerized control of instruments like the power meter and spectrum analyzer during both single-input and two-tone tests that resulted in graphs demonstrating power output as a function of applied power. From this could be calculated the intercept point, which aids in defining the nonlinear portion of test amplifiers and its effect in system performance.

## F-14. FLIGHT DYNAMICS LABORATORY (FDL)

### HIGH SCHOOL APPRENTICESHIP FINAL REPORT

Jean Ay

All work that I did was independent, and most of my involvement was with a personal computer. I read through several manuals and began to learn how to program in simple BASIC. I experimented with spreadsheets and databases, and I used a draw program and an equation program to draw up a presentation. I also set up a UNISYS personal workstation and installed software for it. On occasion I checked the accuracy of computer printouts of equations.

## CONTRACT WITH THE COMPUTER RESOURCES TEAM

Matt Becker

As an apprentice to Dick Smith in the Computer Resources Team, I have spent most of my first two weeks developing a comfortable working knowledge of the local computer environments. These skills will be used to transfer a computer graphics algorithm to a new, more useful system. The systems which I am using include Prime, Unix, and WordMarc. In order to familiarize myself with them I have read the various manuals and carried out a few small projects. As well as working on the graphics package some of my time has been spent setting up 13 new computers and installing their software.

Saving Time, Money, and Lives with CFD

AFOSR apprentice Shari Goldenberg

Experimentation is an expensive, lengthy way of testing equipment. This is especially true in the Air Force where large amounts of equipment must be tested again and again in order to insure a crewman's safety when using them. Ejection seats are one of the many items that take an excessive amount of time and money to test. When I came to the Crew Escape Group of the Flight Dynamics Laboratory, I did not fully realize how much testing actually did occur before an ejection seat was produced. During my first week, I read a two volume book about the history of ejection seats which enabled me to understand these problems in more depth.

WPAFB FIBT STRUCTURAL TESTING: HSAP 1991

Christina Ho, engineering aide

These past eight weeks, I have been fortunate enough to work with warm, interesting, talented people. This is my chance to voice my appreciation and regard for them. When a student goes from a theoretical, academically-based environment to a practical application oriented work atmosphere, one's niche is very much changed and the adjustment in priorities now that one plays a different role, can be enormous. However, the common denominator in both of these types of learning experiences are the people -- people who are willing to help and willing to teach; willing to give constructive criticism and rewarding praise, and people who give human context to all the things we do and learn. What makes any task or lesson worthwhile is the fact that in the end, people are helping other people, and that is the motivation to learn, the motivation to teach, and the motivation to work. My gratitude, like my experience here begins with my mentor, and extends to all with whom I have worked. I wish to thank Mr. Pokorski and I only hope that his experience was at least a fraction as rewarding as mine.

During my eight-week employment term I worked on three major projects: the carbon-carbon wing box test, the TMC torque box, and the Radome test. I learned several plotting programs and used them to present data in graph form from the Rams 180 test and the Vortek arc lamp calibration. I also participated in some high-temperature strain gage testing, and acquired valuable technical skills.

R E P O R T O F A S U M M E R

BY ROBERT C. HORROCKS, JR.

An apprentice is an learner. During this summer through the High School Apprenticeship Program, I did a great deal of learning. Through the projects, their applications, and further study, I can conclude that this summer has been, for me, a most interesting one.

Being in a data control group, one main function of the group is to gather, store, and analyze data. This, for the most part, is done with computer systems. One such system that I have assisted with is the Cyber System. This system will be used to control data for many of the test projects in this branch; projects which are related to the National Aero-Space Plane (NASP) and the F-15 Eagle, among others.

MY SUMMER AT THE AIRCRAFT SURVIVABILITY RESEARCH  
FACILITY

Cathie Moore

This past summer I worked in the Aircraft Survivability Research Facility. This is a facility consisting of four gun range to test military aircraft and parts of military aircraft. During my summer I had a few small projects, but most of my time was spent watching and learning from the other engineers. The two main tests I watched were Dry Bay testing and the testing of the flares carried on aircraft to deflect the heat seeking missiles. I used my observations from these tests and some research I did from other tests to compile a brochure for the facility. The other project I had was to calculate the number of gallons of fuel in the scrap fuel tank at each inch increment.

## A SUMMER AT FIBT

Eugene M. Paige  
Project Engineering Aide

During my tour of duty at the Structures Testing Branch of Flight Dynamics Directorate, I gained experience in all of the varied processes that are used. I worked on many of the different projects in Structures Testing: the ETAP (Elevated Temperature Aluminum Project), TMC (Titanium Matrix Composite) and the NASP (National Aerospace Plane) Task D Carbon-Carbon Wing Test. Due to the nature of structural testing, I was not able to see any of these projects go to completion. This is because most of the data and results which come from structures testing are obtained in a very short period of time which comes after a very long period of preparation. However, I hope to come back during my Christmas break from college to see some of the results of these tests.

## HIGH SCHOOL APPRENTICESHIP PROGRAM FINAL REPORT

Michael I. Richie

During my summer apprenticeship, my main job was organizing the group's database. Their database contained reports, conference proceedings, proposals, and symposiums. My job was to organize this information and then place it into a computer database for easy retrieval.

### INTRODUCTION

I was placed in the Structural Division at Wright-Patterson Air Force Base in Dayton, Ohio. I was assigned to the Vibration Group, which performs vibration tests on structures to be used for aircraft. Although I did not participate in any of these tests, the work I was given benefitted the group and enriched my computer skills.

### PROBLEM PRESENTATION AND RESULTS

Although the database was my main job, I also did view-graphs, charts, and computerized hand-outs for the group. I enjoy computer work and all of this enabled me to do what I liked. The work also introduced me to new programs which enable one to enhance his projects. Such programs, like Harvard Graphics, GEM, and Corel Draw, I had heard of, but never had been able to use.