

**1992 NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM**

**George C. Marshall Space Flight Center  
and  
The University of Alabama**

**FINAL ADMINISTRATIVE REPORT**

**submitted to**

**NASA Headquarters  
Washington, D. C.**

**PROGRAM DIRECTORS:**

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University Affairs Officer  
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**October 1992**



The University of Alabama  
Tuscaloosa, AL  
The University of Alabama in Huntsville  
Huntsville, AL  
Marshall Space Flight Center  
Huntsville, AL  
Aeronautics and Space Research  
10 weeks, 1 June - 7 August, 1992

**Research Opportunities**

**Space Sciences:** Gamma ray, x-ray astronomy, cosmic ray, low temperature, solar, atomic, magnetospheric, and space plasma physics; aeronomy; superconductivity.

**Earth Science:** Storm physics; geophysical fluid dynamics; atmospheric processes, dynamics and composition; remote sensing including laser Doppler and visible/infrared devices.

**Computer Science:** Supercomputer systems optimization; distributed data management, Management Information Systems (MIS).

**Microgravity Science:** Containerless processing, crystal growth, solidification phenomena, separation techniques, fluid modeling, protein crystal growth, optical techniques, solid-state structure and property characterization.

**Materials and Processes:** Engineering physics, advanced NDE techniques, atomic oxygen effects, turbopump bearings, space lubricants, metallic materials, non-materials, composites, propellants, processes engineering, robotic welding, welding process, vacuum plasma spray technology.

**Structures:** Structural design optimization of isotropic and anisotropic space structures and elements, orbital (debris/meteoroid) protection systems, stress analyses, fracture mechanics, fatigue, durability, structural test methods.

**Dynamics:** Rotordynamics, orbital mechanics, computational fluid dynamics, control laws, large flexible space structures dynamics, vibroacoustics response loads analyses, design criteria and verification methods, rarefied gas dynamics, fluid-elastic instabilities.

**Propulsion:** Propulsion concepts for advanced space exploration, propulsion systems analysis, zero and low gravity fluid management, solid rocket motor technology development, hybrid propulsion technology development, combustion stability analysis, health management/reliability, turbo-machinery performance, cryogenic bearing design, engine ignition and transient analysis, combustion analysis, spray combustion experiments, combustion diagnostics, automated control systems, rocket engine testing, and digital/analog data acquisition systems.

**Thermal Control and Life Support:** Closed loop life support analysis/integration/testing, heat pipes/two phase flow analysis and modeling, avionics cooling, low temperature control/refrigeration development, passive thermal protection concepts and thermal vacuum testing techniques.

**Information and Electronic Systems/Avionics:** Electrical systems, electrical power systems and components, solar power systems and components, solar power, high-rate and high-density data acquisition, audio and visual systems, RF and laser communication, LIDAR, antenna systems, flight computers and related models, system and subsystem flight simulations, software development and management, fault tolerant logic systems, electronic device failure analysis techniques, optical instruments and systems, optical metrology, optical fabrication, and photographic processes.

ORIGINAL PAGE IS  
OF POOR QUALITY



Marshall Space  
DISCOVERING  
NEW WORLDS

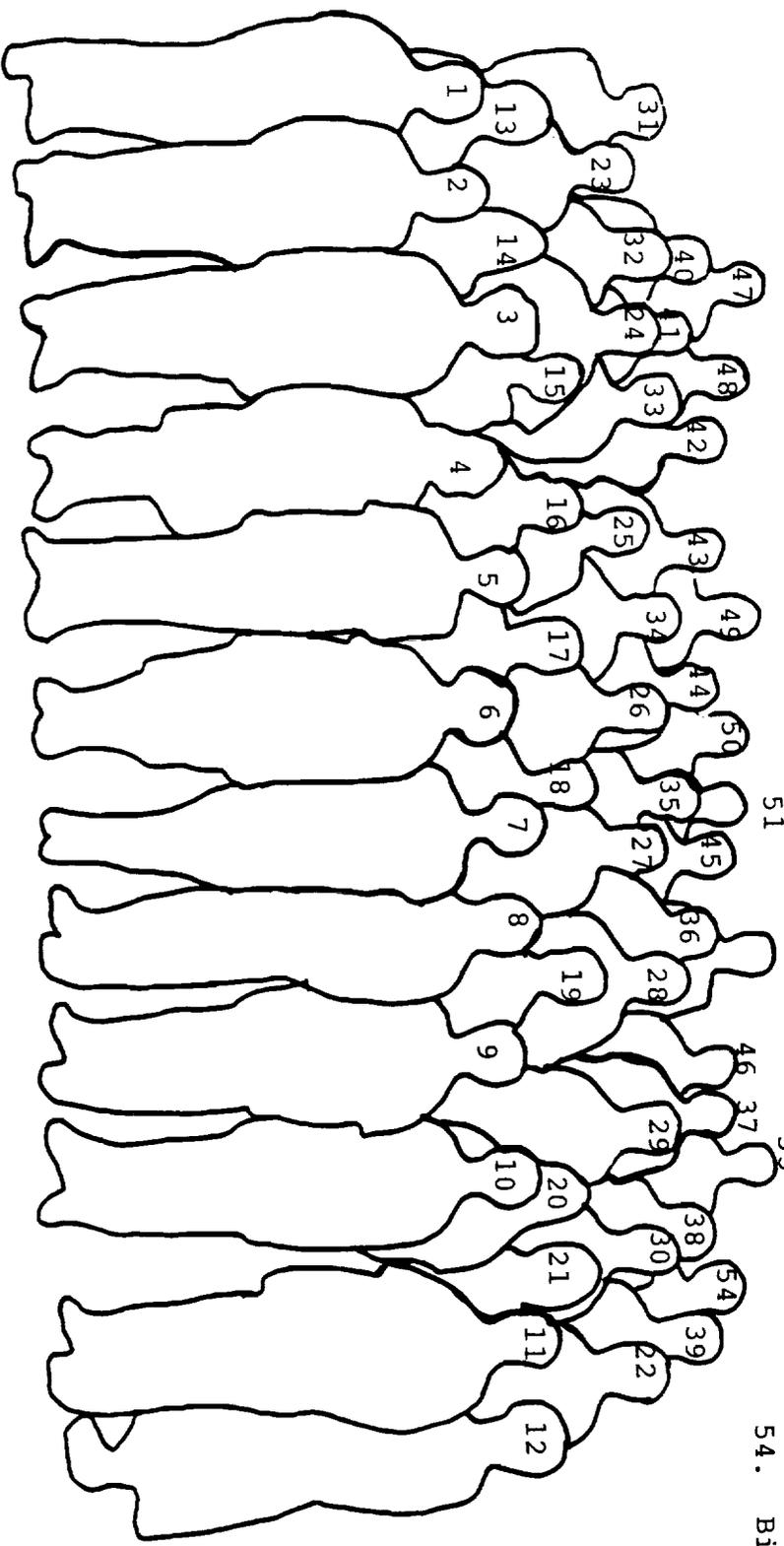
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JULY 25

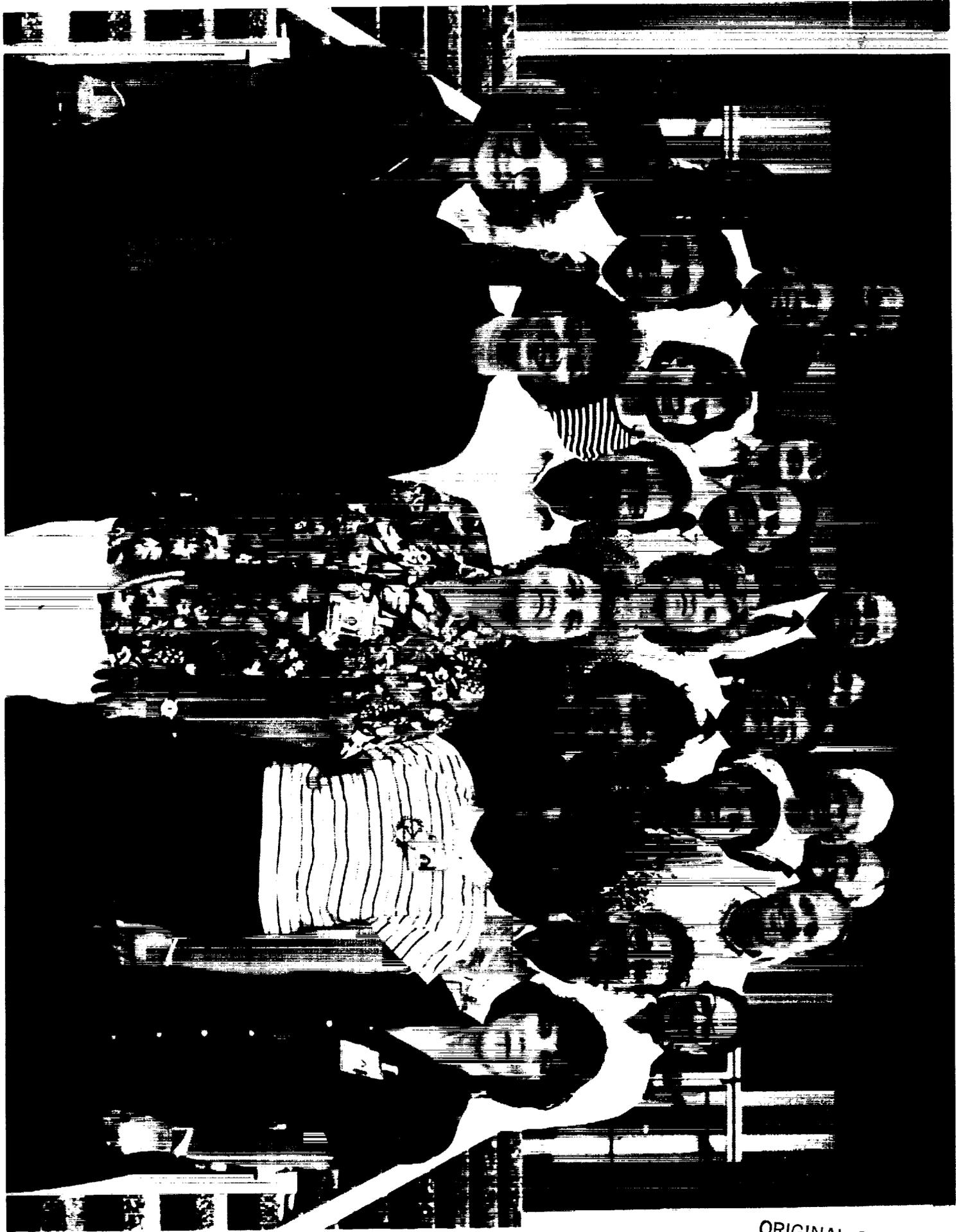




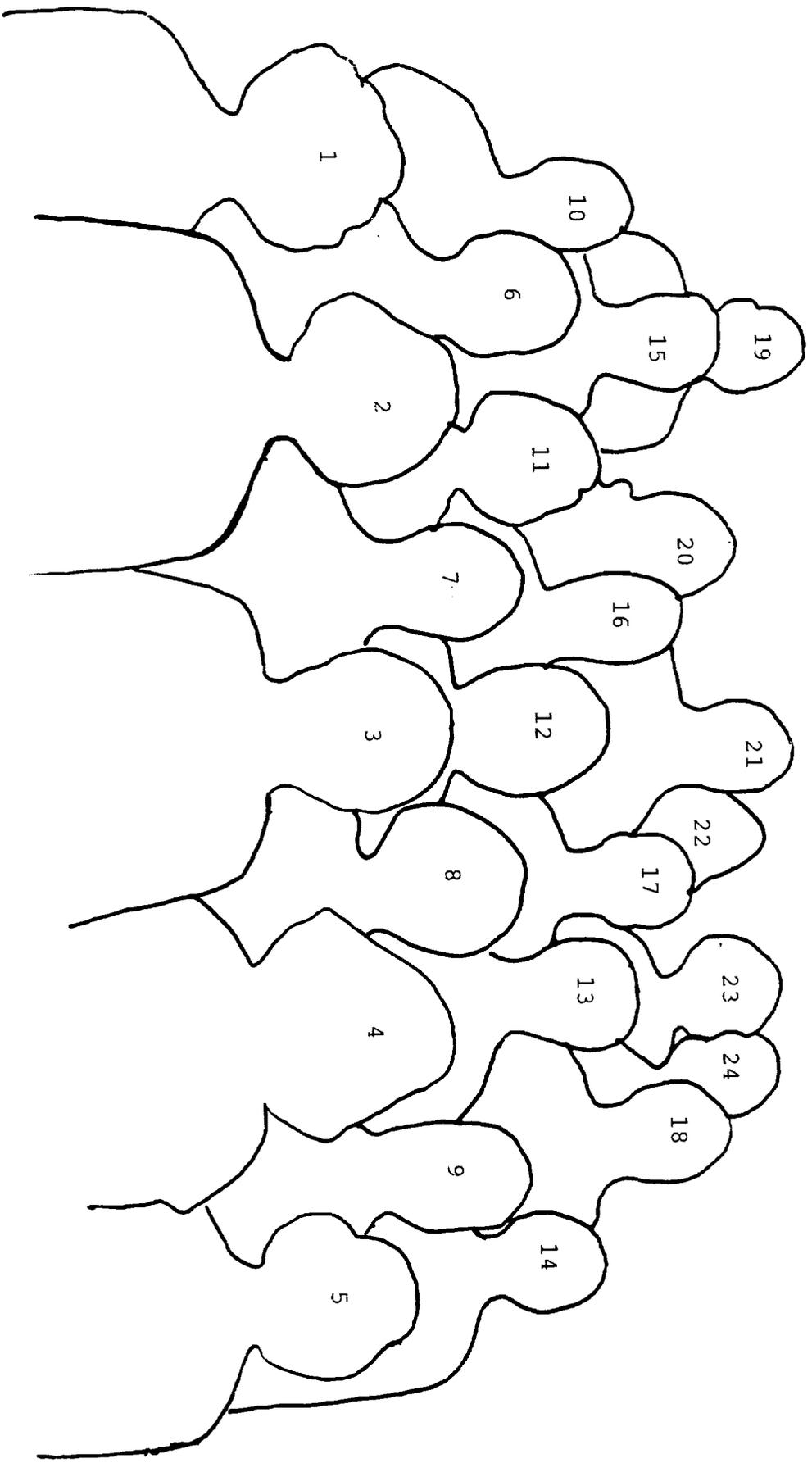
1. J. C. Wang
2. Paul Ray
3. Digen Das
4. Loretta Moore
5. Bor Jang
6. Stella Lawrence
7. Shannon Cobb
8. Michael Pangia
9. Majid Karimi
10. Chandra Putcha
11. David Hedgepath, graduate student
12. Billie Swinford
13. Jean Blake
14. Joni Brooks
15. Y. C. Yang
16. Alex Bykat
17. Conrad Jackson
18. Len Peterson
19. Bob Batsou
20. Stayce Patterson, graduate student
21. Amanie Abdelmessih
22. Art Helmicki
23. Gary Moynihan
24. Russ Rosmait
25. Charles McGruder
26. Phil Farrington
27. Malcolm McDonald
28. Harry Harrison
29. Patrick Tibbits
30. Chris Davis, graduate student
31. Jerry Karr
32. Jim Richie
33. Lunelle Miller
34. Jack Matson
35. James Foreman
36. Tom Wdowiak
37. Peter TenPas
38. Mark Bower
39. Bob Leland
40. Bernie McNamara
41. Richard Solakiewicz
42. Carl Wikstrom
43. Keith Woodbury
44. George Lebo
45. James Martin
46. Adriel Johnson
47. Mike Freeman
48. Stan Bullington
49. Roy Hartfield
50. Alton Highsmith
51. Frank Six
52. Alan Minga, graduate student
53. Roger Thompson
54. Bill Brewer











1. Cecily Agee
2. Jackie Brown
3. Lynn Jones
4. Danielle Willcoxon
5. Minadene Waldrop
6. Carl Freyaldenhoven
7. Hugh Hill
8. Sharon LeJeune
9. David Rouby
10. Helen Broughton
11. Melinda Howell
12. Lisa Nesbit
13. Chris McWilliams
14. Kay Maxfield
15. Bob Robbins
16. Lance Berra
17. Tom Ngar
18. Royce Neidert
19. Mike Freeman
20. Tammie Johnston
21. Dennis Sunal
22. Martha Howard
23. Billie Swinford
24. Frank Six



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## SECTION I. INTRODUCTION

This is the administrative report for the 1992 NASA/ASEE Summer Faculty Fellowship Program which was held at the George C. Marshall Space Flight Center (MSFC) for the 28th consecutive year. The nominal starting and finishing dates for the ten week program were June 1, 1992 through August 7, 1992. The program was sponsored by NASA Headquarters, Washington, D. C., and operated under the auspices of the American Society for Engineering Education (ASEE). This program was one of eight such programs at eight NASA centers sponsored and funded by NASA Headquarters. The basic objectives of the program are:

- a. To further the professional knowledge of qualified engineering and science faculty members;
- b. To stimulate an exchange of ideas between participants and NASA;
- c. To enrich and refresh the research and teaching activities at the participants' institutions; and,
- d. To contribute to the research objectives of the NASA centers.

The major activities of the 1992 program were:

- a. Recruitment, selection, and assignment of faculty fellows;
- b. Research performed by the participants in collaboration with the MSFC colleague;
- c. A seminar and tour program aimed at providing information concerning activities at MSFC;
- d. An activities program of a social/non-technical nature aimed at providing the fellows and their families a means of learning about the MSFC/Huntsville area; and,
- e. Preparation of a volume containing the written reports of the details of the research performed by each of the Summer Faculty.

The success of the 1992 program activities in meeting the stated objectives was measured through questionnaires, which were filled out by participants and their MSFC colleagues. The following sections describe the major activities in more detail and the results of the questionnaires are summarized showing that the 1992 program was highly successful.

This year's program also included 19 participants in the Summer Teacher Enrichment Program (STEP) which is comprised of middle school and high school math and science teachers. Details of the STEP program are presented in Section V.

SECTION II. RECRUITMENT, SELECTION, AND ASSIGNMENT OF FACULTY FELLOWS

Recruiting

The ASEE is responsible for providing promotion and publicity for the NASA/ASEE summer programs. The announcement pertaining to the MSFC program is reproduced on page i. This announcement was contained in a brochure which described all the NASA/ASEE programs and included an application form. The brochures were distributed by ASEE, Dr. Frank Six, NASA/MSFC; Dr. L. Michael Freeman, The University of Alabama; and Dr. Gerald Karr, The University of Alabama in Huntsville. Copies of the brochure were mailed to past participants with a cover letter asking them to encourage their colleagues to apply to the MSFC program. This seems to be an effective way of recruiting in that a number of this year's participants had learned of the program from past participants.

Minority Recruiting

Special effort was made to recruit both minority faculty and faculty from institutions with a large minority student body. Dr. Six of University Affairs at MSFC made mailings to and personal contacts with minority faculty throughout the United States.

This recruiting program produced 41 applications, 20 of which were from minorities and/or non-minorities at historically black colleges and universities (HBCU); and 21 were from minorities at other colleges and universities. Applications from minorities and faculty from historically black colleges and universities are included in the summaries that follow:

Applications Received from Minorities

<u>Minority Group</u>	<u>Returning</u>	<u>First Choice</u>	<u>Second Choice</u>
Asian Female	1	1	0
Asian Male	4	12	5
Black Female	2	3	1
Black Male	1	4	0
Hispanic Female	1	1	0
Hispanic Male	0	2	1
Native American Male	0	1	1
Total	9	24	8

<u>Minority Institutions</u>	<u>Applications Received</u>	
	<u>Returning</u>	<u>New</u>
*Alabama A&M University	2	3
Central State University		1
*Fisk University	1	
Florida A&M University		1
*Jackson State University	1	3
Langston University		1
Morehouse College		1
South Carolina State College		1
Southern University (Baton Rouge)		1
*Spelman College	1	
*Tuskegee University		3
Total	5	15

\* Fellows Selected From This Institution

## Selection

Total Males Applicants	126*
Total Female Applicants	16*

\* Returning Fellows Are Not Included In These Totals

A total of 142 applications from U.S. citizens were received (107 with MSFC as first choice and 35 with MSFC as second choice). MSFC was originally allocated 26 fellowships for the 1992 program. Thirty-three returning fellows were offered and 31 accepted the fellowship.

In addition to the original allocation, MSFC Laboratories provided funds to support 33 additional fellowships. Two additional fellowships were funded by NASA Headquarters.

The total number of allocated positions at MSFC was then set at 61 of which 31 were returning fellows. Of the 61 positions 54 were sponsored by both NASA headquarters and MSFC, 6 were MSFC Laboratory sponsored fellows, and 1 was sponsored 100% by NASA Headquarters.

The committee (Six, Freeman, and Karr) first reviewed all applications and made a determination as to the laboratories or groups that best matched the interests and training of each applicant. Most applicants were identified with at least two groups and in some cases, the applicant was matched with as many as four separate MSFC groups. A summary spreadsheet for all applicants had been prepared by the University Co-Director to assist in the selection process.

Each laboratory or group at MSFC had prepared candidate tasks for Summer Faculty and these tasks were reviewed by the Committee during the selection process. Once the committee identified potential Summer Faculty for the various laboratories and groups, a complete copy of the application material was sent to the coordinator for that lab or group. The laboratory coordinators for 1992 were the following:

<u>Name</u>	<u>Laboratory/Group</u>
John Aberg	Systems Analysis & Integration
Brian Blair	Mission Operations
Jeff Ehmen	Public Affairs Office
Alan Forney	Information Systems Office
Judy Guin	Safety & Mission Assurance Office
Doug Lamb	Structures & Dynamics
J. P. McCarty	Propulsion
Jim Miller	Information & Electronic Systems
Ron Mize	Materials & Processes
Sam Morgan	Space Science
Robert Parks	Program Development

The summary spreadsheet, which listed all the applicants for the 1992 program, was also given to each of the lab coordinators, so they could possibly identify other potential candidates. Each lab was asked to make the selection within the lab. At the same time, the lab was asked to determine what level of funding would be available for those selected. In most cases, the lab was able to identify sufficient funding to support 50% of the Summer Faculty cost (\$6,000) for those faculty who were selected.

The committee, made final selections while taking into consideration the distribution of positions throughout MSFC. The University Director then made offers to those faculty who were selected. In some cases, a particular faculty member was sought by more than one group at MSFC. The faculty member was given a choice in this case, after exchange of information between the faculty member and the various MSFC potential colleagues. In all cases of faculty member selection, the individual potential MSFC colleagues were asked to interview the faculty member by telephone. In some cases faculty members had received offers from other NASA Summer Faculty Programs or programs from other agencies. In all cases, the faculty members were given the final choice after sufficient information had been exchanged.

### Assignment of Fellows

The MSFC Co-Director solicited descriptions of potential research tasks from all areas of the center. The selection committee reviewed the submitted tasks and matched the tasks with the interests of the applicants. The selection process involved a relative ranking of the applicant's qualifications and a matching of interests to the tasks submitted.

An attempt was also made to distribute faculty throughout MSFC. Thus, in some cases, a relative ranking of task importance was also made. Once a selection was made, an offer was extended by the Program Director both by telephone and by written notice.

The first round of selections was made by February 1, after which some rejections of offers were received. Upon receiving confirmation of a rejection, the committee selected other faculty, who were given offers. These selections were made with the lab coordinator's input.

Once confirmation of an offer was made, the University Co-Director fostered communication between the NASA colleague and the faculty member. Telephone conversations and communication by mail were sufficient to start a meaningful dialog. In a few cases pre-program visits were made by the faculty member.

During this year's program, each fellow was asked to prepare a one page research plan for the summer. The research plan was to be received by the University Co-Director prior to the start of the fellow's summer activities. This resulted in an increase in prior communication. The required research plan helped ensure that all participants started the summer activities with good knowledge of what was expected and the research they were to perform. Many participants began study prior to arrival at MSFC.

### SECTION III. PROGRAM DATA AND STATISTICS

The general statistics for the 1992 Summer Program are shown in Table I. The MSFC program continues to draw participants from throughout the U. S., but primarily from the states in the southeast. The number of assistant professors outnumbered the number of professors and the average age of participants is 40.9. The MSFC program continued to show a good record of minority participation with nine (9) faculty from historically black institutions and 16 minority faculty.

The number of first year faculty positions was 30 for the 1992 program. The number of new applications from qualified U. S. citizens was one hundred forty-two (107 MSFC as first choice, 35 MSFC as second choice). The selection process was carefully undertaken to ensure that faculty with the best qualifications were placed with NASA colleagues who could best utilize these qualities. The selections and assignments summarized in Table I show a distribution throughout 13 MSFC laboratories and offices.

Table II-A and -B show the geographic distribution of the 1992 participants and Table III shows the discipline and degree distribution. Table IV shows the distribution by state and school. Table V shows a summary of the Fellows' colleague and project description arranged alphabetically by the Fellows' last name. A short abstract of each of the research projects is given in Appendix C, arranged in alphabetical order by the Fellows' last name.

**TABLE I. GENERAL STATISTICS**

**A. Number of Participants**

Total First-Year Fellows	30
Total Second-Year Fellows	<u>31</u>
Total	61

**B. Geographical Summary**

Number of States Represented	18
Number of Universities/Colleges Represented	37

**C. Degree Distribution**

Number of Fellows holding Ph.D.	57
Number of Fellows holding M.S.	4

**D. Academic Rank Distribution**

Professors	12
Associate Professors	17
Assistant Professors	29
Instructors/Lecturers	2
Academic Head	1

**E. Minority Schools Represented**

**Historical Black Institutions**

Alabama A&M University  
 Fisk University  
 Jackson State University  
 Spelman College  
 Tuskegee University

**Faculty on Program**

**Minority - Non-Minority**

Blake Foreman  
 Wang, J.C. Karimi  
 McGruder Brewer  
 Cardelino  
 Wang, C.J.  
 Yang, Y.C.

**F. Minority Participants**

	<u>Returning</u>	<u>First</u> <sup>Year</sup> <del>Year</del>
Asian Female	1	0
Asian Male	4	4
Black Female	2	● 1
Black Male	1	● 1
Hispanic Female	1	0
Hispanic Male	0	0

**G. Female Participants**

Female Participants	8
Male Participants	53

H. Applicants

Number of first-year applicants indicating MSFC as first choice	107
Number of first-year applicants indicating MSFC as second choice	35
Total	<u>142</u>

I. Summary of Assignments Within Marshall Space Flight Center

Program Development (6)

Program Planning (1)  
Rosmait

Payload and Orbital Systems (3)  
Foreman, Pierson, Wilson

Preliminary Design (1)  
Thompson

Space Transportation and Exploration  
Martin

Science and Engineering (48)

Information and Electronic Systems Lab (6)  
Bykat, Lawrence, Leland, McDonald, Richie, Whitaker

Materials and Processes Lab (10)  
Abdelmessih, Brewer, Farrington, Highsmith, Jang, Karimi, Tibbits, Walsh,  
Wang, Yang

Mission Operations Lab (3)  
Bullington, Matson, Moore

Propulsion Lab (5)  
Bower, Frederick, Hartfield, Wikstrom, Woodbury

Science and Engineering Directorate (1)  
Jackson

Space Science Lab (13)  
Brooks, Cardelino, Duchon, Johnson, Lestrade, McGruder, McNamara, Olsen,  
Pangia, Peterson, Solakiewicz, Wang, Wdowiak

Structures and Dynamics Lab (8)  
Chyu, Das, Helmicki, Hodel, Miller, Palazzolo, Rule, TenPas

Systems Analysis and Integration Lab (2)  
Batson, Cobb

Public Affairs (1)  
Blake

Safety and Mission Assurance Office (3)  
Putcha, Ray, Taneja

Institutional and Program Support (2)

Information Systems Office (2)  
Harrison, Moynihan

Associate Director for Science Office (1)

University Affairs (1)  
Lebo

J. Age Distribution

Average Age of First-Year Fellows	40.3
Average Age of Second-Year Fellows	41.5
Average Age of All Participants	40.9

**TABLE II-A GEOGRAPHIC DISTRIBUTION**

<b>FIRST YEAR FELLOWS</b>		
<b>STATE</b>	<b>NUMBER</b>	<b>UNIVERSITY (Participant)</b>
Alabama	19	Alabama A&M University (Foreman, Wang) Auburn University (Hartfield, Jang, Moore) Tuskegee University (Wang, Yang) University of Alabama (Batson, Highsmith, Martin, Matson, Moynihan, Whitaker) University of Alabama at Birmingham (Wdowiak) University of Alabama in Huntsville (Bower, Farrington, Jackson, Johnson, Wilson)
California	2	California State - Fullerton (Putcha) Naval Postgraduate School (Olsen)
Indiana	1	Indiana Institute of Technology (Tibbits)
Kansas	1	University of Kansas (TenPas)
Maryland	1	Capitol College (Harrison)
Mississippi	1	Northeast Mississippi Community College (Miller)
New Mexico	1	University of New Mexico (McNamara)
Oklahoma	1	University of Oklahoma (Duchon)
Pennsylvania	1	Pennsylvania State University (Thompson)
Tennessee	2	Columbia State Community College (Brooks) University of Tennessee - Chattanooga (Bykat)

**TABLE II-B GEOGRAPHIC DISTRIBUTION**

<b>SECOND YEAR FELLOWS</b>		
<b>STATE</b>	<b>NUMBER</b>	<b>UNIVERSITY (Participant)</b>
Alabama	9	Alabama A&M University (Blake, Karimi) Auburn University (Hodel) University of Alabama (Leland, Ray, Rule, Woodbury) University of Alabama in Huntsville (Cobb, Frederick)
Arkansas	1	University of Arkansas (Wikstrom)
California	2	Cal-Poly - Pomona (Abdelmessih) Cal-Poly - San Luis Obispo (Walsh)
Florida	2	University of Florida (Lebo, Peterson)
Georgia	3	Berry College (McDonald) LaGrange College (Pangia) Spelman College (Cardelino)
Illinois	2	Chicago State University (Solakiewicz) Western Illinois University (Taneja)
Kansas	1	Pittsburg State University (Rosmait)
Mississippi	3	Jackson State University (Brewer) Mississippi State University (Bullington, Lestrade)
New York	2	Bronx Community College (Lawrence) SUNY - Utica (Das)
Ohio	1	University of Cincinnati (Helmicki)

<b>Pennsylvania</b>	<b>1</b>	<b>Carnegie Mellon University (Chyu)</b>
<b>Tennessee</b>	<b>1</b>	<b>Fisk University (McGruder)</b>
<b>Texas</b>	<b>1</b>	<b>Texas A&amp;M University (Palazzolo)</b>
<b>West Virginia</b>	<b>1</b>	<b>West Virginia Institute of Technology (Pierson)</b>
<b>Wisconsin</b>	<b>1</b>	<b>Marquette University (Richie)</b>

### TABLE III. DISCIPLINE AND DEGREE DISTRIBUTION

#### First Year Fellows

M.S.	Aerospace Engineering & Systems (Harrison) Computer Science (Brooks)
Ph.D.	Administrative Science (Jackson) Aerospace Engineering (Hartfield, Whitaker) Animal Science (Johnson) Applied Mechanics (Bower) Astronomy (McNamara, Wdowiak) Atmospheric Science (Duchon) Chemical Engineering (C.J. Wang) Civil Engineering (Foreman) Civil Engineering & Structures (Putchu) Computer Science (Bykat, Moore) Engineering Mechanics (Thompson) Engineering Science (Miller) Flight Science (Martin) Industrial Engineering (Farrington, Moynihan) Management Science (Matson) Material Engineering Science (Highsmith) Material Science (Tibbits) Material Science & Engineering (Jang) Mathematics (Batson) Mechanical Engineering (TenPas) Physics (Olsen, J.C. Wang, Wilson) Solid Mechanics & Composite Material (Yang)

#### Second Year Fellows

M.E.E.	Electrical Engineering (Lawrence)
M.S.	Vocational Education (Rosmait)
Ph.D.	Aeronautical Engineering (Frederick) Applied Mathematics (Solakiewicz) Astronomy (McGruder) Chemical Engineering (Abdelmessih, Wikstrom) Educational Administration (Blake) Electrical Engineering (Helmicki, Hodel, Pierson, Richie) Engineering Mechanics (Rule) Industrial Engineering (Bullington, Ray) Materials Engineering (Walsh) Mathematics (Cobb) Mechanical Engineering (Chyu, Das, Palazzolo, Woodbury) Nuclear Theory (Peterson) Physical Chemistry (Cardelino) Physics (Karimi, Lebo, Leland, McDonald, Pangia) Solid Mechanics (Brewer) Space Physics (Lestrade) Statistics (Taneja)

Combined

M.E.E.  
M.S.

Electrical Engineering (Lawrence)  
Aerospace Engineering & Systems (Harrison)  
Computer Science (Brooks)  
Vocational Education (Rosmait)

Ph.D.

Administrative Science (Jackson)  
Aeronautical Engineering (Frederick)  
Aerospace Engineering (Hartfield, Whitaker)  
Animal Science (Johnson)  
Applied Mathematics (Solakiewicz)  
Applied Mechanics (Bower)  
Astronomy (McGruder, McNamara, Wdowiak)  
Atmospheric Science (Duchon)  
Chemical Engineering (Abdelmessih, C.J. Wang, Wikstrom)  
Civil Engineering (Foreman)  
Civil Engineering & Structures (Putcha)  
Computer Science (Bykat, Moore)  
Educational Administration (Blake)  
Electrical Engineering (Helmicki, Hodel, Pierson, Richie)  
Engineering Mechanics (Rule, Thompson)  
Engineering Science (Miller)  
Flight Science (Martin)  
Industrial Engineering (Bullington, Farrington, Moynihan, Ray)  
Management Science (Matson)  
Materials Engineering (Walsh)  
Material Engineering Science (Highsmith)  
Material Science (Tibbits)  
Material Science & Engineering (Jang)  
Mathematics (Batson, Cobb)  
Mechanical Engineering (Chyu, Das, Palazzolo, TenPas, Woodbury)  
Nuclear Theory (Peterson)  
Physical Chemistry (Cardelino)  
Physics (Karimi, Lebo, Leland, McDonald, Olsen, Pangia, J.C. Wang, Wilson)  
Solid Mechanics (Brewer)  
Solid Mechanics & Composite Material (Yang)  
Space Physics (Lestrade)  
Statistics (Taneja)

**TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS**

**ALABAMA**

**Alabama A&M University**

**Dr. Jean Blake (Sixth Year, Headquarters Sponsored)  
Professor: Mathematics**

**Dr. James Foreman (First Year, Lab Sponsored)  
Assistant Professor: Civil Engineering**

**Dr. Majid Karimi (Second Year)  
Research Associate Professor: Physics**

**Dr. J. C. Wang (First Year)  
Associate Professor: Physics**

**Auburn University**

**Dr. Roy Hartfield (First Year)  
Assistant Professor: Aerospace Engineering**

**Dr. A. S. Hodel (Second Year)  
Assistant Professor: Electrical Engineering**

**Dr. Bor Z. Jang (First Year, Lab Sponsored)  
Associate Professor: Mechanical Engineering**

**Dr. Loretta Moore (First Year)  
Assistant Professor: Computer Science and Engineering**

**Tuskegee University**

**Dr. C. J. Wang (First Year)  
Assistant Professor: Chemical Engineering**

**Dr. Y. C. Yang (First Year)  
Assistant Professor: Aerospace Engineering**

**University of Alabama**

**Dr. Robert Batson (First Year)  
Professor: Industrial Engineering**

**Dr. Alton Highsmith (First Year)  
Assistant Professor: Aerospace Engineering**

**Dr. Robert Leland (Second Year)  
Assistant Professor: Electrical Engineering**

**Dr. James Martin (First Year)  
Associate Professor: Aerospace Engineering**

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS (Continued)

ALABAMA

University of Alabama (Continued)

Dr. Jack Matson (First Year, Lab Sponsored)  
Assistant Professor: Industrial Engineering

Dr. Gary Moynihan (First Year)  
Assistant Professor: Industrial Engineering

Dr. Paul Ray (Second Year)  
Assistant Professor: Industrial Engineering

Dr. William Rule (Third Year, Lab Sponsored)  
Assistant Professor: Engineering Mechanics

Dr. Kevin Whitaker (First Year)  
Assistant Professor: Aerospace Engineering

Dr. Keith Woodbury (Second Year)  
Assistant Professor: Mechanical Engineering

University of Alabama at Birmingham

Dr. Thomas Wdowiak (First Year)  
Associate Professor: Physics

University of Alabama in Huntsville

Dr. Mark Bower (First Year)  
Assistant Professor: Mechanical Engineering

Dr. Shannon Cobb (Second Year)  
Assistant Professor: Math Sciences

Dr. Phil Farrington (First Year)  
Assistant Professor: Industrial and Systems Engineering

Dr. Robert Frederick (Second Year)  
Assistant Professor: Mechanical Engineering

Dr. Conrad Jackson (First Year)  
Associate Professor: Management and Marketing

Dr. Adriel Johnson (First Year)  
Assistant Professor: Biological Sciences

Dr. Gordon Wilson (First Year)  
Senior Research Associate: Physics and CSPA

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS (Continued)

ARKANSAS

The University of Arkansas

Dr. Carl V. Wikstrom (Second Year)  
Assistant Professor: Mechanical Engineering

CALIFORNIA

California Polytechnic State University - Pomona

Dr. Amanie Abdelmessih (Second Year)  
Lecturer: Chemical and Material Engineering

California Polytechnic State University - San Luis Obispo

Dr. Daniel Walsh (Third Year, Lab Sponsored)  
Professor: Materials Engineering

California State University - Fullerton

Dr. Chandra Putcha (First Year)  
Professor: Civil Engineering

Naval Postgraduate School

Dr. R. Chris Olsen (First Year)  
Associate Professor: Physics

FLORIDA

The University of Florida

Dr. George Lebo (Second Year)  
Associate Professor: Astronomy

Dr. Len Peterson (Second Year)  
Professor: Physics

GEORGIA

Berry College

Dr. Malcolm McDonald (Second Year)  
Associate Professor: Physics

LaGrange College

Dr. Michael Pangia (Second Year)  
Assistant Professor: Physics

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS (Continued)

GEORGIA

Spelman College

Dr. Beatriz Cardelino (Second Year)  
Assistant Professor: Chemistry

ILLINOIS

Chicago State University

Dr. Richard Solakiewicz (Second Year)  
Assistant Professor: Math and Computer Science

Western Illinois University

Dr. Vidya Taneja (Second Year)  
Professor: Mathematics

INDIANA

Indiana Institute of Technology

Dr. Patrick Tibbits (First Year)  
Associate Professor: Mechanical Engineering

KANSAS

Pittsburg State University

Russell Rosmait (Second Year)  
Assistant Professor: Engineering Technology

University of Kansas

Dr. Peter W. TenPas (First Year)  
Assistant Professor: Mechanical Engineering

MARYLAND

Capitol College

Harry Harrison (First Year)  
Associate Professor: Computer Engineering

MISSISSIPPI

Jackson State University

Dr. William Brewer (Second Year)  
Associate Professor: Technology

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS (Continued)

MISSISSIPPI

Mississippi State University

Dr. Stanley F. Bullington (Second Year)  
Assistant Professor: Industrial Engineering

Dr. J. Patrick Lestrade (Fifth Year, Lab Sponsored)  
Associate Professor: Physics and Astronomy

Northeast Mississippi Community College

Dr. Lunelle Miller (First Year)  
Academic Head: Mathematics and Science

NEW MEXICO

University of New Mexico - Las Cruces

Dr. Bernard McNamara (First Year)  
Professor: Astronomy

NEW YORK

Bronx Community College

Stella Lawrence (Second Year)  
Professor: Engineering Technology

SUNY Institute of Technology

Dr. Digendra Das (Second Year)  
Associate Professor: Mechanical Engineering Technology

OHIO

University of Cincinnati

Dr. Arthur Helmicki (Second Year)  
Assistant Professor: Electrical and Computer Engineering

OKLAHOMA

University of Oklahoma - Norman

Dr. Claude Duchon (First Year)  
Professor: Meteorology

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS (Continued)

PENNSYLVANIA

Carnegie Mellon University

Dr. Mingking Chyu (Second Year)  
Associate Professor: Mechanical Engineering

Pennsylvania State University

Dr. Roger C. Thompson (First Year)  
Assistant Professor: Aerospace Engineering

TENNESSEE

Columbia State Community College

Joni Brooks (First Year)  
Instructor: Computer Information Systems

Fisk University

Dr. Charles McGruder (Second Year)  
Professor: Physics

University of Tennessee - Chattanooga

Dr. Alex Bykat (First Year)  
Professor: Computer Science

TEXAS

Texas A&M University

Dr. Alan Palazzolo (Second Year)  
Associate Professor: Mechanical Engineering

WEST VIRGINIA

West Virginia Institute of Technology

Dr. William Pierson (Third Year, Lab Sponsored)  
Professor: Electrical Engineering

WISCONSIN

Marquette University

Dr. James Richie (Second Year)  
Assistant Professor: Electrical and Computer Engineering

TABLE V. COLLEAGUES AND PROJECT DESCRIPTIONS

<u>FELLOW</u>	<u>COLLEAGUE</u>	<u>PROJECT DESCRIPTION</u>
Abdelmessih	A. Nunes	Heat Flow in Variable Polarity Plasma Arc Welds
Batson	D. Woodruff	Systems Engineering Process and Organization Assessment
Blake	J. Ehmen	Updating and Expanding the Library of Materials on NASA Spacelink Electronic Information System
Bower	T. Bechtel	Design and Analysis of Seals for Extended Service Life
Brewer	C. S. Jones	Shuttle Flight Experiment Preliminary Proposal: Demonstration of Welding Applications in Space
Brooks	S. Goodman	Investigation of Rainfall Data with Regard to Low-Level Wind Flow Regime For East Central Florida
Bullington	J. Jaap	Requirements for the Implementation of Schedule Repair Technology in the Experiment Scheduling Program
Bykat	Y. Johnson	A 2nd Generation Expert System for Checking and Diagnosing AXAF's Electric Power System
Cardelino	C. Moore	Prediction of Nonlinear Optical Properties of Large Organic Molecules
Chyu	L. Griffin	CFD Analysis on Control of Secondary Losses in STME LOX Turbines with Endwall Fences
Cobb	J. Hanson	Optimal Trajectories for Orbital Transfers Using Low and Medium Thrust Propulsion Systems
Das	B. Tiller	STME Nozzle Thermal Analysis
Duchon	S. Goodman	A Plan for Accurate Estimation of Daily Area Mean Rainfall During the Cape Experiment
Farrington	E. Martinez	Evaluation and Recommendations for Work Group Integration within the Materials and Processes Lab
Foreman	M. Nein	A Study of the LUTE Metering Structure
Frederick	B. Goldberg	Performance Prediction of Hybrid Rocket Motors

TABLE V. COLLEAGUES AND PROJECT DESCRIPTIONS (Continued)

<u>FELLOW</u>	<u>COLLEAGUE</u>	<u>PROJECT DESCRIPTION</u>
Harrison	M. Graham	Guide for Object-Oriented Analysis and Design
Hartfield	C. Schafer	Experimental Investigation of a Simulated Lox Injector Flow Field and Other Nonintrusive Measurement Efforts
Helmicki	T. Fox	Issues in Health Monitoring and Control for the Space Transportation Main Engine
Highsmith	A. Nettles	Post-Impact Behavior of Composite Solid Rocket Motor Cases
Hodel	F. Kuo	Update to MARSYAS: Numerical Methods for the Analysis of Sampled-Data Systems
Jackson	L. Howell	Some Effects of Time Usage Patterns on the Productivity of Engineers
Jang	R. Linton	Space Environmental Effects on Polymers and Composites
Johnson	H. Matsos	Ground Testing of Bioconvective Variables Such As Morphological Characterizations and Mechanisms Regulating Macroscopic Patterns
Karimi	I. Dalins	Energetics and Structural Properties of Twist Grain Boundaries in Cu
Lawrence	K. Williamson	Using Software Metrics and Software Reliability Models to Attain Acceptable Quality Software for Flight and Ground Support Software for Avionic Systems
Lebo	F. Six	An Algorithm to Quantify the Performance of the JOVE Program
Leland	J. Bilbro	Adaptive Optics for Laser Power Beaming
Lestrade	J. Fishman	Structure in Gamma-Ray Burst Time Profiles: Statistical Analysis I
Martin	B. Nixon	Directions for Future Earth-to-Orbit Vehicles
Matson	K. Smith	Development of a Prototype Interactive Learning System Using Multi-Media Technology for Mission Independent Training Program

TABLE V. COLLEAGUES AND PROJECT DESCRIPTIONS (Continued)

<u>FELLOW</u>	<u>COLLEAGUE</u>	<u>PROJECT DESCRIPTION</u>
McDonald	W. Hopkins	Multipath Effects in a Global Positioning Satellite System Receiver
McGruder	J. Fishman	The Ionosphere as a Gamma-Ray Detector
McNamara	J. Fishman	Correlated Optical Observations with BATSE/CGRO for Sco X-1
Miller	H. Lee	Durability Analysis: Problems Involving Combined Loading
Moore	J. Hale	A Process for Prototyping Onboard Payload Displays for Space Station Freedom
Moynihan	A. Forney	Development of Vendor Evaluation Criteria and Post-Implementation Considerations for MSFC Center-Wide Executive Information System
Olsen	T. Moore	On the Consequences of Bi-Maxwellian Plasma Distributions for Parallel Electric Fields
Palazzolo	M. Darden	Simulation of Cryogenic Turbopump Annular Seals
Pangia	D. Gallagher	The Kappa Distribution as a Variational Solution for an Infinite Plasma
Peterson	C. Pollock	Studies of the Charging of a Thin Dust Layer in a Plasma
Pierson	C. Rupp	SEDS1 Mission Software Verification Using a Signal Simulator
Putcha	F. Pizzano	Reliability Analysis of External Tank Attach Ring (ETA)
Ray	J. Livingston	Emergency Egress Requirements for Caution and Warning, Logistics, Maintenance and Assembly State MB-6 of Space Station Freedom
Richie	D. Harris	Analysis of Waves in Space Plasma (WISP) Near Field Simulation and Experiment
Rosmait	J. Hamaker	Industry Survey of Space System Cost Benefits from New Ways of Doing Business
Rule	P. Rodriguez	Design of a Welded Joint for Robotic, On Orbit Assembly of Space Trusses

TABLE V. COLLEAGUES AND PROJECT DESCRIPTIONS (Continued)

<u>FELLOW</u>	<u>COLLEAGUE</u>	<u>PROJECT DESCRIPTION</u>
Solakiewicz	W. Koshak	Electromagnetic Scattering in Clouds
Taneja	W. Smith	Reliability Evaluation Methodology for NASA Applications
TenPas	P. McConnaughey	Acceleration of FDNS Flow Simultions Using Initial Flowfields Generated with a Parabolized Navier-Stokes Method
Thompson	C. Carrington	Control-Structure-Thermal Interactions in Analysis of Lunar Telescopes
Tibbits	I. Dalins	Stiffnesses by (HtN) Ensemble Molecular Dynamics
Walsh	M. Danford	UPT Scenarios - Implications for Sytem Reliability
Wang, C. J.	A. Puckett	Thermostructural Reponses of Carbon Phenolics in a Restrained Thermal Growth Test
Wang, J. C.	A. Lehoczky	Nature of Fluid Flows in Differentially Heated Cylindrical Container Filled with a Stratified Solution
Wdowiak	P. Curreri	An Experiment to Study Fullerene Formation Under Reduced Gravity
Whitaker	W. T. Powers	Neural Network Architectures To Analyze OPAD Data
Wikstrom	C. Schafer	Computerized Reduction of Elementary Reaction Kinetics for CFD Combustion Modeling
Wilson	L. Johnson	The Inner Magnetospheric Imager (IMI): Instrument Heritage and Orbit Viewing Analysis
Woodbury	D. Sparks	Analysis of Film Cooling Rocket Nozzles
Yang	S. Russell	Stress Analysis and Damage Evaluation of Flawed Composite Laminates by Hybrid Numerical Methods

#### SECTION IV. SEMINAR AND ACTIVITY PROGRAM

One of the important aspects of the MSFC Summer program is the exposure given to the fellows of the range of scientific and engineering activities taking place at MSFC. This exposure is achieved through a program of seminars, tours, and other activities which took not more than 10% of the fellows' time while at MSFC. Table VI shows a summary of the 1992 Weekly Activities, in which a total of nine technical presentations were made. The program was planned to provide a number of talks which covered overviews of major MSFC projects. The fellows were also asked to make presentations of their own work, which revealed the varied nature of MSFC interests. Table VII is the list of Seminars for the 1992 program year, which the fellows were asked to attend. Three tours of MSFC facilities were arranged by the Public Affairs Office and the SFFP Program Assistant. The first two tours were designed primarily for the first year fellows, while the third tour was designed for the second year fellows.

A program of activities, which were of a social nature, were also organized and are summarized in Table VIII. These activities fostered communication and also provided The University of Alabama Capstone Society and the UAH Foundation an opportunity to show their appreciation for being able to serve the national academic community.

TABLE VI. SCHEDULE OF WEEKLY ACTIVITIES - 1992  
NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM

*June 8 Monday*

10:00a      Welcome & Official Opening Day Activities  
Building 4200, 10th floor, Room P110  
Guest Speakers:  
James M. McMillion - Deputy Director for Space Systems at MSFC  
  
Dr. John Yost - Provost and V.P. for Academic Affairs at The University of Alabama in Huntsville  
  
Dr. Robert Barfield - Dean of Engineering at The University of Alabama  
  
Dr. Lynn Russell - Dean of Engineering at The University of Alabama in Huntsville

*June 11 Thursday*

10:00a      Seminar  
Speaker:      Carmine DeSanctis  
Topic:        MSFC Future Projects

*June 17 Wednesday*

9:00a - 12:00p      First Year Fellows Bus Tour of MSFC (Group I)

*June 18 Thursday*

10:00a      Seminar  
Speaker:      Richard Hoover  
Topic:        Multilayer X-ray Microscope Development

*June 18 Thursday*

7:00p        Opening Reception  
Huntsville/Madison County Botanical Gardens

*June 19 Friday*

9:00a - 12:00p      First Year Fellows Bus Tour of MSFC (Group II)

*June 25 Thursday*

10:00a      Seminar  
Speaker:      Joe Hale  
Topic:        The MSFC Virtual Reality Applications Program

*June 25 Thursday*

Joe Wheeler State Park Educational Retreat  
(see agenda)

*June 26 Friday*

Joe Wheeler State Park Educational Retreat  
(see agenda)

*July 2 Thursday*

10:00a      Seminar  
Speaker:      Dr. Charles R. Chappell  
Topic:        The Making of a Payload Specialist

TABLE VI. SCHEDULE OF WEEKLY ACTIVITIES - 1992 (Continued)

*July 7, Tuesday*

9:00a - 12:00p Second Year Fellows Bus Tour of MSFC

*July 9 Thursday*

10:00a Seminar  
Speaker: Max Nein  
Topic: Lunar Telescopes

*July 9 Thursday*

5:00p SFFP Group Picnic  
Marshall Space Flight Center's Picnic Area

*July 16 Thursday*

10:00a Seminar  
Speaker: Dr. Frank Six  
Topic: The Hubble Space Telescope

*July 20 Monday*

5:00p SFFP Group Picnic  
Redstone Arsenal's Picnic Area on the Tennessee River

*July 23 Thursday*

10:00a Seminar  
Speaker: Dr. Jerry Fishman  
Topic: BATSE Observations on the Compton Gamma Ray Observatory

*July 25 Saturday*

8:00a - 3:00p MSFC picnic

*July 28, Tuesday*

5:30p Closing Banquet  
Speaker: Charles Boldin, Astronaut  
Held at Redstone Arsenal Officer's Club

*July 30 Thursday*

10:00a Seminar  
Speaker: Bill Huber  
Topic: Space Exploration Initiative

*July 30 Thursday*

7:00a Depart for John F. Kennedy Space Center, Florida

*July 31 Friday*

Space Shuttle Atlantis Launch Scheduled

*August 2 Sunday*

7:00a Depart for Huntsville, Alabama

*August 6 Thursday*

10:00a Seminar  
Speaker: John McCarty  
Topic: Propulsion Perspective

TABLE VII. NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM WEEKLY SEMINARS

**1992 Seminars**

**Bldg. 4200, Room P110 (10th Floor)  
10:00 - Noon**

**June 11**

Carmine DeSanctis, Preliminary Design Office  
"MSFC Future Projects"

**June 18**

Richard Hoover, Space Science Laboratory  
"Multilayer X-ray Microscope Development"

**June 25**

Joe Hale, Systems Analysis and Integration Laboratory  
"The MSFC Virtual Reality Applications Program"

**July 2**

Rick Chappell, Associate Director for Science  
"The Making of a Payload Specialist"

**July 9**

Max Nein, Preliminary Design Office  
"Lunar Telescopes"

**July 16**

Frank Six, University Affairs  
"The Hubble Space Telescope"

**July 23**

Jerry Fishman, Space Science Laboratory  
"BATSE Observations on the Compton Gamma Ray Observatory"

**July 30**

Bill Huber, Program Development  
"Space Exploration Initiative"

**August 6**

John McCarty, Propulsion Laboratory  
"Propulsion Perspective"

TABLE VIII. 1992 ACTIVITIES PROGRAM

Wednesday, June 17

Tour of NASA/MSFC for First Year Faculty and their spouses.

Thursday, June 18

Huntsville/Madison County Botanical Gardens Opening Reception - The 1992 NASA/ASEE Summer Faculty Fellows, STEP Teachers, and their spouses were invited to a reception hosted by The University of Alabama Capstone Society and the UAH Engineering Foundation held at the Botanical Gardens. The NASA Colleagues, NASA Administrators, UA Science and Engineering Department Chairmen, UA Administrators, UAH Science and Engineering Department Chairmen, and UAH Administrators were invited to welcome the Summer Faculty for the 1992 Summer.

Friday, June 19

Tour of NASA/MSFC for First Year Faculty and their spouses.

Thursday, June 25 and Friday, June 26

An Education Retreat was held at Alabama's Joe Wheeler State Park. All Summer Faculty Fellows, JOVE Program Faculty Research Associates, and STEP Teachers were invited to attend. The retreat provided 1992 Summer Program participants an opportunity to learn in a relaxed atmosphere more about NASA/MSFC programs, the experiences of other faculty fellows, and the contract/grant proposal process. Presentations, distribution of informational brochures and videos, and interactive discussions covered the following topics:

"Origins of the Voyager Grand Tour Missions to the Outer Planets" - Gary Flandro, Boling Professor of Advanced Propulsion, University of Tennessee Space Institute

"Taking NASA Back to the Campus" - Bill Pierson, Malcolm McDonald, Hugh Hill

"An Inquiry into the Effectiveness of Current Educational Practices in Engineering - MSFC Perspective" - Bill Rule

"How can NASA assist/promote education and outreach programs?" - Brainstorming Groups

Grantsmanship - Frank Six, MSFC; Mike Freeman, UA; Jerry Karr, UAH; Hugh Hill, 2nd year STEP Teacher.

Tuesday, July 2

Tour of NASA/MSFC for Second Year Faculty and their spouses.

Thursday, July 9

Picnic, for the 1992 Summer Faculty Fellows, JOVE Program Faculty Research Associates and STEP Teachers was held at Marshall Space Flight Center's picnic area. All summer program participants and their spouses were invited to attend the picnic/barbecue. Festivities included volleyball and softball.

TABLE VIII. 1992 ACTIVITIES PROGRAM (Continued)

Monday, July 20

Picnic for the 1992 Summer Faculty Fellows, JOVE Program Faculty Research Associates and STEP Teachers was held at Redstone Arsenal's picnic area. All summer program participants and their spouses were invited to attend the picnic/barbecue. Festivities included volleyball, boating, and softball.

Tuesday, July 28

Closing Banquet - All 1992 Summer Faculty Fellows, JOVE Program Faculty Research Associates, STEP Teachers, and their spouses were invited to the banquet held at the Redstone Arsenal Officer's Club. Everyone enjoyed the semi-formal sit-down dinner. After dinner the guest speaker, Charles Bolden, spoke of his experiences as a NASA Astronaut.

Thursday, July 30 through Sunday, August 2

Trip to Kennedy Space Center to see the launch of the Space Shuttle Atlantis. All Summer Faculty Fellows, JOVE Program Faculty Research Associates and STEP Teachers and spouses were invited to go on the trip, which included a tour of KSC and sightseeing around the area.

**1992**  
**MSFC EDUCATION RETREAT**  
**Joe Wheeler State Park**  
**Thursday & Friday, JUNE 25 - 26, 1992**

On June 25 & 26, there will be an education retreat at Alabama's Joe Wheeler State Park. This retreat is intended to be informational, as well as a relaxing way to get acquainted with your fellow Faculty members. All Faculty members are expected to attend the retreat.

**Final Agenda**

**Thursday, June 25**

- 3:00-5:00 p Registration at the Lodge Check-in desk  
*(earliest hotel check-in time 3:00 p.m.)*  
 Convene at the Education Retreat Suite (room number can be obtained at the registration desk)
- 5:00 p Presentation: Gary Flandro, Boling Professor of Advanced Propulsion, University of Tennessee Space Institute "Origins of the Voyager Grand Tour Missions to the Outer Planets" (River Room, 1st floor)
- 6:00 p Mixer in the Education Retreat Suite
- 7:00-8:30 p Buffet Dinner in (River Room 1st floor). \$16.00/per person (prepaid by 6/23/92).

**Friday, June 26**

- 7:30 a Coffee and Breakfast Items (located in the rear of the River Room, 1st floor)
- 8:00-8:20 a Introduction - Speakers: Frank Six and Jim Pruitt(River Room, 1st floor)
- 8:20-10:10 a "Taking NASA back to the Campus"
- 8:20-8:50 a Presentations by 3 Educators
- Speakers: Bill Pierson, Malcolm McDonald, Hugh Hill
- 8:50-9:30 a Group Discussions
- 9:30-10:10 a Reports from the Discussion Groups
- 10:10-11:00 a Q & A/Discussion of NASA's Programs for Faculty & Students
- 11:00-3:00 p Break (Leisure time/idea exchange/video tape previewing)
- 3:00-3:30 p "An Inquiry into the Effectiveness of Current Educational Practices in Engineering - MSFC Perspective," Bill Rule
- 3:30-4:00 p Outreach Experiences
- Speakers: Len Peterson, Kevin Whitaker, George Lebo
- 4:00-4:30p Brainstorming Groups ("How can NASA assist/promote education and outreach programs?")
- 4:30-5:00 p Reports from Brainstorming Groups
- 5:00-5:40 p Grantsmanship - Speakers: Frank Six, Jerry Karr, Mike Freeman, Hugh Hill
- 5:40-5:45 p Wrap-up/Critique
- 6:00-8:30 p Social/Barbecue (Wheeler's Day Use Pavilions 1 & 2)

# UPCOMING SUMMER FACULTY FELLOW PRESENTATIONS

Wednesday - 7/22/92

**Alex Bykat**, *University of Tennessee at Chattanooga*

Wednesday - 7/29/92

8:30 Bldg. 4481/Room 515

**Bernie McNamara**, *New Mexico State University*

*"Feasibility of Performing Simultaneous Ground-Based Optical Monitoring of Discrete High Energy Sources Monitored by the Compton Gamma-Ray Observatory"*

**Len Peterson**, *University of Florida*

*"The Charging of a Thin Dust Layer in an Ambient Plasma Is Studied Using a Particle Simulation Code"*

**J.-C. Wang**, *Alabama A&M University*

*"Nature of Fluid Flows in Differentially-Heated Cylindrical Container Filled with a Binary Solution"*

## Wednesday - 7/29/92

1:30 Bldg. 4612/Room 1008

**Bill Brewer**, *Jackson State University*

*"Shuttle Experiment Proposal: Welding in Space"*

## Friday - 7/31/92

9:00 Bldg. 4487/Room B104

**Stella Lawrence**, *Bronx Community College of the City University of New York*

*"Using Software Metrics of Software Reliability Models to Attain Acceptable Quality Software"*

**Kevin Whitaker**, *The University of Alabama*

*"The Use of Neural Networks to Analyze Space Shuttle Main Engine Plume Spectral Data"*

**Malcolm McDonald**, *Berry College*

*"A Study of Multipath Effects on a Global Positioning System (GPS) Receiver in a Space Vehicle Operating in the Vicinity of a Large Structure"*

## Monday - 8/3/92

2:30 Bldg. 4200/Room 211

**Chandra Putcha**, *California State University, Fullerton*

*"Reliability Analysis of External Tank Attach Ring (ETA)"*

## Tuesday - 8/4/92

10:30

Bldg. 4666/Room 371H

**Keith Woodbury**, *The University of Alabama*

*"Analysis of Film Cooling in Rocket Nozzles"*

## Wednesday - 8/5/92

8:30

Bldg. 4481/Room 107

**Joni Brooks**, *Columbia State Community College*

*"Investigation of Rainfall Data with Regard to low-level Wind Flow Regime for the KSC Area"*

**Claude Duchon**, *University of Oklahoma*

*"Best Estimates Based on Radar and Rain gage Measurements of Daily Rainfall Totals for East Central Florida"*

**Adriel Johnson**, *UAH*

*"Ground Testing of Bioconvective Variables such as Morphological Characterizations and Mechanisms which Regulate Macroscopic Patterns"*

**Chris Olsen**, *Naval Postgraduate School*

*"The Relationship between Transversely Heated Plasma Distributions and the Resulting Electric Field Structure"*

**Richard Solakiewicz**, *Chicago State University*

*"Investigation of Optical Data from Lightning in Thunderclouds"*

## Wednesday - 8/5/92

10:30

Bldg. 4610/Room 3053

**Peter TenPas**, *University of Kansas*

*"Acceleration of FDNS Flow Simulations with a Parabolized Navier-Stokes Method"*

## Wednesday - 8/5/92

12:00

Bldg. 4712/MIC Room

**Paul Ray**, *The University of Alabama*

*"Emergency Egress Requirements for Caution and Warning, Logistics, Maintenance, and Assembly Stage MB6 of the Space Station Freedom"*

**Vidya Taneja**, *Western Illinois University*

*"Reliability Growth Models for NASA Application"*

## Thursday - 8/6/92

8:30

Bldg. 4612/Room 1008

**Bor Jang**, *Auburn University*

*"The Response of Polymers and Composites to Various Space Environments; Development of an Effective Methodology for Predicting the Service Lifetimes of these Materials"*

**Alton Highsmith**, *The University of Alabama*

*"Impact Damage in Composite Rocket Motor Cases"*

**C. Jeff Wang**, *Tuskegee University*

*"Investigation of the Effects of Material Variants on Rocket Nozzle Thermostructural Behavior"*

**Amanie Abdelmessih**, *California State Polytechnic University - Pomona*

*"Reduction of Variations in Weld Bead Geometry due to Changes in Geometry of the Weld piece of the Fixture in the Vicinity of the Variable Plasma Arc Weld"*

## Thursday - 8/6/92

9:00 Bldg. 4200/Room 329

**Jim Martin**, *University of Alabama*

*"Earth-To-Orbit Vehicles"*

**Roger Thompson**, *Pennsylvania State University*

*"Control/Structure, Thermal Interaction"*

**James Foreman**, *Alabama A&M University*

*"LUTE Metering Structure"*

**Gordon Wilson**, *The University of Alabama in Huntsville*

*"IMI Instrument Heritage"*

**Russ Rosmait**, *Pittsburg (KS) State University*

*"New Ways of Doing Business"*

## Thursday - 8/6/92

9:30 Bldg. 4663/MIC-A

**Harry Harrison**, *Capitol College*

*"Guide to Object-Oriented Analysis and Design"*

## Thursday - 8/6/92

10:00 Bldg. 4610/Room 1086

**Jack Matson**, *The University of Alabama*

*"Development of a Prototype Interactive Learning System Using Multi-Media Technologies for Mission Independent Training Program"*

## Thursday - 8/6/92

10:30 Bldg. 4610/Room 3053

**Bill Rule**, *The University of Alabama*

*"Design of a Welded Joint for Robotic, On-Orbit Assembly of Space Trusses"*

## Thursday - 8/6/92

1:30 Bldg. 4610/Room 2071

**Stan Bullington**, *Mississippi State University*

*"Development of a Requirements List for Implementing Schedule Repair Technology in NASA's Expert Scheduling Program"*

## Friday - 8/7/92

10:30 Bldg. 4610/Room 3053

**Lunelle Miller**, *Northeast Mississippi Community College*

*"Problems Involving Axial and Shear Loads"*

## Friday - 8/7/92

1:00 Bldg. 4612/Room 1008

**Jim Yang**, *Tuskegee University*

*"Stress Analysis and Damage Evaluation of Laminate Composites by Hybrid-Numerical Method"*

**Majid Karimi**, *Alabama A & M University*

*"Structural and Elastic Properties of Twist Grain Boundaries in eo(?) using the Embedded Atom Method"*

**Patrick Tibbits**, *Indiana Institute of Technology*

*"Calculation of Elastic Constants near Grain Boundaries by Molecular Dynamics Simulation in the (T, h, N) Statistical Mechanical Ensemble for Metals and Semimetals"*

**Dan Walsh**, *California Polytechnic State University - San Luis Obispo*

*"Effect of Material Variables on Micro Biologically Influenced Corrosion in Environments that Will be Found on the Space Station and Environments Found on the Space Shuttle"*

**Phil Farrington**, *UAH*

*"Evaluation of Systems within the Materials and Processes Laboratory and Development of a Plan for Integrating Them more Completely"*

## Friday - 8/7/92

1:00 Bldg. 4663/B Wing Conference Room

**Gary Moynihan**, *The University of Alabama*

*"Development of Vendor Evaluation Criteria and Post-Implementation Considerations for the MSFC Centerwide Executive Information System"*

## Tuesday - 8/11/92

9:00 Bldg. 4610/Room 2071

**Bob Batson**, *The University of Alabama*

*"Systems Engineering Process and Organization Assessment"*

## Tuesday - 8/11/92

10:00 Bldg. 4487/Room B104E

**Jim Richie**, *Marquette University*

*"Near Field Analysis (Electromagnetic) in Cargo Bay for the Waves in Space Plasma (WISP) Mission"*

**Bob Leland**, *The University of Alabama*

*"Feasibility of Using Adaptive Optics to Improve Signal-to-Noise Ratios for Laser Wind Measurements and for Space Power Beaming"*

## Tuesday - 8/11/92

3:30 Bldg. 4610/Room 3053

**Alan Palazzolo**, *Texas A & M University*

*"Simulation of Turbopump Liquid Annular Seals Including Variable Profile and Eccentricity Effects"*

## Wednesday - 8/12/92

8:30 Bldg. 4481/Room 107

**Beatriz Cardelino**, *Spelman College*

*"Computation of Nonlinear Optical Properties of Large Organic Molecules"*

**Charles McGruder**, *Fisk University*

**Michael Pangia**, *Georgia Southwestern College*  
*"Space Plasma Distribution Functions"*

**Tom Wdowiak**, *The University of Alabama at Birmingham*  
*"Reduced Gravity Experiment (KC-135) to Investigate  
Convection Effects on Fullerene Formation for Carbon-Arc in  
Helium Atmosphere Process"*

## Wednesday - 8/12/92

10:30            Bldg. 4610/Room 3053

**Digendra Das**, *State University of New York at Utica*  
*"Space Transportation Main Engine Nozzle Thermal  
Analysis"*

## Monday - 8/17/92

9:30            Bldg. 4666/Room 371H

**Carl Wikstrom**, *University of Arkansas*  
*"Computational Reduction of Elementary Reaction  
Mechanisms of Combustion for Localized CFD Applications"*

**Roy Hartfield**, *Auburn University*  
*"Non Intrusive Flow Diagnostics Applied to a Hybrid Rocket  
Motor"*

## Tuesday - 8/18/92

10:00 Bldg. 4610/Room 3053

**Mingking Chyu**, *Carnegie Mellon University*

*"CFD Analysis on Control of Secondary Losses in Turbines with End-Wall Fences"*

## Tuesday - 8/18/92

1:00 Bldg. 4666/Room 371H

**Mark Bower**, *UAH*

*"Viscoelastic Behavior of Seal Materials and Geometries for very Long Service Life"*

## Thursday - 8/20/92

10:00 Bldg. 4610/Room 171E

**Shannon Cobb**, *UAH*

*"Optimal Trajectories for Orbital Transfer"*

## Monday - 8/24/92

12:30 Bldg. 4610/Room 3053

**Scott Edward Hodel**, *Auburn University*

*"Numerical Issues in Control Systems"*

## Thursday - 8/27/92

9:00 Bldg. 4666/Room 371H

**Bob Frederick**, *UAH*

*"Performance Prediction of Hybrid Rocket Motors"*

10:00 Bldg. 4610/Room 1086

**Loretta Moore**, *Auburn University*

*"Prototyping On-Board Payload Displays for Space Station Freedom"*

## Friday - 9/11/92

10:30 Bldg. 4610/Room 3053

**Art Helmicki**, *University of Cincinnati*

*"Health Monitoring and Control for the STME: A Case Study"*

## SECTION V. SUMMER TEACHER ENRICHMENT PROGRAM

A special feature of the 1992 MSFC program was the involvement of a group of 19 pre-college educators in the summer faculty program activities. Funds were provided through the NASA Headquarters (HQ) Office of External Relations and the MSFC Center Director to fund a program which was termed the Summer Teacher Enrichment Program (STEP). The features of the STEP program were:

- a. Nineteen pre-college teachers from the seven state service region of MSFC (Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, and Tennessee) were offered STEP opportunities at MSFC.
- b. Each teacher worked 50% of the time with a NASA employee who volunteered to work with the pre-college teacher on an aerospace project for the summer.
- c. Each teacher was required to also spend 50% of his/her time developing lesson plans for math and science classes at the home institution. The teachers received 3 hours of graduate credit for this activity.
- d. Each teacher was required to participate in the 2-day Education Retreat which was conducted by MSFC and the administration of the NASA/ASEE Summer Faculty Fellowship Program.
- e. Each teacher was provided with educational materials to take back to his/her school.
- f. Each teacher was invited to participate, on a volunteer basis, in travel to Kennedy Space Center (KSC) to view a launch of the Space Shuttle and a tour of KSC.

The primary objectives of the STEP program are to

1. increase the nation's scientific and technical talent pool,
2. improve the quality of pre-college math and science education, and
3. improve math and science literacy.

STEP's underlying philosophical beliefs are:

1. Improvement in the quantity and quality of math and science graduates is critical to the nation's long-term competitiveness.
2. A sustained, effective partnership between NASA and education is essential to accomplish this nation's education goals.
3. NASA can uniquely provide access to state-of-the-art technologies, expertise, and facilities for teacher enrichment.

4. NASA-education partnership interactions lead to:
  - a. improved NASA and education understanding of each other's operating environments and needs,
  - b. increased relevancy of math and science education,
  - c. realistic career planning input for students,
  - d. restoration of high priority status for the teaching profession,
  - e. enhanced opportunities for professional development of the teacher, and
  - f. greater flow of resources to education.

This past summer the 19 STEP teachers divided themselves into 5 groups for purposes of developing lesson plans for use in their classrooms. A list of these 5 projects is attached. Each of the STEP teachers also received 3 hours of graduate credit through The University of Alabama (Tuscaloosa) as part of the summer's effort.

SUMMER TEACHER ENRICHMENT PROGRAM

LABORATORY ASSIGNMENTS

1992

AB/Facilities Office

David Rouby  
Little Rock, AR  
AB10/Environmental Management Office

EB/Information and Electronic Systems Laboratory

Lance Berra  
St. Louis, MO  
EB33/Communications Systems Branch

Lynn Jones  
Monroe, LA  
EB24/Control Electronics Branch

Kay Maxfield  
Springfield, MO  
EB13/Electrical/Electronics Parts Branch

ED/Structures and Dynamics Laboratory

Cecily Agee  
Lebanon, TN  
EB62/Environmental Control and Life Support Branch

Royce Neidert  
Loretto, TN  
ED51/Structures Division

EH/Materials and Processes Laboratory

Lisa Nesbit-Brasch  
Dunkerton, IA  
EH32/Analytical and Physical Chemical Branch

Tammie Johnston  
Monroe, LA  
EH12/Physical Sciences Branch

Minadene Waldrop  
Terry, MS  
EH32/Analytical and Physical Chemical Branch

EL/Systems Analysis and Integration Laboratory

Sharon LeJeune  
Marion, MS  
EL64/Experiments and Components Test Branch

EO/Mission Operations Laboratory

Carl Freyaldenhoven  
Little Rock, AR  
EO24/Training/Crew Support Branch

Thomas Ngar  
Monroe, LA  
EO41/Mission Analysis Division

Robert Robbins  
Bettendorf, IA  
EO23/Man/Systems Integration Branch

EP/Propulsion Laboratory

Melinda Howell  
Pinson, AL  
EP63/Mechanical Systems Development Branch

Danielle Willcoxon  
Booneville, MS  
EP55/Performance Analysis Branch

ES/Space Science Laboratory

Helen Broughton  
Memphis, TN  
ES43/Remote Sensing Branch

Jacqueline Brown  
Saraland, AL  
ES76/Biophysics Branch

Hugh Hill, Jr.  
Wynne, AR  
ES44/Environmental Analysis Branch

Chris McWilliams  
Tuscumbia, AL  
ES76/Biophysics Branch

**1992 SUMMER TEACHER ENRICHMENT PROGRAM  
HOME SCHOOLS AND TEACHING AREAS**

STATE	TEACHER	SCHOOL	GRADE	SUBJECT	DEGREE	YEAR	UNIVERSITY	CHIEF GRADUATE SUBJECTS
TN	WALTER J. AGE	WALTER J. BAIRD MIDDLE SCHOOL	8	GENERAL SCIENCE PHYSICAL SCIENCE	MS	1981	TN STATE UNIV. NASHVILLE, TN	ADMIN & SUPV; AEROSPACE; PSYCHOLOGY
MO	BERBA	BEASLEY ELEMENTARY SCHOOL	6	MATH SCIENCE LANGUAGE SOCIAL STUDIES READING	Ph.D.	1986	CLAYTON UNIV. ST. LOUIS, MO	ELEMENTARY EDUCATION; SOCIAL STUDIES
TN	BROUGHTON	MIDDLE COLLEGE HIGH SCHOOL	11&12	CHEMISTRY PHYSICS	Ed.D.	1984	MEMPHIS STATE MEMPHIS, TN	SCIENCE EDUCATION; CURRICULUM DEV; CHEMISTRY
AL	BROWN	LEFLORE HIGH SCHOOL	9,10,11,12	BIOLOGY (ADV. REG) PHYSICAL SCIENCE	M. Ed.	1981	UNIV OF SOUTH ALABAMA	BIOLOGY; GEOLOGY; AEROSPACE EDUC.
AR	FREYALDENHOVEN	FULLER JUNIOR HIGH SCHOOL	9	PHYSICAL SCIENCE	M. Ed.	1975	U OF CENTRAL AR CONWAY, AR	SCIENCE EDUCATION
AR	HILL	WYANNE HIGH SCHOOL	9 11&12	PHYSICAL SCIENCE AEROSPACE	M.S.E.	1985	AR STATE UNIV. JONESBORO, AR	SECONDARY COUNSELING (PSYCHOLOGY)
AL	HOWELL	SHADES VALLEY RESOURCE LEARNING CENTER	9 10&11 12	ALGEBRA I ALGEBRA II AP CALCULUS	M. Ed.		UAB BIRMINGHAM, AL	EDUCATION (SECONDARY & GIFTED); MATHEMATICS
LA	JOHNSTON	OUACHITA JUNIOR HIGH SCHOOL	7	GT EARTH SCIENCE	M. Ed.	1987	NE LA UNIV. MONROE, LA	GIFTED
LA	JONES	CARROLL HIGH SCHOOL	9,10,11,12	ALGEBRA I INTEGRATED ALGEBRA/GEOMETRY BUSINESS MATH	M. Ed.	1982	NE LA UNIV. MONROE, LA	ADMIN & SUPV (EDUCATION); MATHEMATICS
MS	LEBUNE	MERIDIAN HIGH SCHOOL	10,11,12	CONSUMER SCIENCE BIOLOGY	Ed.S.	1989	LIVINGSTON UNIV. LIVINGSTON, AL	BIOLOGY
MO	MAXFIELD	REED JUNIOR HIGH SCHOOL	8	PHYSICAL SCIENCE	ESEd	1989	SW MO STATE UNIV. FLORENCE, AL	B.S. WORK: EARTH SCIENCE BIOLOGY
AL	MCWILLIAMS	CHEROKEE MIDDLE SCHOOL	7	SCIENCE SOCIAL STUDIES	M.A.	1981	UNA	ADMINISTRATION
TN	NEIDERT	LORETTO HIGH SCHOOL	9,10,11,12 12 11,12	DRAFTING & DESIGN PHYSICS GEOLOGY	M.S.	1984	TN STATE UNIV. NASHVILLE, TN	EDUCATIONAL ADMIN & SUPV
LA	NESSBT, ERASCH	STILWELL JUNIOR HIGH SCHOOL	7, 8	LIFE PHYSICAL GENERAL & CHEMICAL SCIENCE	B.A.	1991	U OF NORTHERN LA CEDAR FALLS, LA	B.A. WORK: NATURAL SCIENCES, COMPUTERS
LA	NGAR	OUACHITA PARISH HIGH SCHOOL	9,10 10,11,12	ALGEBRA I ALGEBRA II	B.S.	1970	U OF ARKANSAS MONTICELLO, AR	B.S. WORK: COMPUTER SCIENCE & MATHEMATICS
LA	ROBBINS	WILLIAMS JUNIOR HIGH SCHOOL	7	GENERAL MATH	M.A.	1989	U OF IOWA IOWA CITY, IA	EDUCATIONAL PSYCHOLOGY; INSTRUCTIONAL DESIGN; VIDEOTAPE IN EDUCATION; INSTRUCTIONAL METHODS
AR	ROUBY	PULASKI HGTS JUNIOR HIGH SCHOOL	7	LIFE SCIENCES	M.Ed.		U OF ARKANSAS LITTLE ROCK, AR	HISTORY OF EDUCATION; SOCIAL PARAMETERS OF TEACHING DURING THE 90'S INSTRUCTIONAL METHODOLOGIES
MS	WALDROP	FOREST HIGH HIGH SCHOOL	10,11,12	HONORS CHEMISTRY CHEM COM. FAMILY LIVING	M. Ed.	1980	MS COLLEGE CLINTON, MS	HOME ECONOMICS; CHEMISTRY; CHEMISTRY EDUC.
MS	WILCOXON	BOONEVILLE HIGH SCHOOL	8,9,10,11,12	ALGEBRA I, ALGEBRA II, ADV. MATH. CALCULUS	M.A.	1977	UAB BIRMINGHAM, AL	MATHEMATICS EDUCATION

# STEP Curriculum Projects

## *"Aerospace Problem Solving Curricula"*

Helen Broughton (Tennessee), Jackie Brown (Alabama), Carl Freyaldenhoven (Arkansas),  
Hugh Hill (Arkansas), and David Rouby (Arkansas)

## *"Tri-State AIMS Project"*

Royce Neidert (Tennessee), Chris McWilliams (Alabama), and Danielle Willcoxon (Mississippi)

## *"Problem Solving in Mathematics and Science"*

Lance Berra (Missouri), Lynn Jones (Louisiana), and Tom Ngar (Louisiana)

## *"Days of Freedom Project"*

Cecily Agee (Tennessee), Tammie Johnston (Louisiana), Lisa Nesbit (Iowa),  
and Robert Robbins (Iowa)

## *"Space, the Search for New Beginnings Project"*

Melinda Howell (Alabama), Sharon LeJeune (Mississippi), Kay Maxfield (Missouri),  
and Minadene Waldrop (Mississippi)

## SECTION VI. CONCLUSIONS AND RECOMMENDATIONS

As in past years, the number of qualified applicants, after screening by the MSFC selection committee, far exceeded the number of fellowships. This of itself is a strong indication that the NASA/ASEE Summer Faculty Fellowship Program at MSFC continues to be an attractive program and notable success. This view is shared by both MSFC personnel and by the science and engineering academic community from which the Fellows are chosen.

The various aspects of the 1992 program were evaluated by both the fellows and the NASA colleagues through evaluation forms which are reproduced in Appendices A and B, respectively. The Fellows' questionnaire was furnished by ASEE. The colleagues questionnaire remained the same as in the past 13 years. This has allowed monitoring of any areas needing improvement.

The Fellows' questionnaire is presented in Appendix A. The tabulated results are included with the questionnaire itself. Some of the questions precluded an easy presentation of results and, thus, a synopsis of the results is presented here. The NASA Colleagues' questionnaire and tabulated results are presented in Appendix B.

Questionnaire results from both groups are comparable to results obtained in the past. It is clear that both the Fellows and their Colleagues are very well satisfied with all aspects of the program. A significant change in recent years of the evaluation over prior years responses is in the increased interest by the Summer Faculty to perform research back at their home institution. This interest has been brought about by increased emphasis by the program co-directors on this aspect of the program. The support of the NASA Colleagues for the program is seen in their average scores. The colleague evaluation (see appendix B) shows high scores as in years past with some small fluctuation for a few particular questions.

Again this year, each Fellow's "Certificate of Recognition" has been mailed to the Fellow's Dean, or other institution administrator of the Fellow's choice, in order to ensure maximum recognition for the Fellow and maximum exposure for the program. A sample of the letter accompanying the certificate is shown on the following page.



# THE UNIVERSITY OF ALABAMA

College of Engineering  
DEPARTMENT OF AEROSPACE ENGINEERING

Box 870280  
Tuscaloosa, Alabama 35487-0280  
(205) 348-7300

August 5, 1992

Dr. Ernest Nester, Dean  
College of Engineering  
WVIT  
Montgomery, WV 25136

Dear Dr. Nester:

Enclosed is a *Certificate of Recognition* from NASA and the American Society for Engineering Education (ASEE) to be presented to Dr. William E. Pierson in recognition of his work at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama, during the summer of 1992. As you know, Dr. Pierson has conducted a research project at MSFC which was chosen in consultation with his NASA colleague. This certificate recognizes Dr. Pierson's contribution and expresses the appreciation of NASA, ASEE, and The University of Alabama for a job well done.

Please present this certificate to Dr. Pierson with our thanks.

Sincerely,

L. Michael Freeman  
University Program Co-Director  
1992 NASA/ASEE Summer Faculty Fellowship Program

LMF:srn

Enclosure

## **APPENDICES**

- A. Specific Comments by Fellows and Copy of Questionnaire Form**
- B. Specific Comments by Colleagues and Copy of Questionnaire Form**
- C. Abstracts of Fellows' Final Research Reports**
- D. STEP Teachers Questionnaire**
- E. STEP Mentors Questionnaire**

## APPENDIX A: Specific Comments by Fellows

I am convinced that the coordinators of this program have put a great deal of effort and work and that the program is very successful, due to their enthusiasm. I suggest scheduling the tours during the 3rd or 4th weeks. Earlier during the program, the research work is usually slow. The directory only includes Huntsville and NASA addresses. It would be nice if it would include home institution address and phone number. As a person from out of state, I wish that the social events were scheduled on weekends. Weekends can be very long and lonely.

Include in your information to prospective participants the fact that the space provided for work will not be the same as that provided at their own institutions. Only those who can adjust should be encouraged to apply. Keep on including many African-Americans. Keep up the good work that you now do.

Tour Kennedy [Space Center] earlier, whether or not the Shuttle launches.

I believe the program should be expanded to 12 weeks. It would be good if each center had a "pot" of money reserved to fund a few continuation projects - it is a shame that NASA spends money "investing" in training of faculty fellows in a research area and is then unable to find funds to continue those relationships. One of NASA's strategies appears to be to increase the size (i.e., number of participants) of the summer programs. Although this is desirable in the sense that more faculty members are able to be exposed to NASA, I feel that the program may be near, or at, an upper limit in terms of manageability. It might be good to consider holding the numbers down just a little and using the freed-up funds as suggested above. THIS IS AN EXCELLENT PROGRAM!!!

The program was very well organized. It was a fruitful experience.

The program as it is - appears to me almost perfect. Very good and well organized program. Credit certainly goes to the managers of the program - Keep up the good work.

More information on how MSFC is organized - what each division and branch does. If possible, high level overview of current and future projects - if possible within a reasonable time frame. More information on solicited and unsolicited proposal preparation process. Even with some of the frustrations, this was a very worthwhile learning experience. It was great to have an opportunity to meet and interact with faculty from other institutions.

Have the colleague arrange phone numbers and computer accounts before we show up, rather than when we get here. ... I had to wait a more than a week for phones and computers.

I wish I had a little more time to bring the project to closure. I didn't know that it was possible to stay longer than 10 weeks until I arrived. The people administering the program try to keep the faculty member thinking some about education and I think this is good. Perhaps some ASEE representatives could be part of the educational retreat, and could address effective teaching techniques.

More opportunity to participate in courses offer by the sponsoring University and by the NASA center. Dr. Frank Six is an excellent lecturer and teacher.

## APPENDIX A: Specific Comments by Fellows (Continued)

The program has been honed pretty well. We need to avoid change for "change's" sake. Care must be taken to stay on schedule in the summer conference. On the length of brainstorming sessions at the summer retreat: We overran badly because the conference leaders truly wanted to hear everything we had to say and university faculty have a lot to say (even if it is repetitive or trite). My suggestion is to limit (strictly) discussion of a topic with the caveat that, after the scheduled time has elapsed, those who desire may stay and speak their piece but those not interested will be free to flee.

More barbecues and volleyball after work. Less meetings that take time away from research time.

Reduce retreat to one day, no overnight.

If faculty wants, [he/she] should be able to extend beyond 10 weeks. Longer research time.

Weekly meetings are too long. Perhaps bi-weekly meeting would be better.

The way my NASA colleagues worked out a program for me was perfect for my teaching preparation. My tasks were designed in order to work me into the routine, so that I would be thoroughly familiar with the computer programs and the problem-solving procedure as they were needed. I wanted things I could take back to the classroom and apply them directly to the assignment. My students will reap the benefits of my summer at NASA for the rest of my teaching career.

Eliminate or reduce off-site meeting. Schedule KSC trip earlier in the summer. Ideally, this should be before the fifth week. Progressively less faculty will attend as trip slips past this date (due to conflict with research).

Try and coordinate housing - so SFFP are co-located. Develop activities to improve teaching as well as research. The stipend replaces my normal salary - it needs to roughly match what I would make at home and cover additional outstanding expenses (e.g. rental car).

More social activities. I would like to return next year for a third year if possible. Dr. Mike Freeman and his staff are to be commended on the excellent job they do on administering this program.

One possible way to enhance the effectiveness of the research is to provide for or encourage a pre-summer visit for a few days to help get started and to get familiar with the area. The MSFC group has a very good program going. The leadership is strong and supportive.

Make very clear to NASA management that "take-home" funding may be the only "credit" faculty members get for this program. This is important if you want to continue to attract good faculty.

It would be beneficial if the duration of the program was extended to a year. It is difficult to do very much significant research in the course of ten weeks. Less time could be spent at the seminars. Provide an opportunity for additional summers.

## APPENDIX A: Specific Comments by Fellows (Continued)

Include a program for grad students or include them in the program. Meetings with research colleagues prior to the summer are extremely beneficial. A formal visitation program would help. I wish to comment further about the stipend. I think that the stipend was very fair. It allowed me to participate in the program without having to incur unreimbursed expenses. If the objective of the participants and the program is to obtain summer support - such as research on a university contract during the summer, then the stipend is not adequate. I, personally, believe that the program should provide adequate stipends; if participants want "summer support" they should look elsewhere. In that regard, the stipend is what it should be.

Arrange more social activities for faculty and NASA engineers to exchange research/teaching experiences.

Make 12 weeks long - 10 weeks goes by very fast!

More emphasis on interaction with STEP program- We need more qualified students.

Require minimum "training" for colleagues, so there is some uniformity of experience from lab to lab.

**American Society for Engineering Education**  
**NASA/ASEE Summer Faculty Fellowship Program**  
**Evaluation Questionnaire**

**(Faculty Fellows are asked to respond to the following questions)**

**Name:** \_\_\_\_\_

**Birthdate:** \_\_\_\_\_

**Social Security Number:** \_\_\_\_\_

**Permanent Mailing Address:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Home Institution:** \_\_\_\_\_

**NASA Center and (Laboratory) Division:** \_\_\_\_\_

**Name of Research Associate:** \_\_\_\_\_

**Brief Descriptive Title of Research Topic:** \_\_\_\_\_

**A. PROGRAM OBJECTIVES**

1. Are you thoroughly familiar with the research objectives of the research (laboratory) division you worked with this summer?

	<u>1992</u>	<u>1991</u>	<u>1990</u>
Very much so _____	36	28	28
Somewhat _____	15	18	19
Minimally _____	3	0	1

2. Do you feel that you were engaged in research of importance to your Center and to NASA?

Very much so _____	39	38	37
Somewhat _____	14	9	11
Minimally _____	1	0	0

3. Is it probable that you will have a continuing research relationship with the research (laboratory) division that you worked with this summer?

Very much so _____	38	34	30
Somewhat _____	12	10	17
Minimally _____	4	2	0

4. My research colleague and I have discussed follow-up work including preparation of a proposal to support future studies at my home institution, or at a NASA Center.

Yes _____	41	41	38
No _____	13	6	7

5. What is the level of your personal interest in maintaining a continuing research relationship with the research (laboratory) division that you worked with this summer?

Very much so _____	52	46	42
Somewhat _____	1	1	4
Minimally _____	1	0	0

**B. PERSONAL PROFESSIONAL DEVELOPMENT**

1. To what extent do you think your research interests and capabilities have been affected by this summer's experience? (you may check more than one)

	<u>1992</u>	<u>1991</u>	<u>1990</u>
Reinvigorated _____	23	26	20
Redirected _____	18	17	17
Advanced _____	38	33	31
Just maintained _____	3	0	6
Unaffected _____	1	0	0

2. How strongly would you recommend this program to your faculty colleagues as a favorable means of advancing their personal professional development as researchers and teachers.

With enthusiasm _____	41	41	33
Positively _____	15	7	14
Without enthusiasm _____	0	0	0
Not at all _____	0	0	0

3. How will this experience affect your teaching in ways that will be valuable to your students? (you may check more than one) 1992 - 1991 - 1990

By integrating new information into courses 43 - 38 - 32

By starting new courses 9 - 6 - 4

By sharing research experience 41 - 42 - 39

By revealing opportunities for future employment in government agencies 33 - 39 - 29

By deepening your own grasp and enthusiasm 28 - 30 - 14

Will affect my teaching little, if at all 1 - 1 - 2

4. Do you have reason to believe that those in your institution who make decisions on promotion and tenure will give you credit for selection and participation in this highly competitive national program?

Yes _____	35	30	34
No _____	14	14	12

C. ADMINISTRATION

1. How did you learn about the program? (Please check appropriate response)
- |  | <u>1992</u> | <u>1991</u> | <u>1990</u> |
|--|-------------|-------------|-------------|
| ____ Received announcement in the mail.        | 23          | 23          | 14          |
| ____ Read about in a professional publication. | 4           | 4           | 2           |
| ____ Heard about it from a colleague.          | 27          | 25          | 20          |
| ____ Other (explain). _____                    | 8           | 2           | 11          |
| _____  |             |             |             |
| _____  |             |             |             |
2. Did you also apply to other summer faculty programs?
- |                                     |    |    |    |
|-------------------------------------|----|----|----|
| No _____                            | 42 | 17 | 17 |
| Yes _____ (indicate which programs) | 12 | 30 | 31 |
| DOE _____                           | 3  | 2  | 4  |
| Another NASA Center _____           | 5  | 7  | 8  |
| Air Force _____                     | 3  | 3  | 4  |
| Army _____                          | 5  | 7  | 5  |
| Navy _____                          | 5  | 3  | 5  |
3. Did you receive an additional offer of appointment from one or more of the above? If so, please indicate from which.
- |           |    |    |    |
|-----------|----|----|----|
| Yes _____ | 6  | 4  | 6  |
| No _____  | 33 | 43 | 28 |
4. Did you develop new areas of research interest as a result of your interaction with your Center and laboratory colleagues?
- |             |    |    |    |
|-------------|----|----|----|
| Many _____  | 11 | 12 | 10 |
| A few _____ | 38 | 32 | 35 |
| None _____  | 5  | 3  | 4  |
5. Would the amount of the stipend be a factor in your returning as an ASEE Fellow next summer?
- |                   |    |    |    |
|-------------------|----|----|----|
| Yes _____         | 30 | 19 | 27 |
| No _____          | 24 | 26 | 18 |
| If not, why _____ |    |    |    |
| _____             |    |    |    |
| _____             |    |    |    |
6. Did you receive any informal or formal instructions about submission of research proposals to continue your research at your home institution?
- |           |    |    |    |
|-----------|----|----|----|
| Yes _____ | 50 | 43 | 44 |
| No _____  | 4  | 4  | 3  |

7. Was the housing and programmatic information supplied prior to the start of this summer's program adequate for your needs?

	<u>1992</u>	<u>1991</u>	<u>1990</u>
Yes _____	50	46	47
No _____	0	0	0

8. Was the contact with your research colleague prior to the start of the program adequate?

Yes _____	50	44	45
No _____	2	2	3

9. How do you rate the seminar program?

Excellent _____	23	21	27
Very good _____	18	14	18
Good _____	10	8	2
Fair _____	2	2	0
Poor _____	0	0	1

10. In terms of the activities that were related to your research assignment, how would you describe them on the following scale? 1992 - 1991 - 1990

Check one per activity	Time Was			
	Adequate	Too Brief	Excessive	Ideal
Research	23-24-19	20-12-12	0-0-0	11-11-14
Lectures	32-27-24	3-0-1	4-3-1	11-16-17
Tours	29-27-26	5-3-0	3-4-3	10-11-17
Social/Recreational	29-29-26	3-4-2	7-2-1	11-11-16
Meetings	33-30-20	0-3-0	9-3-1	7-7-11

11. What is your overall evaluation of the program?

Excellent _____	37	34	32
Very good _____	14	10	14
Good _____	3	2	1
Fair _____	0	0	0
Poor _____	0	0	0

12. If you can, please identify one or two significant steps to improve the program.

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13. For second-year Fellows only. Please use this space for suggestions on improving the second year.

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**D. STIPEND**

1. To assist us in planning for appropriate stipends in the future would you indicate your salary at your home institution.

\$ \_\_\_\_\_ per Academic year \_\_\_\_\_ or Full year \_\_\_\_\_. (check one)

2. Is the amount of the stipend the primary motivator to your participation in the NASA-ASEE Summer Faculty Fellowship Program?

	<u>1992</u>	<u>1991</u>	<u>1990</u>
Yes _____	3	3	0
No _____	27	45	31
In part _____	24		

3. What, in your opinion, is an adequate stipend for the ten-week program during the summer of 1992?

\$ \_\_\_\_\_

**E. ASEE MEMBERSHIP INFORMATION**

1. Are you currently a member of the American Society for Engineering Education?

Yes \_\_\_\_\_

No \_\_\_\_\_

2. Would you like to receive information pertaining to membership in the ASEE?

Yes \_\_\_\_\_

No \_\_\_\_\_



## APPENDIX B: Specific Comments by Colleagues

I feel that this continues to be a good program.

I am actively pursuing an appointment for next summer in S&E; the funding for the study we are currently doing will be transferred to S&E in FY93.

Dr. (Patrick) Tibbits certainly accomplished a lot, practically all that was planned, except that there still appears to be some serious "bugs" in the computer program that he reformulated and therefore, the use of this computer program may be much more limited than it could be.

This fellow's (Dr. Majid Karimi) efforts complement very well my own research in surface science; essentially it amounts to interpreting recent advances in this field and then try to apply to NASA's - MSFC's mainline projects. Our cooperation with the fellow, Dr. Majid Karimi, has been in progress since July 1990, and in all respects it has been very worthwhile to me personally and, I believe also to NASA. This has enabled (us) to bring very recent developments to bear to NASA's technical problems. Dr. Karimi has done his share in this "somewhat private initiative." The use of large modern computers and other modern instrumentation, has been very beneficial.

Dr. (Daniel) Walsh's efforts very much qualify him for further participation in the program. We would welcome him any time he is able to come and participate. Dr. Walsh's experience and knowledge in the fields of microbiologically-induced corrosion and welding, along with his enthusiasm and skill with research, have benefited us greatly.

Dr. (Alan) Palazzolo has developed codes that will aid in rotordynamic analysis of turbomachinery. Dr. Palazzolo's work has been outstanding and ED14 will benefit from his work.

(Dr. Art Helmicki is) smart, motivated and industrious.

Dr. (Michael) Pangia achieved results beyond our expectations. We have a real interest in continuing a relationship with him in the future.

He (Dr. Digen Das) approached the program with enthusiasm.

I think a few more weeks due to length of learning curve (or is it steep slope) would have been very productive.

Dr. (Claude) Duchon was instrumental in helping us get a continuation of our RTOP funding, which if successful (i.e., publications) could continue the collaboration through the end of the decade!

The Fellow put forth a minimum amount of effort into his research product. The results of the research were less useful than we anticipated. The Fellow was obviously knowledgeable in his field, but he seemed to lack dedication to his research project.

Extend program where/when possible (e.g., up to 12 weeks particularly for "first timers"). Encourage program/project "set asides" for the 1/2 funding requirements and for small SFFP continuation grants.

The program was a good experience for the Fellow and for our NASA branch.

## APPENDIX B: Specific Comments by Colleagues (Continued)

Dr. (Malcolm) McDonald's efforts and contributions were outstanding and we would welcome him back next summer if he is eligible. Dr. McDonald has the ability to quickly get "up to speed" on his assigned task and quickly identify the central issues and required tasks to complete his summer research assignment. Dr. McDonald worked very hard operating our GPS system many different ways. In so doing, he determined on optimal operating procedure for us to follow when doing our multipath studies. Dr. McDonald's knowledge of science has helped those who interrogated him. I, now, have a better understanding of orbital mechanics. I, also, have a new avenue to evaluate the physics of a hybrid coupler. Likewise, Dr. McDonald is very acquainted with the Global Positioning Satellite system, NASA's goals for space navigation, and the excitement of solving science problems.

Gordon (Wilson) has provided valuable technical assistance to our advanced project definition efforts. He has taken the initiative on his summer project and prepared an Instrument Heritage assessment that will help us plan mission science instrument development. We would like to work with him again next year!

I highly recommend Dr. (Alex) Bykat for further participation on the program. He was very knowledgeable in the area of work being done. He, also, provided innovative concepts for our projects. The summer faculty fellowship program is a good vehicle for exchanging ideas between universities and NASA. We were fortunate enough to receive a highly qualified individual to exchange ideas and accomplishments.

I would strongly encourage further work with fellow.

This office strongly endorses the selection of Dr. (Lunelle) Miller for further participation in the MSFC program and would like to acquire her services again next summer. Her math and science skills proved quite adequate for accomplishing the structural analysis tasks. Dr. Miller was always enthusiastic in the accomplishment of her tasks. She was a significant contributor to our Spacelab rack post structural testing and in the preparation of a NASA TM for preloaded fasteners. As a professor of some basic math/science skills, she a gained valuable experience which she can directly relate to aspiring graduates. Our future plans for her (next summer) would include involvement in structural testing and finite element computer analysis of AXAF-S payload

Dr. (Paul) Ray is a hard worker, who is very interested in the work at MSFC and building relationships between the University of Alabama and MSFC.

Dr. (Philip) Farrington was very interested in the automation work taking place in the Productivity Enhancement Complex. His experience and background are ideally suited for his work here and also mutually beneficial to him and NASA.

The work initiated by Dr. (Beatriz) Cardelino during the summer should provide a basis for a productive collaboration throughout the rest of the year. Dr. Cardelino is an enthusiastic, persevering researcher. Dr. Cardelino has been very instrumental in establishing professional contacts with other faculty fellows.

As much participation in our composite damage tolerance program as possible from Dr. (Alton) Highsmith will be pursued. The Fellow has an outstanding background working knowledge to help NASA. We must use him to help further our research.

## APPENDIX B: Specific Comments by Colleagues (Continued)

I certainly think his efforts qualify him for further participation. Dr. (James) Martin has an excellent background in advanced transportation, is highly motivated to do further work in the field, and has been exceptionally helpful with suggestions, observations, references, and analysis during his tenure here.

This Summer Faculty Fellow demonstrated excellent participation and contribution and would certainly be an asset to the program with further participation. This Fellow (Dr. Chandra Putcha) displayed outstanding interest and cooperation in the research project and was always thinking ahead and anticipating difficult areas, so that they could be resolved in a timely manner to enable completion of the study to a satisfactory point.

This summer was primarily used for research time (on job, at RSIC - other) to identify the course of action needed for the next year's task, which involves interface with other NASA centers, mostly ARC, as well as original work. The main work will be during FY93. The Fellow (Dr. Kevin Whitaker) is well organized and understands what is necessary to operate a task in consort with an organization such as ours. Being a good observer will be of immense utility in codifying what now is essentially a manual operation.

As usual, Dr. (Bill) Pierson helped us more than we helped him. This was his third term and he was able to begin work without delay.

The Fellow (Dr. William Rule) is ideally suited to continue research in this area since he has a better understanding of the objectives and goals. The Fellow has shown interest, dedication, and knowledge of the research effort. I believe it is beneficial to maintain a working relationship with the academic profession.

Dr. (Peter) TenPas' efforts qualify him for further participation on the program.

The Fellow split time between SA01 and EL51 during the summer tour. This did not allow adequate time to address the systems engineering-related topics.

**NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM  
MSFC RESEARCH COLLEAGUES' EVALUATION QUESTIONNAIRE**

NAME OF MSFC COLLEAGUE \_\_\_\_\_

LABORATORY/DIVISION/BRANCH \_\_\_\_\_

NAME OF FELLOW ASSIGNED TO YOU \_\_\_\_\_

**Note:** The Summer Faculty Fellowship Program objectives, as set forth by NASA and ASEE are:

- a. To further the professional knowledge of qualified engineering and science faculty members;
- b. To stimulate an exchange of ideas between participants and NASA;
- c. To enrich and refresh the research and teaching activities of participants;
- d. To contribute to the research objectives of the NASA centers.

In view of these objectives and the time frame (10 weeks) of the program, please evaluate the program by answering the following questions. (When appropriate, circle the number indicating 5-excellent, 4-very good, 3-good, 2-fair, 1-poor.)

<u>FELLOW</u>	<u>E</u>	<u>VG</u>	<u>G</u>	<u>F</u>	<u>P</u>
1. Preparation for research project:	5	4	3	2	1
2. Cooperation, industry, interest, etc.:	5	4	3	2	1
3. Effectiveness of his/her work:	5	4	3	2	1
4. Stimulation to your office:	5	4	3	2	1
5. Overall rating of Fellow:	5	4	3	2	1

PROGRAM

6. Effectiveness in improving Fellow's research and teaching potential:	5	4	3	2	1
7. Benefit to NASA from technical standpoint:	5	4	3	2	1
8. Benefit to NASA in terms of university and public relations:	5	4	3	2	1
9. Effectiveness as a means of stimulating an exchange of ideas between faculty and NASA:	5	4	3	2	1
10. Overall rating of program	5	4	3	2	1

**MSFC RESEARCH COLLEAGUES' EVALUATION QUESTIONNAIRE (Continued)**

11. In your opinion, do the Fellow's efforts qualify him/her for further participation on the program (if eligible)?

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12. Any additional comments related to the Fellow, his/her work, or the program will be greatly appreciated.

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APPENDIX B. (CONTINUED)

SUMMARY OF COLLEAGUES' QUESTIONNAIRE RESPONSES

	5 - Excellent 4 - Very Good 3 - Good 2 - Fair 1 - Poor	<u>1992</u>	<u>1991</u>	<u>1990</u>
1. Preparation for research project		4.4	4.5	4.6
2. Cooperation, industry, interest		4.6	4.8	4.9
3. Effectiveness of his/her work		4.5	4.7	4.5
4. Stimulation to your office		4.4	4.5	4.3
5. Overall rating of Fellow		4.6	4.7	4.6
6. Effectiveness in improving Fellows' research and teaching potential		4.2	4.4	4.1
7. Benefit to NASA from technical standpoint		4.4	4.7	4.5
8. Benefit to NASA in terms of university and public relations		4.4	4.6	4.6
9. Effectiveness as a means of stimulating an exchange of ideas between faculty and NASA		4.5	4.6	4.6
10. Overall rating of program		4.5	4.6	4.5

## APPENDIX C. Abstracts of Fellows' Final Research Reports

Abstracts of final research reports submitted by the Fellows, providing title of report, department where the Fellow conducted his/her research, and a brief summary of his/her paper, are contained herein. These are arranged alphabetically by the authors' last names.

Copies of an individual report can be obtained by writing to:

Dr. Michael Freeman  
Department of Aerospace Engineering  
University of Alabama  
Box 870280  
Tuscaloosa, AL 35487-0280

List the title and author of the report desired, and a copy will be sent postpaid to the requester.

# HEAT FLOW IN VARIABLE POLARITY PLASMA ARC WELDS

Amanie N. Abdelmessih

Lecturer

Chemical and Materials Engineering Department  
California State Polytechnic University

Materials and Processes Office

Process Engineering Division

Metals Processing Branch

Arthur C. Nunes, Jr., Ph.D., MSFC Colleague

Temperature fields were measured for two plate configurations during variable polarity plasma arc (VPPA) welding. The first configuration was a uniformly flat plate and the second a flat plate with a groove along the weld. Thermocouples attached to a data acquisition system and infrared imaging were used. The measured temperature fields were compared to the moving line source solution.

It had been thought that as welding progresses, the work-piece effective ambient temperature would rise, thus raising the temperature with respect to melting at the weld and pushing out the melting zone to presumably create taper. From this study, of a one pass bead on a plate, it was found that, although the average plate temperature rose with welding heat input, there was negligible change in the effective ambient temperature of the flat plate and this explained why there was no measurable taper.

SYSTEMS ENGINEERING PROCESS AND  
ORGANIZATION ASSESSMENT

Robert G. Batson  
Professor  
Department of Industrial Engineering  
The University of Alabama

Systems Analysis and Integration Laboratory  
Systems Analysis Division

L. Don Woodruff, MSFC Colleague  
Glen D. Ritter, MSFC Colleague

The systems engineering (SE) process for space systems is a disciplined approach used by both NASA/MSFC and its contractors to convert mission needs into a system specification, the key technical input to NASA Phase C Detail Design activities. Although only 5% of the program effort is expended during Phase A Preliminary Analysis and Phase B Definition, 85% of the program cost is determined by the end of Phase B. The responsibility for SE work at the Center during Phases A, B, and C rests primarily with two organizations: Program Development, which manages Phases A and B; Systems Analysis and Integration Lab, whose involvement begins in Phase B and continues throughout Phase C.

The purpose of this report is to describe the results of an assessment or "audit" of NASA/MSFC Phase A and Phase B systems engineering processes, methodologies, and activities. Inconsistencies and weaknesses were identified in the areas of:

- o SE process flow and technical reviews
- o Organizing to accomplish Phases A and B
- o Documentation resulting from Phase B and C
- o Planning Documents for Phase B and C SE work
- o Trade Study Management and Tools
- o Program Risk Management Tools

For each weakness or inconsistency, a recommendation is made for corrective action and how the Center might organize itself to design and implement the action.

UPDATING AND EXPANDING THE LIBRARY OF MATERIALS  
ON NASA SPACELINK ELECTRONIC INFORMATION SYSTEM

Jean A. Blake, Ph.D.  
Professor  
Alabama A & M University  
Department of Mathematics

Jeffrey S. Ehmen and William E. Anderson, MSFC Colleagues

NASA Spacelink, a proven resource medium, may be accessed over telephone lines or via the Internet by teachers or anyone with a computer or modem. It is a collection of historical and current information on NASA programs and activities. Included in this library is information on a variety of NASA programs, updates on Shuttle status, news releases, aeronautics, space exploration, classroom materials, NASA Educational Services, and computer programs and graphics. The material stored in Spacelink has found widespread use by teachers and others, and is being used to stimulate students, particularly in the area of aerospace science.

To refurbish the system I assisted in updating and expanding the NASA Spacelink collection.

To accomplish this I used computer equipment in:

Editing documents for the system.

Modifying and testing menus for the system.

Updating and entering information in the system.

Rendering the available information more accessible to the Spacelink user.

Converting Macintosh based documents to Standard Text Form (ASCII) and uploading to system for posting.

# DESIGN AND ANALYSIS OF SEALS FOR EXTENDED SERVICE LIFE

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Assistant Professor

Department of Mechanical and Aerospace Engineering  
The University of Alabama in Huntsville

Propulsion Laboratory

Component Development Division

Mechanical Systems Development Branch

Thomas D. Bechtel, MSFC Colleague

Brian K. Mitchell, MSFC Colleague

Space Station Freedom is being developed for a service life of up to thirty years. As a consequence, the design requirements for the seals to be used are unprecedented. Full scale testing to assure the selected seals can satisfy the design requirements are not feasible. As an alternative, a sub-scale test program has been developed by MSFC to calibrate the analysis tools to be used to certify the proposed design. This research has been conducted in support of the Space Station Seal Test Program.

Seals are simple devices that are in widespread use. The most common type of seal is the O-ring. There are four basic design parameters that are to be considered in the development of an O-ring seal: O-ring diameter, groove design, O-ring squeeze, and material. In this research a single O-ring diameter was considered. Groove design is typically selected from one of four fundamental groove shapes: rectangular -- no side wall contact, rectangular -- side wall contact, dove tail, and half-dove tail. This research addresses both types of rectangular grooves, and the half-dove tail design. The O-ring squeeze levels range from 10% to as much as 50%. In this research three squeeze levels were considered: 15, 25, and 40%. The materials studied were selected from candidate materials for Space Station Freedom: Viton (Parker V747) and Silicone (Parker S383).

In spite of the relative simplicity of the O-ring it does not lend itself to analysis. Which is why O-rings have been so frequently designed based on handbook values, without extensive analysis. O-ring analysis is complicated by the inherent nonlinearities in the problem. The O-ring problem involves nonlinear geometric effects; due to the contact, or moving boundary, problem and the large deformations. It also involves nonlinear material effects; due to the material nonlinearities at large deformations (hyperelasticity) and the viscous behavior of the material (viscoelasticity). Current advancements in computational methods have led to the development of the tools that are capable of handling the O-ring problem.

The designs considered in this research were analyzed using a commercial finite element analysis code: ABAQUS by Hibbitt, Karlsson, and Sorensen, Incorporated. Preliminary model development was accomplished using EMS and IFEM by Intergraph and translation to ABAQUS and post processing using PATRAN by PDA. ABAQUS is a multipurpose finite element program developed without the classical assumptions of small displacements and rotations. It was used in this research because of its ability to analyze contact problems, nonlinear material behavior, and viscoelastic response. Sample results from the analyses are presented.

# SHUTTLE FLIGHT EXPERIMENT PRELIMINARY PROPOSAL: DEMONSTRATION OF WELDING APPLICATIONS IN SPACE

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Department of Technology  
Jackson State University

Materials & Processes Office  
Process Engineering Division  
Metals Processes Branch

Clyde S. Jones III, MSFC Colleague  
Carolyn K. Russell, MSFC Colleague

Local consensus guided the choice of 6 representative weld joints, called FX (flight experiment) modules, that would be of general utility for space construction. For each module a scenario is hypothesized anticipating the need for that weld in an example application. For each scenario simulations were constructed ranging from the simple and inexpensive to higher fidelity and most expensive. The crudest simulations were prelaunch assembled parts joined on orbit by a weld torch constrained to move along a fixed path. Hard automation for on-orbit part assembly is a step toward higher fidelity. A fully robotic process represents the ultimate simulation.

Integration of the FX modules into a flight experiment package is the next task. Reliability vs. cost becomes an added concern. In the event of a critical path failure, damage to the results would be minimized if all modules were totally independent having separate utilities, motion systems, and welding torch. Such a degree of redundancy, in effect six separate flight experiments, would be expensive. At the other end of this scale, a single universal robotic end-effector capable of manipulating all component parts and performing all weld types would be ideal. It would be even more expensive. End-effector complexity and its associated high developmental cost would be incurred in pursuit of reliability for the very interdependent subsystems. The best return on investment lies somewhere between these two extremes.

Two end-effectors are proposed. Each is specialized for one of the two difficult tasks. Both could service the simpler tasks, giving a measure of redundancy. Many subsystems for these end-effectors would share the same design features thus reducing developmental cost.

**CONCLUSIONS:** Combinations of Flight Experiment Modules that share subsystems will increase simulation fidelity at a reduced developmental cost. Additional reliability can be obtained thru partially redundant end-effectors. This approach gives the most cost effective results.

**INVESTIGATION OF RAINFALL DATA  
WITH REGARD TO LOW-LEVEL WIND FLOW REGIME  
FOR EAST CENTRAL FLORIDA**

**Joni Brooks  
Assistant Professor  
Department of Computer Information Systems  
Columbia State Community College**

**Earth System Analysis Team  
Earth Science & Applications Division  
Environmental Analysis Branch**

**MSFC Colleague(s)**

**Steve Goodman, Ph.D. - NASA  
Bill Crosson, Ph.D. - USRA  
Claude Duchon, Ph.D. - Univ. of Oklahoma**

**This research investigates the phenomenon of the effect of a disturbed natural sea breeze on rainfall in east central Florida. This study utilizes data gathered for the Cape (Convection and Precipitation/Electrification Experiment) field program from July 8, 1991 to August 18, 1991. Each day of this study period will be classified as disturbed or undisturbed sea breeze days. Methods of analysis will include comparison and contrast of the diurnal cycle, the distribution of rain rates, and the period of rain events for disturbed and undisturbed days.**

REQUIREMENTS FOR THE IMPLEMENTATION  
OF SCHEDULE REPAIR TECHNOLOGY IN THE  
EXPERIMENT SCHEDULING PROGRAM

Stanley F. Bullington  
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Department of Industrial Engineering  
Mississippi State University

Mission Operations Laboratory  
Mission Analysis Division  
Planning Systems Branch

John P. Jaap, MSFC Colleague

NASA's Experiment Scheduling Program (ESP2) is used by mission planners to develop timelines for spacelab missions, as well as for prospective Space Station Freedom missions. In order to provide better support for these planning tasks, it is desirable that a graphical user interface (GUI) be developed for ESP2. Prior to the development of a GUI, it is necessary that requirements be developed for providing ESP2 with some schedule repair capability. Due to the size and difficulty of space mission scheduling problems, complete rescheduling is, in most cases, undesirable or impossible. Mission planners need to be able to quickly modify an existing schedule in response to changes in resource availabilities, requests for additional performances of experiment models, mission extension or truncation, and other unplanned events. This report presents a discussion of some requirements for implementing schedule repair technology in ESP2. This work will hopefully serve as a useful foundation for the development of a GUI for ESP2.

A 2nd Generation Expert System for  
Checking and Diagnosing  
AXAF's Electric Power System

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Professor  
Department of Computer Science  
Armstrong State College

Information and Electronic Systems  
Electrical Division  
Electrical Power Branch

ABSTRACT

This paper discusses ESCAPADE, a multi-level 2nd generation monitoring and troubleshooting expert system for the AXAF's electrical power system. Design of such a system brings in the advantages of delegation of telemetry monitoring to the software system, and of helping the ground personnel by offering diagnoses and possible corrective actions for EPS malfunctions.

ESCAPADE is a knowledge-based system capable of supervising and managing operation of the AXAF's EPS in (semi)autonomous mode. It monitors AXAF's EPS telemetry and identifies malfunction manifestations, diagnoses suspected/imminent malfunctions and explains/verifies their causes, and specifies repair procedures. The knowledge base of ESCAPADE consists of explicit causal models of the EPS, human expert's empirical operational knowledge, and rules derived from the system's inference chains.

The explicit model, supported by model-based reasoning, will be used to a) produce a robust system when faced with unanticipated events, b) improve explanation capability by offering explanations based on causal model's description, c) provide a rule learning capability by compiling model-based inferences into new heuristic rules. The rule compiler can be used to offer a methodical coverage of model's search space with heuristic rules (systematic enumeration of the knowledge).

ESCAPADE is expected to offer advantages such as: efficient diagnosis due to multi-level reasoning; effective explanation through judgmental explanations (via heuristic rules) and causal explanations (via the explicit model); dynamic rule learning through compilation of deep (model-based) inference chains into shallow (heuristic) rules; dynamic model adaptation to incorporate environment induced changes in the modelled device.

# PREDICTION OF NONLINEAR OPTICAL PROPERTIES OF LARGE ORGANIC MOLECULES

Beatriz H. Cardelino  
Assistant Professor/Research Scientist  
Spelman College/Department of Chemistry  
Atlanta University Center/D. E. Milligan Science Research Institute

ES-74  
Microgravity Science and Applications  
Chemistry and Polymeric Materials

Craig E. Moore, Ph.D., MSFC Colleague

The preparation of materials with large nonlinear responses usually requires involved synthetic processes. Thus, it is very advantageous for materials scientists to have a means of predicting nonlinear optical properties. For example, correlating the strengths of the nonlinear properties of a family of compounds with different substituents at various bonding sites may be of great utility in selecting good candidates for experimentation. A method for calculating static second and third-order molecular polarizabilities has been developed. Several classes of compounds have been extensively studied using this technique. Synthesis of some of these compounds is under way at other institutions. Currently, the theoretical method is being modified to include dispersion effects. Several thermodynamic properties will be examined via molecular mechanics in order to predict the effect of intermolecular interactions on the nonlinear properties.

CFD ANALYSIS ON CONTROL OF SECONDARY LOSSES IN STME LOX TURBINES  
WITH ENDWALL FENCES

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Department of Mechanical Engineering  
Carnegie Mellon University

Structure and Dynamics Laboratory  
Aerophysics Division  
Computational Fluid Dynamics Branch

Lisa W. Griffin, MSFC Colleague

In the newly designed LOx turbine of the future Space Transportation Main Engine (STME), estimated secondary loss in the rotor alone accounts for nearly 50% of the total loss over the entire stage. Turbine Team of CFD Consortium at MSFC has been devoting significant effort to exploring viable means to reduce such a loss. The general scope of the present research is to investigate the potential of fence attachment on the turbine endwall for secondary loss reduction, using a computational fluid dynamics approach. This report describes the first phase of a series of parametric studies, which is to examine the effects of endwall fence on the secondary flows in a 160-degree curve duct. The duct geometry preserves basic turning features in the LOX turbine passage. Results from the present computation reveals that streamwise extension of an endwall fence may have insignificant influence on the overall flow structure. The results also implies that inclusion of turbine inlet condition and horseshoe vortex separation near the blade-endwall junction is important for an accurate modeling.

# OPTIMAL TRAJECTORIES FOR ORBITAL TRANSFERS USING LOW AND MEDIUM THRUST PROPULSION SYSTEMS

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Department of Mathematics  
University of Alabama in Huntsville

Systems Analysis and Integration Laboratory  
Systems Analysis Branch  
Flight Mechanics Division

John Hanson, MSFC Colleague

The problem presented in this report is to find the fuel-optimal solution for an orbit-to-orbit transfer using low and medium thrust propulsion systems. This research is expected to be beneficial to NASA in several regards: (i) optimal steering laws will be necessary for orbital maneuvering-type vehicles that could deliver cargoes to the Space Station Freedom, (ii) a low thrust (nuclear or solar electric) propulsion system, as well as a medium thrust (nuclear thermal) propulsion system will be of interest for transfer to Mars and back, (iii) low and medium thrust orbit transfer. The approach taken for the low thrust case takes advantage of the slowly varying elements describing the state of the spacecraft by using an averaging technique. However, along the transfer mass losses will yield a thrust acceleration too large for continued averaging; therefore, a precision integration method will be necessary. FORTRAN code has been written to compute this minimum-fuel solution.

## STME NOZZLE THERMAL ANALYSIS

Digendra K. Das  
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State University of New York  
Institute of Technology at Utica/Rome, NY

Structures & Dynamics Laboratory  
Thermal Engineering & Life Support Division  
Thermal Analysis Branch

Brian K. Goode, MSFC Colleague  
James W. Owen, MSFC Colleague

A one dimensional coupled (conjugate) fluid/thermal analysis model has been developed for the nozzle cooling of the Space Transportation Main Engine (STME). The model utilizes the standard SINDA 1987/ANSI solution procedure. The input data on the geometry and the gas properties for the model have been obtained from the engineering drawings and archives made available by Pratt & Whitney and Rocketdyne. The model will be further developed to include the primary and secondary film cooling aspects of nozzle thermal analysis.

**A PLAN FOR ACCURATE ESTIMATION OF DAILY  
AREA-MEAN RAINFALL DURING THE CAPE EXPERIMENT**

Claude E. Duchon  
Professor  
School of Meteorology  
University of Oklahoma  
Norman, OK

Earth Science & Applications Division  
Space Science Laboratory  
Environmental Analysis Branch

Steven J. Goodman, Ph.D., MSFC Colleague

The CaPE (Convection and Precipitation/Electrification) experiment that took place in east-central Florida in the summer of 1991 provided a wealth of data from direct and remote sensing of the atmosphere and land surface. The data sets obtained from radars and raingages thus far appear to have the potential to be used for evaluating the daily mean rainfall for the CaPE experiment area. Rainfall is the largest component of the hydrologic cycle. A plan is presented for analyzing daily precipitation that incorporates the results of a previous Florida experiment which occurred nearly twenty years ago as well as utilization of state-of-the-art research radars and numerous raingages that were operational in CaPE. The plan involves adjusting radar estimates of rainfall using a dense raingage network in order to obtain an optimal rainfall data set whose accuracy can be determined.

EVALUATION AND RECOMMENDATIONS FOR  
WORK GROUP INTEGRATION WITHIN THE MATERIALS AND PROCESSES LAB

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Department of Industrial and Systems Engineering  
The University of Alabama in Huntsville

Materials and Process Lab  
Process Engineering Division  
Chemical & Non-Metals Processes Branch

Eutiquio Martinez, MSFC Colleague

This report details a study undertaken to evaluate and make recommendations on ways to improve the level of integration of the various systems and functions within six branches of the Materials and Processes Lab. The branches evaluated include EH13 - Non-Destructive Evaluation, EH42 -Metals Processes, EH43 - Chemicals & Non-Metals Processes, EH44 - Tooling Applications, EH52 -Planning and Control, and EH53 - Fixture Design. The study evaluated the level of automation within each branch, the information needs of NASA and contractor personnel, the present level of data sharing, as well as making an assessment of the overall communication system. Overall, the investigation revealed a high level of process automation. The primary need within the Materials and Processes Lab is an increased emphasis on cooperation and communication between branches. More specific recommendations are made regarding the installation of a local area network within the Non-Destructive Evaluation branch, the use of database technology for tracking ongoing research and development work, the integration of machine controllers within the overall communications system, and the use of experimental design/Taguchi methods for conducting experimental investigations.

## **A STUDY OF THE LUTE METERING STRUCTURE**

**James W. Foreman  
Assistant Professor**

**Space Science and Applications  
Program Development Group  
Payload and Orbital Systems**

**Max Nein, MSFC Colleague  
Robert Porter, MSFC Colleague**

**NASA is considering a Lunar Ultraviolet Telescope Experiment (LUTE) as one the scientific payloads for an early return to the moon mission planned for the late 1990's. The main goal of this report is to structurally evaluate two metering structure concepts and to determine the most efficient configuration and material. The results of this study are contained in this report.**

## Performance Prediction of Hybrid Rocket Motors

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Assistant Professor  
School of Mechanical and Aerospace Engineering  
Propulsion Research Center  
University of Alabama in Huntsville

Propulsion Laboratory  
Propulsion Systems Division  
Solid Propulsion Branch

Benjamin Goldberg, MSFC Colleague

A hybrid rocket is a system consisting of a solid fuel and a gaseous/or liquid oxidizer. Hybrid rocket motors have regained stature as a propulsion alternative. They are being studied to fulfill requirements for a moderate cost, environmentally acceptable propulsion system. The objective of this work was to establish a methodology for hybrid rocket performance prediction. The scope included completion of: a literature review, a simplified performance model, and a methodology recommendation. A student review team was established with Master's Students at the University of Alabama in Huntsville to provide a comprehensive review of related topics. The team identified 450 references on the topic and gathered 110 of the most relevant papers. The team completed a bibliography of the literature and has scheduled four short review lectures for the fall. The hybrid performance review focused on techniques and approaches for predicting the performance of hybrid rockets. A PC-based computer program was developed that calculates the time-dependent nature of the fuel burning rate, chamber pressure, and thrust of a hybrid rocket motor. An integral part of this approach was the optimization of a thermochemical equilibrium program so that it would run efficiently on a Personal Computer. Finally, a methodology for doing a more complete performance prediction on hybrid rocket motors was recommended. The methodology consists of (1) an efficient ballistics model for design studies, (2) Computational Fluid Dynamics for determining entrance effects and mixing efficiency, and (3) subscale experiments for establishing burning rate parameters. Although hybrid rockets look like a combination of a liquid and solid rocket motor, the combustion process are most similar to a solid fuel ramjet (SFRJ). The main conclusion reached is that the hybrid motor burning rate must be determined using approaches and codes from the SFRJ arena, as well as some of the established practices of liquids and solids analysis. The Summer Faculty Program also allowed the author to participate publish a conference paper entitled "Results of a Labscale Hybrid Rocket Motor Investigation" that resulted from the 1991 SFFP.

# GUIDE FOR OBJECT-ORIENTED ANALYSIS AND DESIGN

Harry C. Harrison  
Associate Professor  
Department of Computer Engineering  
Capitol College

Information Systems Office  
Systems Development and Implementation Division  
Data Systems Branch

Marcellus Graham, MSFC Colleague

A new software methodology is revolutionizing the way software is developed and maintained. It promises to significantly reduce the cost of software. In this times of budgets constraints, it is important that NASA/MSFC be at the forefront of this technology. This report provides guidance to MSFC personnel regarding the use of object-oriented analysis. A brief introduction to the symbology used is provided. It is shown how the products of object-oriented analysis will fit into the Software Development Plan used at MSFC. Further work on the design guidance is being conducted.

EXPERIMENTAL INVESTIGATION OF A SIMULATED  
LOX INJECTOR FLOW FIELD AND OTHER  
NONINTRUSIVE MEASUREMENT EFFORTS

A Report For a Summer Faculty Fellowship

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Abstract

This document is a report on the application of optical diagnostic techniques to propulsion flow fields of current interest. The primary focus of the effort reported on herein has been to investigate the spray pattern from a swirl coaxial injector being considered for use on the space transport main engine (STME). For this work, water is sprayed through a swirl element injector at pressures up to 500 psia to simulate the liquid oxygen flow field. Optical techniques employed in this investigation include planar laser-induced fluorescence from a dye seeded into the water, and light scattered from both a laser and a strobe. Some quantitative information about the time-averaged water concentration is obtained from the fluorescence. Photographs of the scattered light provide both time-averaged and time-resolved information about the plume structure. During the period covered by the fellowship for which this report was written, an additional effort was made to resolve fluctuations in the combustion product composition in the exhaust of a hybrid rocket motor using laser-induced NO<sub>2</sub> fluorescence. This project was both less intense and less successful than the swirl injector investigation; nevertheless, a brief discussion of the measurement attempt in the hybrid motor is included.

**ISSUES IN HEALTH MONITORING AND CONTROL  
FOR THE SPACE TRANSPORTATION MAIN ENGINE**

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The Space Transportation Main Engine (STME) is a liquid hydrogen/oxygen, gas generator engine currently under development to power the National Launch System. A key feature of this engine is that it will be designed specifically for improved reliability and reduced cost of operation rather than increased performance and reduced weight. As a result, health monitoring and control functions will play a key role in the development of this engine system. This paper will present the results of a study of health monitoring and control issues for the STME. The results of this study were obtained by applying system-theoretic tools for the design of integrated health monitoring and control systems developed by the author during his first NASA/ASEE Summer Faculty Fellowship to a preliminary model of the STME. Specific issues addressed by this study include the development of health monitoring and control specifications, sensor suite selection, and actuator selection.

POST-IMPACT BEHAVIOR OF  
COMPOSITE SOLID ROCKET MOTOR CASES

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Presently, there is considerable interest in fabricating solid rocket motor cases out of composite materials. This interest is due to the significant weight savings, and hence increased performance, that a composite rocket motor case offers. One of the difficulties with using composite materials is that composites can develop significant amounts of internal damage during low velocity impacts. Such low velocity impacts may be encountered in routine handling of the rocket motor. The objective of the present study was to assess damage development in and reduction in tensile strength of composites subjected to low velocity impacts.

Flat plate laminates were fabricated from Fiberite T300/934 graphite epoxy with a stacking sequence of  $[0_4/(\pm 70)_2/0_4/(\pm 70)_2/0_2]$ . In these laminates, the  $0^\circ$  layers and the  $\pm 70^\circ$  layers represent the hoop and helical layers, respectively, found in a typical filament wound solid rocket motor case. In order to assess the effect of having the rocket motor filled with propellant, half of the specimens were backed with a layer of inert propellant. Six backed specimens and six unbacked specimens were impacted at each of three impact energies – low, intermediate, and high. From each set of six replicate impacts, three specimens were used to determine the residual tensile strength, and three specimens were used for damage documentation via dye-penetrant enhanced x-ray radiography.

As expected, specimens which were backed with inert propellant developed less damage during impact than specimens which were unbacked. Further, backed specimens showed a distinct impact energy threshold for damage development. Finally, the specimens were found to be quite tolerant of matrix damage. Specimens with extensive ply cracking and delamination but little or no fiber fracture exhibited little or no reduction in tensile strength, while specimens with more extensive fiber fracture showed more pronounced reductions in tensile strength.

# Update to MARSYAS: Numerical Methods for the Analysis of Sampled-Data Systems

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## Abstract

MARSYAS (MARshall SYstem for Aerospace Simulation) is a computer-aided control-system analysis and design tool developed at Marshall Space Flight Center. MARSYAS was recently updated to incorporate the simulation and analysis of sampled-data systems, i.e., dynamic systems that are represented by a combination of differential equations and difference equations. While most analysis features of purely continuous time systems carry over to the sampled-data case, several features of MARSYAS required modification in order to provide accurate and meaningful information regarding the simulation and analysis of these systems. Our work comprised the examination of the MARSYAS `openat` command, root-locus calculation, and treatment of sampled-data systems with feed-forward coefficients in the discrete-time subsystem.

## SOME EFFECTS OF TIME USAGE PATTERNS ON THE PRODUCTIVITY OF ENGINEERS

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Most of the work of the Center depends greatly on the productive efforts of the 1500+ employees in engineering jobs. Much of the MSFC budget is dedicated to compensating, training, housing, and supporting this major workforce segment. However, little systematic scientific knowledge exists about the effects of various factors on engineers' productivity. This report summarizes the key findings of an observation study of several Marshall engineers from three S&E labs and one Chief Engineer's office, including 40 engineers who were interviewed in depth.

This report discusses why problems in measuring engineers' productivity is an important hindrance to facilitating productivity increases. Several suggestions related to productivity measurement are included. Attributes and activities associated by interviewees with highly effective engineers are discussed in relationship to management and supervisory tasks. Also discussed are management issues associated with five career types observed at MSFC (listed below in descending order of their observed frequency of occurrence):

1. "Worker Bees", whose work often lacks general technical challenge, but who attend to details of information and data management which are critical to the success of most projects;
2. "New Kids", in the early phases of their NASA careers, who often do not yet know for what Marshall job they are best suited, and whose work habits and standards are still extremely open to influence;
3. "Techo-Wizards", who have carved out for themselves an area of great technical expertise and who are key influencers of design, analysis, or test methodology decisions;
4. "Movers and Shakers", who question and help define departmental/organizational priorities and strategic direction, and who seem inclined toward management track careers; and
5. "Lost Souls", who have eventually become relegated to tasks which are least critical to the organizational mission and who have low expectations for their own career prospects.

Plans for a followup questionnaire study of a larger sample are discussed.

## SPACE ENVIRONMENTAL EFFECTS ON POLYMERS AND COMPOSITES

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### ABSTRACT

The long-term performance of polymers and polymer-based composites in the space environment were investigated. Three groups of materials were included in the study: seal elastomers, polymer films, and carbon fiber reinforced composites. The methodologies that have been proposed for predicting the useful life of elastomeric seal materials were critically reviewed. The merit of using a rate-process approach to describe the thermo-mechanical response of elastomers was evaluated. A constitutive model was developed that would allow correlation between the commonly used compression set test data and the stress relaxation plus creep data. A time-temperature-dose rate superposition approach was proposed for characterizing the degradation kinetics and predicting the service lifetimes of elastomers in the space environment. Environmental factors of interest include thermal or mechanical stresses, atomic oxygen, UV, and other forms of radiation. Potential approaches to estimating the residual strength of polymer films and composites after atomic oxygen erosion were evaluated. Attempts were also made to understand the effects of space debris impacts and thermal cycling on the failure behavior of polymer composites.

**GROUND TESTING OF BIOCONVECTIVE VARIABLES SUCH AS MORPHOLOGICAL  
CHARACTERIZATIONS AND MECHANISMS REGULATING MACROSCOPIC  
PATTERNS**

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Conditions of variable gravity may alter macroscopic pattern formation in eukaryotic cells, but whether these changes are gravity driven is not certain. Fluid density models (gravity dependent) and the wave reinforcement theory (gravity independent) characterize the macroscopic patterns formed by different microorganisms. Microtubules are cellular components which regulate mechanisms related to motility. Isolation of tubulin, the subunit of microtubules, can generate polygonal networks similar to macroscopic patterns observed from microorganisms under conditions of variable gravity. Thus the microtubule system could serve as a model for studying pattern formations by organisms for ground base experiments and for future studies under conditions of variable gravity.

ENERGETICS AND STRUCTURAL PROPERTIES OF  
TWIST GRAIN BOUNDARIES IN Cu

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### Introduction

Structural and energetics properties of atoms near a grain boundary are of great importance from theoretical and experimental standpoints. From various experimental work it is concluded that diffusion at low temperatures at polycrystalline materials take place near grain boundary. Experimental and theoretical results also indicate changes of up to 70% in physical properties near a grain boundary. The Embedded Atom Method (EAM) (1) calculations on structural properties of Au twist grain boundaries (2) are in quite good agreement with their experimental counterparts. The EAM is believed to predict reliable values for the single vacancy formation energy as well as migration energy. However, it is not clear whether the EAM functions which are fitted to the bulk properties of a perfect crystalline solid can produce reliable results on grain boundaries.

One of the objectives of this work is to construct the EAM functions for Cu and use them in conjunction with the molecular static simulation to study structures and energetics of atoms near twist grain boundaries  $\Sigma 5$  and  $\Sigma 13$  in Cu. This provide test of the EAM functions near a grain boundary. In particular, we determine structure, single vacancy formation energy, migration energy, single vacancy activation energy, and interlayer spacing as a function of distance from grain boundary. Our results are compared with the available experimental and theoretical results from grain boundaries and bulk.

USING SOFTWARE METRICS AND SOFTWARE RELIABILITY MODELS  
TO ATTAIN ACCEPTABLE QUALITY SOFTWARE FOR  
FLIGHT AND GROUND SUPPORT SOFTWARE  
FOR AVIONIC SYSTEMS

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This paper is concerned with methods of measuring and developing quality software. Reliable flight and ground support software is a highly important factor in the successful operation of the space shuttle program. Reliability is probably the most important of the characteristics inherent in the concept of "software quality." It is the probability of failure free operation of a computer program for a specified time and environment.

There has been an increased awareness in recent years of the critical problems that have been encountered in the development of large scale software systems. These problems not only include the cost and schedule overruns typical of development efforts, and the poor performance of the systems once they are delivered, but also include the high cost to maintain the systems, the lack of portability and the high degree the systems can be sensitive requirement changes.

The efforts related to the development of a standard programming language, and of software development tools and aids, all provide partial solution to the above problems by encouraging disciplined development of software and therefore a controlled development process.

Recently there has been a great deal of research in the area of software metrics. A number of metrics which measure various attributes of software and relate them to different aspects of software quality have been developed and evaluated. The program manager responsible for the development of the software can establish specific software product quality goals and measure the progress towards these goals during development. Metrics can also provide the means to assess the difficulty in modifying a software product.

ABSTRACT

AN ALGORITHM TO QUANTIFY THE PERFORMANCE OF THE JOVE PROGRAM

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NASA's new Administrator, Daniel Goldin, has instructed each of his employees and departments to identify quantifiable criteria by which he/she wishes to be evaluated. To that end, the author has examined the goals of NASA's JOVE program and has developed an algorithm that will measure each school's performance.

The author also started a collaborative effort among Southwest Research Institute, The University of Florida, and Goddard Space Flight Center in which correlations between Jupiter's aurorae and its decametric radio waves will be studied. Hubble Space Telescope UV photographs of Jupiter's aurorae will be correlated with its ground-based decametric radio emission as recorded at the University of Florida's radio observatory.

## ADAPTIVE OPTICS FOR LASER POWER BEAMING

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The feasibility of using adaptive optics to control a large segmented mirror in order to produce a collimated high energy pulsed laser beam from ground to space was investigated. Performance of the system was evaluated for several types of beacons. First, Rayleigh scattering from the outgoing 12 m diameter beam was considered. Due to speckle from the large target and anisoplanatism, this approach was rejected. Next a single laser guide star, scattered either from aerosols or the sodium layer was considered. Again, for a 12 m aperture, anisoplanatism significantly degraded system performance. An alternative approach of using multiple guide stars was considered assuming a Hufnagel-Valley-Boundary turbulence profile. The number of guide stars was calculated for a 1 micron wavelength and Fried coherence length of  $r_0 = 23$  cm. The feasibility of several methods of producing multiple guide stars is discussed.

## **Structure in Gamma-Ray Burst Time Profiles: Statistical Analysis I**

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Gamma-ray burst (GRB) time histories show structures with no apparent periodicity nor regularity. The durations span several orders of magnitude from milliseconds to hours. In this paper we begin an analysis of the spikiness of GRB's from a statistical point of view. Using a criterion for spikiness developed by Lestrade et al. (1991), we present an analysis of theoretical poissonian background data as a base of understanding for our future analysis of GRB time profiles.

DIRECTIONS FOR FUTURE  
EARTH-TO-ORBIT VEHICLES

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NASA is currently assessing several possibilities, with the goal of developing a space station, providing transportation to orbit, and initiating an exploration program while maintaining a level budget. One possibility being considered is a new National Launch System which might reduce the cost of transportation to orbit. An option has been developed for a reusable pressure-fed booster for the new launch system. One pressure-fed booster could be used for a small vehicle. Four of these boosters could be used as the first stage of a larger vehicle. A fifth booster could be used in an expendable mode for the second stage of the larger vehicle. Both vehicles could use the same upper stage. An examination of the pulsed detonation engine has indicated that the engine has great potential, but significant effort will be required to verify that potential.

DEVELOPMENT OF A PROTOTYPE INTERACTIVE LEARNING  
SYSTEM USING MULTI-MEDIA TECHNOLOGY  
FOR MISSION INDEPENDENT TRAINING PROGRAM

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Spacelab Mission Independent Training is currently presented in workbook form with some lecture sessions to supplement selected topics. The objective of this project was to develop a prototype interactive learning system for one of the Mission Independent Training topics to demonstrate how the learning process can be improved by incorporating multi-media technology into an interactive learning system. This report documents the development process and some of the problems encountered during the system development.

**Multipath Effects in a  
Global Positioning Satellite System Receiver**

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Of interest to NASA are the possibilities for employing Global Positioning Satellite (GPS) system receivers in space vehicles as navigational support devices. A particular consideration for such applications is the possibility that such a GPS receiver, operating in a vehicle approaching a large space structure such as the Space Station Freedom (SSF), would encounter position-determination uncertainties brought on by the effects of multipath reflections of the GPS satellite signals into the receiver along with the direct-path signals. The work reported herein is part of a larger study being undertaken in the Communications Systems Branch at MSFC to simulate multipath effects in a variety of state-of-the-art GPS receivers and to determine the effects multipath reflections introduce into the position-determining operations of the receivers.

This study focused on the multipath effects inherent to a specific GPS receiver which was already available in the laboratory. That receiver did not represent state-of-the-art, but the work with it provided a suitable scenario to be applied in measuring multipath effects in new GPS receivers which had been ordered and were being received at the time of conclusion of the effort presented in this report.

The results indicated that multipath reflections of a single GPS satellite signal into the receiver can cause large fluctuations (in excess of one hundred meters, in some instances) in the raw pseudorange data of that satellite, especially when the strength of the reflected signal competes strongly with the direct satellite signal.

ABSTRACT

THE IONOSPHERE AS A GAMMA-RAY DETECTOR

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We report the second observation of an ionospheric disturbance caused by a gamma-ray burst. The burst, 1B910503, which occurred at 7:4:14.72 UT, is one of the strongest observed by the Gamma-Ray Observatory (GRO). The ionospheric disturbance started 1 minute after the GRO Trigger time and it was observed simultaneously as amplitude changes on two completely different very low frequency (VLF) radio wave propagation paths (Maine-Puerto Rico and Washington State-Houston). We suggest that the probability of detecting an ionospheric disturbance created by a gamma-ray burst will be significantly enhanced if the burst is observed aligned along a propagation path and is also seen at large zenith angles.

## Correlated Optical Observations with BATSE/CGRO for Sco X-1

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### ABSTRACT

Changes in high and low energy emission are frequently coupled in low-mass X-ray binaries. One can use correlated observations from these different energy regimes to probe the source environment, study its energetics, and examine how mass is transferred within these systems. We have investigated the feasibility of using the 8-16 keV energy channel of the Burst and Transient Source Experiment (BATSE) spectroscopic detectors to perform correlated optical and high energy observations of Sco X-1. In addition to the BATSE 8-16 keV flux values measurable when this source rises and sets with respect to the Earth's limb, it is possible to obtain a rather accurate 8-16 keV light curve while Sco X-1 is above the limb. This latter result requires subtraction of the cosmic background 8-16 keV radiation. Two different techniques, and a brief discussion of their limitations, are presented for performing this subtraction. Examples of 8-16 keV Sco X-1 light curves are presented and compared with those obtained in the optical Johnson B filter. A strong correlation between these signals is noted.

DURABILITY ANALYSIS:  
PROBLEMS INVOLVING COMBINED LOADING

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NASA Headquarters in Iuka, Mississippi, organized the Tri-State Education Initiative for the tri-state area. Community college teachers from the tri-state area were selected to participate in the Summer Faculty Fellowship Program. A variety of problems have been examined in order to gather as much "real" world experience as possible to take back to the classroom.

The first problem was to determine the capability of a ground support equipment knee bracket for handling a spacelab rack. This problem was solved using simple static procedures. The second problem was to determine the exact margin of safety for an axial and shear load on a bolt. This problem was set up using calculus to minimize the distance. A seventh degree polynomial resulted, and it was decided further study was needed. The third problem was to simplify an expression for stress on a generic non-symmetrical bolt configuration to a form familiar to "bolt people." This was done using algebra. The final problem was the structural analysis of the spacelab rack corner posts. The analytical procedure for the sample test specimen, a front corner post, is believed to be complete. Problems with the actual test specimens prevent executing the tests before completion of the summer program.

A PROCESS FOR PROTOTYPING ONBOARD PAYLOAD DISPLAYS FOR  
SPACE STATION FREEDOM

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The Mission Operations Laboratory at the Marshall Space Flight Center is interested in a cost-effective way to develop requirements for the onboard payload displays for Space Station *Freedom*. Rapid prototyping allows a designer to generate effective displays in a short amount of time, to experiment with different interface approaches, and to evaluate the displays with end users. This in turn keeps development costs down by iteratively refining the interface during the requirements definition phase, thus minimizing changes that need to be made during and after flight code development. The purpose of this report is to present an efficient Human-Computer Interface Prototyping Process. This prototyping process includes methodologies for gathering and refining operations and end user requirements, approaches to display design, and techniques for the static and dynamic evaluation of the Human-Computer Interface. An architecture for carrying out this process is also presented.

DEVELOPMENT OF VENDOR EVALUATION CRITERIA AND  
POST-IMPLEMENTATION CONSIDERATIONS FOR  
MSFC CENTER-WIDE EXECUTIVE INFORMATION SYSTEM

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In 1992, development began on a Center-Wide Executive Information System for the Marshall Space Flight Center. Central to this effort is the selection of an appropriate EIS application development software. An analysis was conducted to develop a means of properly assessing commercial off-the-shelf software packages under consideration. The intent of the study is to provide the Information Systems Office with an overall evaluation strategy, including detailed criteria, that will quantitatively gauge vendor responses to user requirements. The recommended technique encompasses subordinate technical, cost and risk assessments for any vendor product considered functionally acceptable. An analysis of relevant post-implementation EIS considerations was also conducted. This second analysis included recommendations concerning data availability and integrity; corrective actions and enhancements; system evolution and migration; and security issues.

ON THE CONSEQUENCES OF BI-MAXWELLIAN  
PLASMA DISTRIBUTIONS FOR PARALLEL ELECTRIC FIELDS

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The presence of anisotropic plasma distributions, trapped at the earth's magnetic equator, has consequences for the electric field structure which must exist in equilibrium along the magnetic field line. Data from SCATHA and Dynamics Explorer 1 indicate that the core ion distributions at the magnetic equator can be well-described as bi-Maxwellian distributions, with a perpendicular temperature an order of magnitude larger than the parallel temperature. The core electron anisotropy is generally low, and the resulting electric field of  $\sim 0.1 \mu\text{V/m}$  is pointed away from the equator. The self-consistent electric field can never overcome the effects of magnetic trapping, however, and the resulting potential distribution results in a local maximum in total plasma density at the equator.

SIMULATION OF CRYOGENIC  
TURBOPUMP ANNULAR SEALS

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Mechanical vibration can impose a limiting constraint on the performance levels achieved by a cryogenic turbopump, and can be a source of mechanical degradation in the pump itself. Proper design of the annular damper seals in these pumps is an essential step for reducing vibrations, as well as for improving efficiency by reducing leakage. Simulation software for seal analysis was developed to aid in the design of annular seals. Many important capabilities are contained in this software including effects of variable profile in the axial and circumferential directions, both Moody and Hirs friction factor models, eccentricity and preload. The software is being utilized for designing an effective damper seal for the Alternate Turbopump Development (ATD) LOX pump.

# THE KAPPA DISTRIBUTION AS A VARIATIONAL SOLUTION FOR AN INFINITE PLASMA

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A variational approach is used to identify the preferred steady state of an infinite, collisionless plasma. The criterion is that a plasma will tend to the steady state that when perturbed from equilibrium will change the least. Using an electrostatic perturbation, quasi-linear theory is used to find that the criterion translates to a statement that the preferred steady state is one for which damping is maximized. Subject to physical constraints, a variational solution exists in the limit of vanishing wave number, with a kappa distribution as the result. The absolute maximum in damping occurs for kappa tending to  $3/2$ .

STUDIES OF THE CHARGING OF A  
THIN DUST LAYER IN A PLASMA

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A plasma particle simulation code originally developed by G. R. Wilson has been modified and extended for continued studies of the electric-field structure, charge distribution and dynamics of a thin dust layer embedded in a proton-electron plasma. A major feature of the model is the presence of relatively large electric fields, sufficient to redistribute the dust as a function of position in the layer. Since the code in its original form requires excessive CPU time, some effort has been directed at increasing the convergence rate of the code and ensuring accuracy. The Wilson model has been extended to include two effects, 1) the assumption of a dust-size distribution instead of the simpler assumption of a uniform average grain size and 2) the ability of the charged dust particles to move as a result of the forces exerted by the electric fields. When effect 1) is included, the large electric fields and the basic charge structure seen in the single-size case have been found to remain unchanged as prominent features. The reason is that the smallest grains dominate. Effect 2) has not yet been examined in detail but is likely as a candidate both for muting the strength fields and for leading to an understanding of the dynamics of a dust layer such as Saturnian rings. Plasma and dust parameters consistent with the rings of Saturn have been used.

**SEDS1 MISSION SOFTWARE VERIFICATION  
USING A SIGNAL SIMULATOR**

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The first flight of the Small Expendable Deployer System (SEDS1) is scheduled to fly as the secondary payload of a Delta II in March, 1993. The objective of the SEDS1 mission is to collect data to validate the concept of tethered satellite systems and to verify computer simulations used to predict their behavior.

The Program Development Laboratory has developed a data system for the SEDS1 flight which will be used to collect and transmit mission data and to control the application of the tether brake and cutter mechanisms. To provide a means for formally verifying this software, a device has been developed which will simulate input signals monitored by the SEDS Data System during the SEDS1 mission. Furthermore, test sequences have been defined which test the design requirements of the SEDS Mission Software and which emulate both normal and anticipated anomalies which may occur during the experiment.

A test procedures document, MSFC-SPEC-2033, SEDS Software Verification Test Specifications (DM20), has been written. This document incorporates test procedures for using the signal simulator to test the SEDS Mission Software as well as other SEDS software components.

# RELIABILITY ANALYSIS OF EXTERNAL TANK ATTACH RING (ETA)

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## ABSTRACT

This report deals with reliability analysis of the External Tank Attachment (ETA) Ring used as an interface between the External Tank (ET) attach struts and Solid Rocket Motor (SRM). It is part of the Solid Rocket Booster (SRB) and is located at SRB Station 1511.0. It is a critical element of the shuttle, the failure of which could be catastrophic for the functioning and the safety of the shuttle and is, hence, chosen for the reliability study. The ETA Ring has been analyzed using the detailed NASTRAN finite element model and the traditional/conventional margin of safety approach for the ultimate and yield allowable stresses. The finite element model for the ETA Ring consisted of about 10,000 nodes and 20,000 elements. The intent of this study is to arrive at the reliability levels of the ETA Ring for the stress limit state at various critical sections of tunnel splice plate and H-fitting lugs. Reliability levels are calculated both in terms of standard reliability and commonly used safety index ( $\beta$ ) values, which in turn give the distance of the mean limit state function from the failure surface. It is to be noted that the final conclusions of this reliability study will form part of the preferred reliability guidelines/practices being developed in the reliability group with respect to structural testing.

EMERGENCY EGRESS REQUIREMENTS  
FOR  
CAUTION AND WARNING, LOGISTICS, MAINTENANCE,  
AND ASSEMBLY STAGE MB-6  
OF  
SPACE STATION FREEDOM

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The safety and survival of the Space Station and its crewmembers has been a prime concern of NASA. This study was conducted to evaluate the safety and emergency egress requirements for: (a) caution and warning methods; (b) operation of the pressurized logistic modules; (c) maintenance modes of major equipment; and (d) assembly of the Station in space at the Sixth Mission Base (MB-6) Configuration.

The study recommended improvements to the Emergency Monitoring and Distribution System (EMAD) and suggested a graphical cum alphanumeric model for displaying emergency action information at Multipurpose Application Consoles (MPAC). In addition, the study suggested a safe handling method for operation of logistic modules and evaluated the impact of maintenance on emergency egress. Finally, a procedure for emergency egress was suggested for potential emergency scenarios at the assembly configuration MB-6.

ANALYSIS OF WAVES IN SPACE PLASMA (WISP)  
NEAR FIELD SIMULATION AND EXPERIMENT

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Information and Electronic Systems Laboratory  
Computers and Communications Division  
Communication Systems Branch

David P. Harris, MSFC Colleague  
Hubert Gangl, MSFC Colleague

The WISP payload scheduled for 1995 will include a large power transmitter on board at a wide range of frequencies. The levels of electromagnetic interference/electromagnetic compatibility must be addressed to insure the safety of the shuttle crew. This report is concerned with simulation and experiment of the WISP payload in the shuttle cargo bay. The simulations have been carried out using the method of moments for both thin wires and patches to simulate closed solids. The solid body used to simulate the cargo bay has been modeled using the four basic parameters of thickness, area, aspect ratio and the corner dimension (defined in this work). Data obtained from simulation is presented along with an investigation of the accuracy of the modeling approach. The model precision is evaluated by looking directly at the degree that the boundary conditions are satisfied. This is tabulated for a collection of model parameter values. The voltage standing wave ratio (VSWR) is compared with experimental results obtained using a one tenth scale model of the cargo bay in an anechoic chamber.

**INDUSTRY SURVEY OF SPACE SYSTEM  
COST BENEFITS FROM NEW WAYS OF DOING BUSINESS**

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Department of Engineering Technology  
Pittsburg State University  
Program Development Division  
Program Planning Office  
Engineering Cost Group  
Joseph Hamaker MSFC Colleague**

The scope of this project was to survey the aerospace industry for information which would assist in quantifying the reduction in cost, of space system hardware and launch vehicles due to new ways of doing business. A tree chart is included to illustrate the five major categories that make up New Ways Of Doing Business (NWODB) which assist in reducing space system costs. Along with these categories is a list of the specific ideas or techniques that are associated with them. Conclusions and recommendation are discussed.

DESIGN OF A WELDED JOINT FOR ROBOTIC,  
ON-ORBIT ASSEMBLY OF SPACE TRUSSES

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Department of Engineering Mechanics  
The University of Alabama

Structures and Dynamics Laboratory  
Structures Division  
Structural Development Branch

Frank P. Thomas, MSFC Colleague  
Pedro I. Rodriguez, MSFC Colleague

A preliminary design for a weldable truss joint for on-orbit assembly of large space structures is described. The joint was designed for ease of assembly, for structural efficiency, and to allow passage of fluid (for active cooling or other purposes) along the member through the joint. The truss members were assumed to consist of graphite/epoxy tubes to which were bonded 2219-T87 aluminum alloy end fittings for welding on-orbit to truss nodes of the same alloy. A modified form of gas tungsten arc welding was assumed to be the welding process. The joint was designed to withstand the thermal and structural loading associated with an 120 ft. diameter tetrahedral truss intended as an aerobrake for a mission to Mars.

# ELECTROMAGNETIC SCATTERING IN CLOUDS

Richard Solakiewicz

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Department of Mathematics and Computer Science

Chicago State University

Space Science Laboratory

Earth Sciences/Applications Division

Remote Sensing Branch

William Koshak, MSFC Colleague

Richard Blakeslee, MSFC Colleague

Hugh Christian, MSFC Colleague

We report on the development of a model for the scattering of light produced by lightning in clouds. The cloud is assumed to be composed of a uniform distribution of spherical water droplets. Furthermore, we assume that the cloud has a spherical shape and is isolated. Green's functions are obtained for sources modeled as Hertz dipoles outside and inside a sphere after transformation to the frequency domain. Solution of the problem for a dipole outside a sphere (a water droplet) may be used to obtain equivalent bulk parameters inside the cloud. The solution for a source inside the sphere may then be constructed by superposition. Time domain results for an impulsive source are recovered in a symbolic form.

## ABSTRACT

### RELIABILITY EVALUATION METHODOLOGY FOR NASA APPLICATIONS

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Analysis Branch

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In this paper we develop an overall evaluation process which predicts reliability during design and verify it during development and verification. The work completed is intended to predict and verify reliability of the Space Transportation Main Engine (STME). The reliability verification involves prediction techniques which incorporate historical data bases, expert opinion and engineering analysis to predict reliability during the design phase. The predicted reliability is then verified using the Design of Experiments (DOE) technique and other tools during the development and certification phases. The verification process includes first verifying assumptions and resolve concerns raised during the design prediction phase, and then applying Bayesian analysis to verify the system reliability.

The reliability evaluation process described in this paper provides a continuous improvement approach to "Design In" reliability. It also provides a tool to identify and prioritize high risk failure modes during design and development. The design reliability prediction process assist in identification of critical design parameters and needed process controls, tests, and inspections. The verification process provides ways to enhance the effectiveness of development test program. Finally, the process could be used to establish a database of information to assist in later programmatic decisions. To summarize, the above described process provides tools for design engineers and program managers to improve and track reliability through the program.

ACCELERATION OF FDNS FLOW SIMULATIONS  
USING INITIAL FLOWFIELDS GENERATED  
WITH A PARABOLIZED NAVIER-STOKES METHOD

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A parabolized Navier-Stokes method is presented and used to compute approximate flowfields for the starting condition of the FDNS flow simulation code. The front-end program uses the standard FDNS input and output, but generates a solution with a single space-marching pass. Reduction in FDNS execution time is evaluated for incompressible flow through a 180 degree turn-around-duct and over a backward-facing step. Both laminar and turbulent flow are considered. The parabolized method produces good estimates for laminar flow, which reduces the FDNS execution time by 20% to 80% depending on the grid and flow geometry. Much smaller reductions, on the order of 10%, were achieved for turbulent flow. The flow initialization code is of practical use as a pre-processor to reduce the engineering time needed to set up a FDNS case.

CONTROL-STRUCTURE-THERMAL INTERACTIONS  
IN ANALYSIS OF LUNAR TELESCOPES

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The Pennsylvania State University

Program Development Office  
Subsystems Design Division  
Guidance, Navigation, and Control Branch

Connie Carrington, Ph.D., MSFC Colleague

A concurrent engineering approach to the design and analysis of spacecraft is presented. Although the approach is very general, and can be applied to a number of different projects, the research focused specifically on the subject of lunar telescopes. The lunar surface has many advantages as a location for the placement of telescopes, chief among them is the lack of an atmosphere and a massive, stable platform for pointing control and tracking of celestial objects. There are also very serious disadvantages, the most significant being the large thermal variations that occur. A telescope is a very sensitive instrument; a few microns of displacement over the surface of the mirrors can render the device useless, and thermal distortions of the mirrors will be a substantial problem that must be overcome. Consequently, the Control-Structures-Thermal Interaction (CSTI) study was initiated to develop an analysis tool which could be used in the design of space structures in which control-structural-thermal interactions will be significant. The objective is to develop a procedure that integrates, as tightly as possible, analytical methods and computer software from each of the fields in which interactions are to be considered (i.e. active control systems, structural dynamics, and thermal loading). Individual tasks of the procedure are: develop a finite element model of the structure, determine the temperatures of the nodes, perform a modal decomposition of the static displacement pattern, and introduce the thermal displacements as an equivalent disturbance force in the control system. A commercially available code was used for the finite element and thermal modeling, and a different software package was used for the control system simulations. Some of these codes had never been applied to structures as complex and sensitive as a lunar telescope; consequently, simple beam and truss models were used initially to develop the techniques that comprised each step of the process and to debug the software. Finally prototype telescope models were analyzed with this procedure; but very simple models were used at this stage to reduce the size of the data files and to keep computation time within reasonable limits. By analyzing the displacement pattern generated by the thermal environment and examining the response of the control system, at each stage in the development of the telescope, improved performance of the structure, thermal controls, and active control system can be determined. Consequently, the CSTI study was developed as a technique by which analysts in the very different fields could share results and iteratively refine the design of the subsystems by working more interactively. With the tools developed in the CSTI study, important issues in each field that will affect the other subsystems can be addressed at an early stage in the project, before the configuration is fixed, by analyzing the interactions of the systems at an appropriate level of detail.

## STIFFNESSES BY (HtN) ENSEMBLE MOLECULAR DYNAMICS

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Office: Science and Engineering  
Division: Materials and Processing

Ilmars Dalins, Ph.D., MSFC Colleague

Defects and interfaces defined on the atomic level, but having macroscopic extent in one or two dimensions, determine many of the macroscopic properties of materials. Modifications of material properties by such phenomena, including grain boundaries, stacking faults, dislocations, interphase boundaries and surfaces, are observable in computer experiments by molecular dynamics. Reformulation of the algorithms implemented in a molecular dynamics computer code included modification of Newton's equations of motion for molecular dynamics, modification of energy calculation for energy minimization, and inclusion of new routines for calculation of  $\sigma$  and  $\epsilon$  fluctuations. Reformulation of the FORTRAN implementation included enabling the use of all available interatomic potentials, improvements to memory management and data flow, and improvements to program documentation. Available interatomic potentials vary greatly in the structure and size of the lookup tables for interpolation. Inclusion of data structures for each type of potential enabled selection of the potential by setting an input variable. Improvements to memory management and data flow included eliminating common blocks, and implementing all data flow through argument lists. Improvements to documentation included writing a descriptive header for each module describing its algorithm and I/O parameters.

1992

NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM

UPT SCENARIOS - IMPLICATIONS FOR SYSTEM RELIABILITY

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Metallic Materials Division  
Corrosion Branch

Merlin Danford, Ph.D., MSFC Colleague

This project treated the corrosion resistance of 316L stainless steel in several urine pre-treat solutions. Four solutions were examined - untreated urine (control), urine pretreated with oxone (potassium peroxymonosulfate sulfate), urine pretreated with sodium hypochlorite (NaOCl) and urine pretreated with ozone (O<sub>3</sub>). In accordance with current procedures, all solutions but the control were acidified to a pH of 2.5 using sulfuric acid - this suppresses the generation of ammonia in the solutions and is intended to limit microbial growth. Welded and unwelded coupons were exposed to each solution. In addition, Titanium coupons (welded and unwelded) were exposed to biologically active environmental control and life support system (ECLSS) water. Microbial attachment and biofilm growth were monitored. Ozone was examined as a biocide/oxidizer/corrosion preventative (simultaneous addition) and as a remediation method (added one week after exposure). Corrosion rates and surface morphologies were studied. The results of this investigation indicate that:

- urine pretreatment diminishes the corrosion rate in 316L
- the corrosion rates in welded samples are an order of magnitude greater than corresponding base metal samples
- localized colonies of bacteria are associated with weld fusion zone and HAZ structures in all pretreatments but ozone
- localized corrosion could be damaging, even at low overall corrosion rates
- ozone removed established biofilms on Ti surfaces

**THERMOSTRUCTURAL RESPONSES OF CARBON PHENOLICS  
IN A RESTRAINED THERMAL GROWTH TEST**

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Ann N. Puckett, MSFC Colleague

**ABSTRACT**

The occurrence of anomalous performance of carbon phenolic components has been an indication of technical shortfalls in the design and manufacturing of solid rocket motor (SRM) nozzles. Each anomaly was followed by investigations under RSRM program. In addition, certain SPIP programs were initiated to address these anomalies. To support consolidation and assimilation of the knowledge acquired from these programs, a literature search on testing reports was conducted and a bibliography was developed. A study based on the concept of engineering process development was used to correlate the failure mechanisms with thermostructural responses of carbon phenolics, and critical material properties for these anomalies were investigated. Restrained thermal growth (RTG) testing, simulating the rocket flight environment, was used to study the thermostructural responses of a series of carbon phenolics. Characteristics of RTG responses in three temperature regions, corresponding to three thermochemical states, were examined. The combined, dominant effects of across-ply coefficient of thermal expansion (A/P CTE), in-plane permeability, and internal gas pressure on RTG responses were investigated. Investigation into the critical role of gas permeability in failure mechanisms was explored. Further research work in the interrelationships between these three dominant factors, as well as the role of resin-fiber bonding in failure mechanism are recommended.

# NATURE OF FLUID FLOWS IN DIFFERENTIALLY HEATED CYLINDRICAL CONTAINER FILLED WITH A STRATIFIED SOLUTION

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Space Science Lab  
Electronic & Photonic Materials/ES 75  
Microgravity Science & Application/ES 71

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In this investigation, we have studied nature of fluid flows of a stratified solution in a cylindrical container. The cylindrical container wall is considered to be maintained at a constant higher temperature than the middle of the solution and the solution in the lower gravitational direction has a higher concentration than that in the higher gravitational direction. The formulation given by J. E. Hart for a parallel-plates geometry has been followed to obtain the governing equations of momentum, mass, heat and solute in the cylindrical coordinates for the system. An initial equilibrium state consisting of linear variations of temperature and composition is considered. A finite element method simulation program, FIDAP, developed by Fluid Dynamics International, Inc. has been adapted to simulate the buoyancy driven fluid flow convection. Preliminary results have been obtained. These results show that convection affects the solute field much more than it does the temperature field. This is due to the fact that the diffusion of heat takes place much faster than the diffusion of solute. Analytical solution and numerical simulation will be continued to study the stability conditions against thermal solutal convection and to obtain approximate solution to the linearized stability problem to assess the effect of various parameters on flow velocity and stability conditions.

AN EXPERIMENT TO STUDY  
FULLERENE FORMATION UNDER  
REDUCED GRAVITY

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Microgravity Science and Applications Division  
Electronic and Photonic Materials Branch

Peter Curreri, Ph.D., MSFC Colleague

The experiment for which key components have been constructed will investigate the formation of the carbon species known as fullerenes and represented by  $C_{60}$  and  $C_{70}$ , in an electric arc in a helium atmosphere while under reduced gravity afforded by the KC-135 aircraft. The rationale for carrying out such research is that convective transport occurs when the processing occurs at normal gravity. An electromechanical actuator for controlling the carbon arc and a time-resolving sampler have been constructed. Besides the experimental aspects of the project, a model that suggests reducing convective transport by reducing effective gravity will enhance fullerene production, has been conceived. Being able to alter the scale of convection should result into the process by which fullerenes are formed and may assist in improving the efficiency of production with subsequent reduction in cost of this now very expensive material. Fullerenes have demonstrated interesting potential as 3-dimensional high temperature superconductors, encapsulators of atoms, being optically nonlinear, selective absorbers of oxygen, being a new base for organic chemistry, etc.

## NEURAL NETWORK ARCHITECTURES TO ANALYZE OPAD DATA

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The space shuttle main engine (SSME) became the subject of plume emission spectroscopy in 1986. Since then, plume spectral acquisitions have recorded many nominal tests and the qualitative spectral features of the SSME plume are now well established. Significant discoveries made with both wide-band and narrow-band spectroscopy systems led MSFC to promote the Optical Plume Anomaly Detection (OPAD) program with a goal of instrumenting all SSME test stands with customized spectrometer systems. OPAD data analysis efforts to determine how much of a specie (or element) is present in the plume and where it came from require the processing of a massive database. Thus, OPAD data analysis is an incredibly labor intensive task and not one to be performed by hand. To address this need of the OPAD system, a study was conducted into how artificial neural networks could be used to assist in the analysis of plume spectral data.

Four neural network architectures were considered in this study. Traditional neural networks, fuzzy neural networks, probabilistic neural networks, and entropy networks were all found to have qualities which could quickly analyze OPAD data. Unfortunately, there are no reliable rules for selecting neural network architectures for a given problem. With no basis for eliminating any of the network types, a systematic evaluation procedure was recommended. First, an investigation should be undertaken to construct neural networks of the various architecture types discussed and then train each one on a simplified subset of OPAD data to learn how network behavior and architecture interact. Items to be looked at should be ease of training, final size of the trained network, generalizability, and accuracy and speed of predictions. Once each of the network types has been studied using a simplified set of data, they should be trained and evaluated using full sets of OPAD data. A parallel research effort into developing new network architectures should also be conducted since the neural network architectures considered may not be entirely appropriate for the OPAD system. By combining some of the architectures it may be possible to develop a neural network which is, in essence, customized for OPAD data analysis.

COMPUTERIZED REDUCTION OF ELEMENTARY REACTION  
KINETICS FOR CFD COMBUSTION MODELING

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University of Arkansas

Propulsion Laboratory  
Propulsion Systems Division  
Performance Analysis Branch

Charles Schafer, Ph.D, MSFC Colleague

A procedure for automatically reducing elementary reaction kinetics for a particular problem was developed in Summer 1991 under this program. The procedure is to be tested in cells from a computational solution which contains sufficient variation in conditions that different reduced mechanisms might result from calculations from different cells from a CFD calculation. A two-phase CFD modeling of the F-1 engine, with its locally varying mixture ratio and complicated hydrocarbon combustion chemistry was selected as the next test case for the procedure. The two-phase solution was obtained and large variation of conditions with the computational grid were found. The actual selection of cells and testing of the procedure is yet to be performed.

# THE INNER MAGNETOSPHERIC IMAGER (IMI): INSTRUMENT HERITAGE AND ORBIT VIEWING ANALYSIS

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The Inner Magnetospheric Imager (IMI) Engineering Working Group  
Program Development Office

Les Johnson, MSFC Colleague  
Dennis Gallagher, MSFC Colleague

The proposed Inner Magnetospheric Imager will attempt to obtain global images of select regions of the inner magnetosphere (plasmasphere, ring current, inner plasmasheet, geocorona, and aurora) with sufficient time resolution so as to observe a number of important magnetospheric processes. A wide range of imaging instrument technology will be needed for this mission. The strawman instrument compliment, as identified by the science working group, includes: (1) a high angular resolution vacuum ultraviolet (1304 Å, 1356 Å, LBH bands) auroral imager, (2) a Lyman- $\alpha$ , proton aurora, imaging spectrograph, (3) an electron aurora, bremsstrahlung x-ray imager, (4) a He<sup>+</sup> 304 Å plasmasphere imager, (5) an O<sup>+</sup> 834 Å imager (for the plasmasphere, polar cap region, sunlit ionosphere, etc.), (6) a hydrogen geocoronal imager (1216 Å), (7) an energetic neutral atom imager (ring current), and (8) a low energy neutral atom imager (ring current, inner plasmasheet). During this summer the current state of the technology relevant to these various instruments was assessed. It was found, surprisingly, that much of the technology needed for IMI is in place, despite the mission's novelty. Although this mission is not scheduled to fly until the year 2000, in the next two years the flights of POLAR (carrying a VUV auroral imager, an x-ray auroral imager, and an instrument with ENA capabilities), a sounding rocket with a 304 Å plasmasphere camera (WIDGET), the SAC-B satellite (with an ENA camera called ISENA) and the JASPR sounding rocket (with a proton aurora spectrographic imager) will test and further refine much of the basic technology for IMI.

In addition to researching IMI instrument heritage, a study of the viewing characteristics of various proposed IMI orbits was also conducted. The goal was to determine which orbit offered the best overall spacecraft location, over the life of the mission, from which to see the various magnetospheric regions. It was found that an orbit inclined at 90° with a perigee altitude of 4844 km, an apogee altitude of 7 R<sub>c</sub>, and an initial argument of perigee of 290° would provide the best viewing during the nominal two year life of the spacecraft.

# Analysis of Film Cooling in Rocket Nozzles

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Combustion Devices Group  
Component Development Division  
Dave Sparks, MSFC Colleague

## Abstract

Conventional liquid rocket engine designs employ regenerative cooling to protect the nozzle from the engine's high temperature exhaust gases. In regenerative cooling, unburned engine fuel flows through an array of tubes, which constitute the nozzle body, on its path to the combustion chamber. However, the Space Transportation Main Engine (STME) will utilize a combination of film cooling and convective cooling rather than conventional regenerative cooling. In film cooling, a thin layer of relatively cool gas is injected along the wall to protect the nozzle body from the high temperature exhaust gases. Film cooling, having been less frequently utilized historically, is outside of NASA's experience base, and is being studied both analytically and experimentally as part of the STME development.

This report details the progress made in constructing a CFD model to predict the heat transfer to the wall in a film cooled rocket nozzle. Specifically, the objective of this work is to use the NASA code FDNS to predict the heat transfer which will occur during the upcoming hot-firing of the Pratt & Whitney 40k subscale nozzle.

Before using the code to perform the desired calculations, its effectiveness in predicting film cooling effects will be evaluated by performing benchmark calculations against the Holden wall jet Case #45 [1]. As a further measure of the code's usefulness in computing wall heat fluxes, FDNS will be used to compute the wall heat transfer from the Pratt & Whitney 40K calorimeter chamber, which was hot-fired in September, 1990.

# **STRESS ANALYSIS AND DAMAGE EVALUATION OF FLAWED COMPOSITE LAMINATES BY HYBRID-NUMERICAL METHODS**

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Tuskegee University**

**Material Processes Laboratory  
Engineering Physics Division  
Non-Destructive Evaluation Branch**

**Samuel Russell, Ph.D., MSFC Colleague**

**It is important to know how structural components of flight vehicle can be used and survived with flaws and initial damages. Since composite laminates have been frequently used in flight vehicles, the major goal of this report is to investigate the stresses and failure of composite laminates with defects. A Hybrid-Numerical approach has been proposed to correct the inefficiency of experimental methods. In which Finite Element analysis is applied only at local areas with the measured displacement data as input boundary conditions. It reflects the actual situation in experiments and services. So that the stress field can be precisely analyzed, and the failure can be predicted. Examples of quasi-isotropic and cross-ply laminates with small central hole and impact damage have been investigated. Preliminary results has shown an excellent agreement with the observation in experiments.**

NOTE: 18 of 19 questionnaires were returned.

SUMMER TEACHER ENRICHMENT PROGRAM

JUNE 15 - AUGUST 7, 1992

TEACHER EVALUATION QUESTIONNAIRE

NAME \_\_\_\_\_

LABORATORY/DIVISION/BRANCH \_\_\_\_\_

MSFC COLLEAGUE \_\_\_\_\_

Please evaluate your eight-week STEP experience as completely as possible by answering the following questions:

1. Did you become familiar with the objectives of the research (laboratory) division you worked with this summer?

Very much so 13  
Somewhat 5  
Minimally \_\_\_\_\_

2. Do you feel that you were engaged in research/work of importance to the Marshall Center and to NASA?

Very much so 13  
Somewhat 5  
Minimally \_\_\_\_\_

3. Is it likely that you will remain in contact with the NASA colleagues with whom you have worked this summer during the coming school year?

Very much so 11  
Somewhat 4  
Minimally 3

4. Is it likely that you will remain in contact with some/all of your fellow STEP participants during the coming school year?

Very much so 12  
Somewhat 6  
Minimally \_\_\_\_\_

5. Did your NASA colleague(s) make an effort to fit you into the routine of the lab and provide you with ample, productive work?

Very much so 15  
Somewhat 3  
Minimally \_\_\_\_\_

6. To what extent do you think your interests and capabilities have been affected by this summer's STEP experience? You may check more than one.

Reinvigorated	<u>17</u>
Redirected	<u>10</u>
Advanced	<u>11</u>
Just Maintained	<u>          </u>
Unaffected	<u>          </u>

7. How strongly would you recommend this program to your faculty colleagues as a favorable means of advancing their personal professional development as teachers?

With enthusiasm	<u>18</u>
Positively	<u>1</u>
Without enthusiasm	<u>          </u>
Not at all	<u>          </u>

8. How will this experience affect your teaching in ways that will be valuable to your students? (you may check more than one)

By integrating new information into courses	<u>18</u>
By starting new courses	<u>8</u>
By sharing the experience with your colleagues	<u>18</u>
By relating career opportunities	<u>18</u>
By deepening your own grasp and enthusiasm	<u>17</u>
Will affect my teaching little, if at all	<u>          </u>

9. Were the education course requirements reasonable?

Very much so	<u>10</u>
Somewhat	<u>8</u>
Minimally	<u>          </u>

10. Is the development of the education activities and products a positive aspect of the STEP experience?

Very much so	<u>15</u>
Somewhat	<u>3</u>
Minimally	<u>          </u>

11. Is the amount of time allocated each day to project development (group work) adequate?

Very much so	<u>14</u>
Somewhat	<u>2</u>
Minimally	<u>          </u>

12. Is the daily schedule of working in the lab in the morning and working on the education project in the afternoon a good arrangement? (Alternative suggestions can be made in either item 25 or 26.)

Very much so 2  
Somewhat 7  
Minimally 7

13. Did your group have a room/workspace available in a lab for afternoon group meetings?

Very much so 4  
Somewhat 4  
Minimally 9

14. Did you find the weekly seminars beneficial and worthwhile?

Very much so 16  
Somewhat 2  
Minimally           

15. Was the interaction with the Summer Faculty Fellows at the weekly seminar/lunch a positive aspect of STEP?

Very much so 14  
Somewhat 3  
Minimally 1

16. Did you find the Education Retreat to be an experience worthy of taking time away from your lab assignment and group work?

Very much so 16  
Somewhat 2  
Minimally           

17. Is the opportunity to view a Shuttle launch a positive aspect of STEP, even though you pay your own expenses?

Very much so 16  
Somewhat             
Minimally           

18. Was the housing and programmatic information supplied prior to the start of this summer's program adequate?

Very much so 10  
Somewhat 5  
Minimally

19. Is the amount of the stipend, moving allowance, and travel expense reimbursement adequate?

Very much so 13  
Somewhat 4  
Minimally           

20. Were the quantity and variety of education materials and other publications that you received adequate?

Very much so 17  
Somewhat 1  
Minimally           

21. Did you find the field trip to Iuka, MS, educational, informative, and worthy of remaining part of the STEP agenda?

Very much so 10  
Somewhat 2  
Minimally             
Did not participate 5

22. Did you find the social functions that were planned throughout the summer a positive aspect of the program?

Very much so 14  
Somewhat 3  
Minimally 1  
Did not participate           

23. What is your overall evaluation of the program?

Excellent 15  
Very Good 3  
Good             
Fair             
Poor           

24. Participation in the second year of STEP is by invitation. How do you feel about returning to the Marshall Center next summer to participate in STEP again? (for first-year participants)

Would definitely return if invited 13  
Would consider returning if invited 2  
Would not wish to participate again

25. Please comment on the areas of the program that you feel need improvement, and make suggestions that will help us to plan the program for next summer.

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26. Please add any other comments.

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NOTE: 15 of 19 questionnaires were returned. Questionnaires for one second-year and three first-year teachers were not returned

**SUMMER TEACHER ENRICHMENT PROGRAM (STEP)  
MSFC COLLEAGUE EVALUATION QUESTIONNAIRE**

NAME OF MSFC COLLEAGUE \_\_\_\_\_

LABORATORY/DIVISION/BRANCH \_\_\_\_\_

NAME OF STEP TEACHER ASSIGNED TO YOU \_\_\_\_\_

Note: The Summer Teacher Enrichment Program serves to enhance the scientific and technical knowledge of the teachers by providing a setting in which they can:

- Acquire information about state-of-the-art technologies;
- Learn about the activities that are supported by the seven laboratories at MSFC;
- Experience the reality of a scientist's or engineer's profession in a laboratory setting;
- Interact with NASA experts, Summer Faculty Fellowship Program participants, and other STEP participants to stimulate an exchange of ideas and educational information;
- Use the information gained and the resources acquired to improve science and math education;
- Develop lesson plans and activities that will motivate student interest in math, science, and technology, and illustrate the many careers that are available in the fields of math, science, and engineering.

In view of these objectives and the time frame (8 weeks) of the program, please evaluate the program by answering the following questions.

STEP Participant

1. Was the education background and experience of the STEP participant appropriate for his/her assignment?

Very much so	<u>12</u>
Somewhat	<u>1</u>
Minimally	<u>2</u>

2. Was the participant assigned to you eager to learn about NASA and the activities in your lab/office?

Very much so 14  
Somewhat 0  
Minimally 1

3. Did the participant exhibit professionalism while working in your lab/office?

Very much so 15  
Somewhat 1  
Minimally 1

4. Did the participant make an effort to "fit into the routine" of your lab/office and to make a worthwhile contribution?

Very much so 15  
Somewhat 1  
Minimally 1

5. Was the participant cooperative in completing the tasks that were assigned to him/her?

Very much so 15  
Somewhat 1  
Minimally 1

6. Was there good rapport between the participant and other lab/office personnel?

Very much so 14  
Somewhat 1  
Minimally 0

7. The STEP participants were expected to be in the lab/office for five hours (mornings) Monday through Wednesday, and Friday. Was the participant reliable and responsible?

Very much so 15  
Somewhat 1  
Minimally 1

8. Were you able to provide ample tasks to make the participant feel productive and useful in the lab/office?

Very much so 14  
Somewhat 1  
Minimally 0

9. Please evaluate the effect that the STEP participant's presence and the quality of his/her work had on your lab/office during the eight-week period.

Positive influence 15  
No influence 2  
Negative influence 0

10. Would you recommend that the participant be assigned to your lab/office for a second summer? (Applies only to first-year STEP participants)

Yes 10  
No 0  
N/A 5

Program

1. In view of the program objectives (see first page), is STEP an effective means of stimulating an exchange of ideas among pre-college teachers, university faculties, and NASA?

Very much so 15  
Somewhat 0  
Minimally 0

2. Do you view the STEP program as an effective instrument through which pre-college teachers can acquire information about state-of-the-art technologies; gain experience in a laboratory setting; and have access to resources, all of which can be used to motivate student interest in math, science, and engineering?

Very much so 15  
Somewhat 0  
Minimally 0

3. Did the basically one-half day in the laboratory/office (mornings) present any problems to the laboratory/office or hamper the completion of tasks assigned to the participant?

Very much so 1  
Somewhat 8  
Minimally 6

4. Was the availability of space (desk, phone, computer, etc.) for a STEP participant a problem in your lab/office?

Very much so 2  
Somewhat 8  
Minimally 5

5. In addition to their lab/office assignments, the STEP participants worked (afternoons) in teams to develop curriculum materials. Was space (conference room, office, etc.) for daily afternoon group meetings for STEP participants available in your lab/office?

Very much so 1  
Somewhat 5  
Minimally 9

6. Do you think that the split of the STEP teacher's time (20 hrs/week in the lab/office and 20 hrs/week developing curriculum materials) was the right mix?

Very much so 1  
Somewhat 11  
Minimally 3

7. The time distribution in 1992 was as follows:  
Monday-Wednesday  
5 hrs. lab/3 hrs. curriculum development;  
Thursday  
8 hrs. curriculum development and seminar;  
Friday  
5 hrs. lab/3 hrs. curriculum development.

How would you like to see their time split?

COMMENTS:

1. Perhaps use two full days for curriculum development and three full days in laboratory
2. 60/40 to 70/30 lab
3. More time available for lab work
4. Looks OK to me
5. Alternation of the time slots for lab time and curriculum development may give the teachers an opportunity to view project stages, as well as the lab setting itself, at differing times of the day.
6. 5 hrs. daily lab--3 hrs. curriculum development

7. Continued...

7. Full days in the lab might prove more useful, however it is probably task specific.
8. Because of the types of activities ongoing in our microbial ecology facility it would have been useful for the STEP teacher to spend whole days in the lab. Certain activities begun in the morning require a full day for completion. For example, 2 whole days (8hrs. ea.) and one half-day in the lab is a suggestion.
9. Curriculum development requirements are determined elsewhere, so can't comment
10. MWF 5 hrs lab/3hrs. c.d.  
T 8 hrs lab  
Th 8 hrs c.d. and seminar
11. I believe that this worked fine and should be tried again.
12. As the NASA colleague, this was no factor. Probably need to get inputs from STEP participants' point of view. Generally labs or offices can easily adapt to their schedules.
13. No preference
14. 3 days of lab work M-W 24 hrs.  
2 days of curriculum T-F 16 hrs.
15. No comment