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NASA/AMERICAN SOCIETY FOR ENGINEERING
EDUCATION (ASEE) SUMMER FACULTY
FELLOWSHIP PROGRAM 1986

John H. Spencer (Compiler)

HAMPTON UNIVERSITY
Hampton, Virginia

FOR REFERENCE

NOT TO BE TAKEN FROM THIS BOOK

NASA

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

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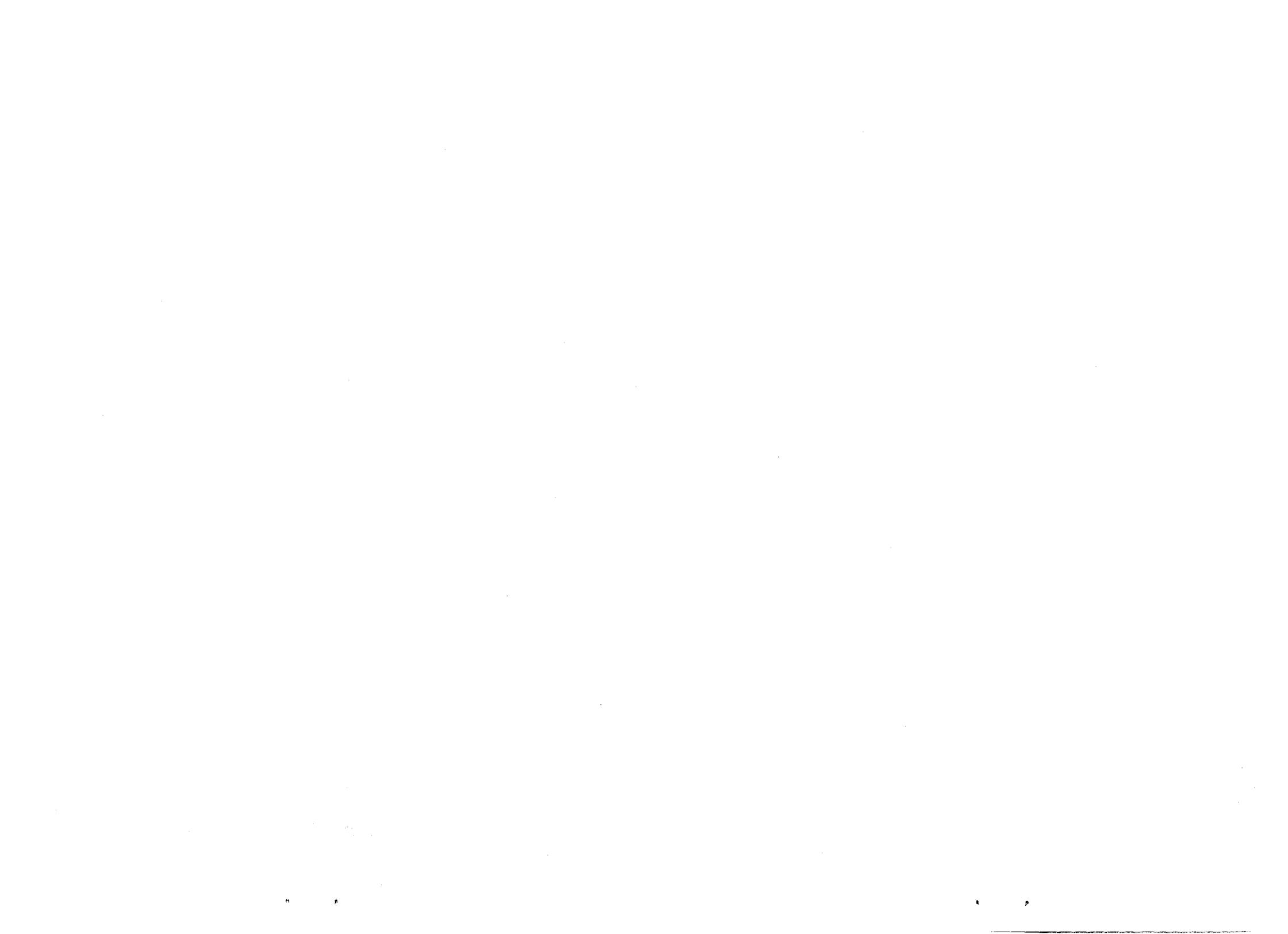
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Section I

ORGANIZATION AND MANAGEMENT

The 1986 Hampton University-NASA-Langley Research Center Summer Faculty Research Program, the twenty-third such institute to be held at the Langley Research Center, was planned by a committee consisting of the Co-Director, Langley staff members from the Research Divisions and the Office of University Affairs. It was conducted under the auspices of the Langley Research Center Chief Scientist Mr. Jerry C. South, Jr.

Each individual applying for the program was provided a listing of research problems available to the Langley Fellows. Each individual was requested to indicate his or her problem preference by letter to the University Co-Director. The desire to provide each Fellow with a research project to his/her liking was given serious consideration.

An initial assessment of the applicant's credentials was made by the NASA-Langley University Affairs Officer. The purpose of this assessment was to ascertain to which Divisions the applicant's credentials should be circulated for review. Each application was then annotated reflecting the Division to which the applications should be circulated. After the applications had been reviewed by the various divisions, a committee consisting of staff members from the various Divisions, the University Affairs Officer and the University Co-Director met. At this meeting the representatives from the various Divisions indicated those individuals selected by the Divisions.

The University Co-Director then contacted each selected Fellow by phone extending the individual the appointment. The University Co-Director also forwarded each selected Fellow a formal letter of appointment confirming the phone call. Individuals were given ten days to respond in writing to the appointment. As letters of acceptance were received, the University Affairs Officer contacted the various Directorate Technical Assistants advising them of their Fellows for the summer program.

Each Fellow accepting the appointment was provided material relevant to housing, travel, payroll distribution and a listing of all NASA-Langley Research Fellows. Each Fellow, in advance of commencing the program, was contacted by his or her Research Associate or a representative of the branch.

At the assembly meeting, Dr. Samuel Massenberg, the NASA-Langley University Affairs Officer, introduced the Langley Research Center Chief Scientist, Mr. Jerry South, Jr., who formally welcomed the Summer Fellows. Mrs. Jane Hess, Head, Technical Library Branch, then briefed the Fellows on the use of the library. Mr. Richard Meeks, Manager, Langley Research Cafeteria, briefed the Fellows relevant to the cafeteria policies, hours, etc. Mr. Samuel McPherson, III, of the Computer Management

Branch briefed the Fellows on the Computational Facilities. The subject of security at the Langley Research Center was discussed by O. J. Cole, Chief, Security Branch. Further instructions were given and information, disseminated by Dr. Samuel Massenberg and Professor John Spencer, Director, ASEE Program.

Throughout the program the University Co-Director served as the principal liaison person and had frequent contacts with the Fellows. The University Co-Director also served as the principal administrative officer. At the conclusion of the program, each Fellow submitted an abstract describing his/her accomplishments. It has long been felt that the marathon of presentations by the research fellows stretched over a two to three day period was a bit strenuous. It was decided by the University Co-Director and the University Affairs Officer to try a new system. Each Fellow gave a talk on his/her research within the division. The Research Associate then forwarded to the Co-Director the name of the person recommended by the division for the final presentation. Nine excellent papers were presented to the Research Fellows, Research Associates and invited guests. The presentations were all given in less than one day rather than the usual two to two and one-half days.

Each Fellow and Research Associate was asked to complete a questionnaire provided for the purpose of evaluation of the summer program.

Section II

RECRUITMENT AND SELECTION OF FELLOWS

Returning Fellows

An invitation to apply and participate in the Hampton University-Langley Research Center Program was extended those individuals who held previous Langley Fellow appointments. Thirty individuals responded to the invitation; however, only fourteen were selected. Eighteen applications were received from Fellows from previous years or from other programs.

New Fellows

Although ASEE distributed a combined brochure of the Summer Programs, many personal letters were mailed to Deans and Department Heads of various engineering schools in the East, South and Midwest, by Dr. Goglia of Old Dominion University, requesting their assistance in bringing to the attention of their faculties the Hampton University-Langley Research Center Program. In physics, computer science and mathematics at colleges (including community colleges) and universities in the State of Virginia as well as neighboring states were contacted regarding this program. Although minority schools in Virginia and neighboring states were included in the mailing, the Co-Director from Hampton University made site visits to minority schools soliciting applicants, and sent over three hundred letters to Deans and Department Heads. These efforts resulted in a total of one hundred one formal applications, all indicating the Hampton University-Langley Research Center Program was their first choice and a total of forty-nine indicating HU-LaRC Program was their second choice. The total number of applications received came to one hundred fifty (Table 1).

Thirty-nine applicants formally accepted the invitation to participate in the program. Seventeen applicants declined the invitation. Several Fellows delayed their decision while waiting for acceptance from other programs. The top researchers seem to apply to more than one program and will make their selection based on research interest and stipend. There were two late withdrawals due to developing commitments at home institutions.

The average age of the participants was 41.5.

TABLE 1

First Choice Applications

Total	Females		Males		Minority Schools
	Black	NonBlack	Black	NonBlack	Represented
101	2	7	13	29	7

Second Choice Applications

Total	Females		Males		Minority Schools
	Black	NonBlack	Black	NonBlack	Represented
49	1	2	1	45	1

NASA-LaRC FELLOWS

TOTAL	Females		Males		Minority Schools
	Black	NonBlack	Black	NonBlack	Represented
39	1	3	6	29	4

First Year Fellows	Returnees	Number Declined
22	17	17

Positions Funded NASA/ASEE	Local Purchases
31	8

4

Section III

STIPENDS AND TRAVEL

A ten-week stipend of $7,000 was awarded to each Fellow. Although this stipend has improved over previous years, it still falls short (for the majority of Fellows) of matching what they could have earned based on their university academic salaries. This decision on their part does, however, clearly reflect the willingness of the Fellow to make some financial sacrifice in order to participate in the Summer Program.

Travel expenses incurred by the Fellows from their homes to Hampton, Virginia, and return were reimbursed in accordance with current Hampton University regulations.

Section IV

LECTURE SERIES, TOUR, PICNIC AND DINNER

Lecture Series

In response to statements made by the research fellows the lecture series was again arranged around research being done at LaRC and the speakers were Langley Research scientists.

The Langley Colloquium Series and ICASE Series were announced and notices for the individual lectures were distributed. Many Fellows took advantage of this lecture program.

Appendix III contains the agenda for the special ASEE Summer lecture series for 1986.

Tour, Picnic and Dinner

A briefing tour of the Langley Research Center was arranged for June 4, 1986.

A picnic for the Fellows, their families, and guests was held on June 20, 1986. A Seminar/dinner was held on July 18, 1986.

RESEARCH PARTICIPATION

The 1986 Hampton University-Langley Research Program, as in the past years, placed greatest emphasis on the research aspects of the program. Included in this report are abstracts from the Fellows showing their accomplishments during the summer. These abstracts, together with the comments of the Langley Research Associates with whom the Fellows worked, provide convincing evidence of the continued success of this part of the program. The Fellow's comments during the evaluation of the program indicated their satisfaction with their research projects as well as with the facilities available to them.

The research projects undertaken by the Fellows were greatly diversified as is reflected in their Summer Research Assignments. Their assignments were as follows:

Number of Fellows Assigned	Division
2	Analysis and Computation Division
3	Instrument Research Division
2	Flight Electronics Division
2	Structures and Dynamics Division
4	Materials Division
1	Acoustics Division
3	Transonic Aerodynamics Division
1	Low-Speed Aerodynamics Division
2	High-Speed Aerodynamics Division
2	Atmospheric Sciences Division
5	Space Systems Division
1	Information Systems Division
2	Guidance and Control Division
5	Flight Management Division
1	Personnel Division
1	Business Data Systems Division
1	Interdisciplinary Research Office
1	Acquisition

Thirty-Three (84.6%) of the participants were holders of the doctorate degree. Six (15.4%) held the masters degree. The group was a highly diversified one with respect to background. Areas in which the last degree was earned:

Number	Last Degree
3	Aeronautical Engineering
2	Aerospace Engineering
1	Astronomy
1	Organic Chemistry
1	Nuclear Chemistry
1	Chemical Engineering

1	Civil Engineering
3	Computer Science
1	Education
1	Education Administration
1	Electrical Engineering
1	Engineering Mechanics
1	Geology
1	Industrial Engineering
1	Applied Mechanics
5	Mathematics
1	Materials Science
2	Mechanical Engineering
1	Language and Literature
1	Oceanography
6	Physics
1	Psychology
1	Systems Dynamics/Robotics

Extensions

A portion of the funds remaining in the travel budget was used to grant extensions to twelve Fellows in the program. To be considered for the extension the Research Fellow submitted a statement of justification which was supported by the Research Associate. The requests were reviewed by the University Director and the Director for University Affairs. The following individuals were granted extensions:

Ernest Battifarano	1 Week
Patricia Carlson	1 Week
Milton Ferguson	1 Week
David Hart	2 Weeks
Mark Maughmer	1 Week
Duc Nguyen	2 Weeks
David Payne	1 Week
Albert Payton	1 Week
George Rublein	1 Week
John Stith	1 Week
John Swetits	1 Week
Ahmed Zaki	1 Week

Attendance at Short Courses, Seminars and Conferences

During the course of the summer there were a number of short courses, seminars and conferences, the subject matter of which had relevance to Fellows' research projects. A number of Fellows requested approval to attend one or more of these conferences as it was their considered opinion that the knowledge gained by their attendance would be of value to their research projects. Those Fellows who did attend had the approval of both the Research Associate and the University Co-Director. The following is a listing of those Fellows attending either a short course, seminar or conference:

George Trevino attended the 10th U.S. National Congress of Applied Mechanics in Austin, Texas.

John Swetits was invited to attend a conference on "Constructive Function Theory," at the University of Alberta, Edmonton, Alberta, Canada, July 21-27.

Milton Ferguson attended a National Teachers Workshop on "Update in Engineering Materials Technology," Norfolk State University, June 17-19.

Gerald Johnson attended the MECA Symposium on Mars: Evolution of its Climate and Atmosphere, Smithsonian Institute, Washington, D.C., July 17-19. Gerald Johnson also attended the 8th International Conference on the Origin of Life, Berkeley, California, July 21-25.

Ronald Bieniek attended the "Eighth International Conference on Spectral Line Shapes," Williamsburg, Virginia.

In addition to the above there was attendance and participation in conferences, seminars and short courses held at the Langley Research Center.

Anticipated Publications Resulting From Fellows Research Efforts

Turbulence Structure in Microburst Phenomena - to be submitted to Journal of Aircraft - George Trevino.

Quasi Classical Theory of Redistribution of Polarized Light in Sr + Ar Collisions - Ronald Bieniek.

Primary SPECTRAL Satellites of Cesium Doublets - Ronald Bieniek.

Acoustic Emission and Fracto Emission from Cracking in Resin Matrix Compact Tension Specimens - Michael Gorman.

Model AE Amplitude Distributions in Composite Materials - Michael Gorman.

The Early Atmosphere of Earth and Mars - paper presented at the "Eighth International Conference on the Origin of Life," Berkeley, California - to be submitted for publication - Levine, J. S.; Kuhn, W. R.; and Johnson, G. H.

Effects of Electron Radiation on Graphite/Polyethermide Composites - Milton W. Ferguson.

Teaching a Course in Writing for the Computer Industry - accepted by the Indiana Teachers of Writing - Patricia Carlson. Writing for the Computer Industry - to be submitted to ASEE Engineering Education - Patricia Carlson.

Desktop Publishing Systems and the "Visualization" of Knowledge Structures in Text - Patricia Carlson.

Below Ground Geochemical Processes in a Tidal Wetland, Lewes, Delaware - William Lyons.

A Strategy for the use of Alpine Glaciers in Studying Paleo-atmospheric Chemistry of the Pacific Basin - William Lyons

Multilevel Structural Sensitivity Analysis in the Sequential Computer Environment - Duc Nguyen.

Design of a Blackbody - Pumped Mixing Gas Dynamic Laser - Kwan-Yu Chen.

Nonlinear Dynamics of Rotating Flexible Spacecraft - submitted as a NASA T.P. - Larry Silverberg.

Running Mainframe Versus Microcomputer Simulations: A Comparison Study - Neal Bengtson.

Electron Bombardment of Polyarylene Ethers at High Dose Rates-Polymer reprints, 27, no. 2 - to be published September 1986-Kingsberg, K. B.; Hawkins, D. S.; Kiefer, R. L.; Orwoll, R. A.; and Sykes, G. F., Jr.

Other fellows are planning publications based on their research but have not solidified their plans at this time.

Anticipated Research Proposals

Laser Flow Analysis - submitted to NASA Langley - Kwan-Yu Chen.

The Use of Alpine Glaciers in South America in Studying Paleo-atmospheric Chemistry of the Pacific Basin - to be submitted to NASA Langley - Douglas Lindner.

Control Design for the LCDM Actuator - to be submitted to NASA Langley - Douglas Lindner.

Mathematical Modeling of Solid State Lasers - to be submitted to NASA Langley - John Swetits.

"Documentation Kits" - Improving User Manuals Without a Resident Technical Writer - Patricia Carlson.

13 C NMR Analysis of the Effects of Electronic Radiation on Fibers and Graphite/Polyetherimide Composites - to be submitted to NASA Langley - Milton Ferguson.

Decentralized Closed Loop Maneuver - submitted to NASA Langley-Larry Silverberg.

Orbit Identification of Space Station Dynamics - submitted to

NASA Langley - Larry Silverberg.

Broad Ban Tranducer Array Measurement of Acoustic Emission from Fiber Cracking in Unidirectional Graphite Epoxy Tension Specimens - submitted to NASA Langley - Michael Gorman.

Redistributed in Atomic Collisions - submitted to National Science Foundation - Ronald Bieniek.

Simple Scaling Relations for Broadening and Quenching of OH Spectral Lines in Hot Vapors - submitted to NASA Langley - Ronald Bieniek.

In addition to the above there are eleven fellows anticipating submittal of proposals to NASA, NSF or other agencies.

Funded Research Proposals

A "Cooperative Research Agreement" for continued research in the area of advanced applications of the Microwave Landing System (MLS). Funded by NASA Langley - August. 86 - Charles Scanlon.

Space Radiation Effects on Polymeric Materials. Funded by NASA Langley - R. L. Kiefer and R. A. Orwoll.

Section VI

SUMMARY OF PROGRAM EVALUATION

A program evaluation questionaire was given to each Fellow and to each Research Associate involved with the program. A Sample of each questionaire is in Appendix V of this report. Thirty-nine (100%) Fellows responded. The questions and the results are given beginning on the next page.

NASA/ASEE Summer Faculty Fellowship Program
Evaluation Questionnaire

A. **Program Objectives**

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

    Very much so ___30___ (77%)
    Somewhat ___8___ (20.5%)
    Minimally ___1___ (2.5%)

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

    Very much so ___34___ (87%)
    Somewhat ___3___ (8%)
    Minimally ___2___ (5%)

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 ___25___ (64%)
    Somewhat ___9___ (23%)
    Minimally ___5___ (13%)

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

    Yes ___27___ (69%)   No ___12___ (31%)

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 ___36___ (92.5%)
    Somewhat ___2___ (5%)
    Minimally ___1___ (2.5%)

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.

    Reinvigorated ___19___ (49%)
    Redirected 12 (31%)
    Advanced ___29___ (74%)
    Just maintained 3 (8%)
    Unaffected 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 __30__ (77%)
Positively __8__ (20.5%)
Without enthusiasm _1_ (2.5%)
Not at all __0__

3. 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 __33__ (85%)
By starting new courses __6__ (15%)
By sharing research experience _29_ (74%)
By revealing opportunities for future employment in government agencies __20__ (51%)
By deepening your own grasp and enthusiasm __24__ (62%)
Will affect my teaching little, if at all __1__ (2.5%)

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 __24__ (62%)   No __12__ (31%)
Don't Know __3__ (7%)

C. Administration

1. How did you learn about the Program? (please check appropriate response)

18 (46%) Received announcement in the mail.
4 (10%) Read about it in a professional publication.
17 (44%) Heard about it from colleague.
6 (15%) Other (explain). _____

_____

_____

2. Did you also apply to other summer faculty programs?

Yes __12__ (31%)   No __27__ (69%)
_1_ DOE
_7_ Another NASA Center
_2_ Air Force
_2_ Army
_2_ Navy

3. Did you receive an additional offer of appointment from one or more of the above? If so, please indicate from which.

Navy - 3   Army - 2   Another Center - 2

4. Did you develop new areas of research interest as a result of your interaction with your Center and laboratory colleagues?

Many 10   (26%)
A few 23   (59%)
None   6   (15%)

5. Would the amount of the stipend ($700) be a factor in your returning as an ASEE Fellow next summer?
                        .Amount adequate and competitive
Yes 21 (54%)   .Cannot come for less
No   17 (44%)   .At LaRC I can use the computer facility
If not, why _____ .Money not most important factor
.This is higher than net salary - lower than gross

6. Did you receive any informal or formal instructions about submission of research proposals to continue your research at your home institution?

Yes 25 (64%)   No 14 (36%)

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

Yes 28 (72%)   No 9 (23%)

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

Yes 34 (87%)   No 4 (10%)

9. How do you rate the seminar program?

Excellent 12   (31%)
Very good 14   (36%)
Good 9   (23%)
Fair 3   (8%)
Poor 0
Not of interest 1 (2%)

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

| Check one per Activity | Time Was | | | |
Activity	Adequate	Too Brief	Excessive	Ideal
Research	18 (46%)	7 (18%)	1 (2.5%)	13 (33%)
Lectures	27 (69%)	2 (5%)	2 (5%)	7 (18%)
Tours	18 (46%)	8 (21%)	3 (8%)	3 (8%)
Social/Recreational	20 (51%)	7 (18%)	1 (2.5%)	6 (15%)
Meetings	24 (62%)	1 (25%)	1 (2.5%)	7 (18%)

11. What is your overall evaluation of the program?

Excellent 27   (69%)
Very good   9   (23%)
Good   2   (5%)
Fair   0
Poor   0

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

SEE FELLOWS' COMMENTS AND RECOMMENDATIONS

_____

_____

_____

_____

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

.Provide mini-grants to help support publication of research

.Less emphasis on lectures and tours-allow more time for research

.Spell out relationship between Research Fellow and Associate

_____

_____

D. Stipend

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

    $_____ per _____.

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

    Yes __3__ (8%)   No __19__ (49%)   In part __14__ (36%)

3. What, in your opinion, is an adequate stipend for the ten-
    week program during the summer of 1987?

    7,000 - 2 (5%)   8,000 - 21 (54%)   9,000 - 4 (10%)   13,000 - 1 (25%)
    7,500 - 2 (5%)   8,500 - 4 (10%)   10,000 - 2 (5%)

E. American Society for Engineering Education (ASEE) Membership
    Information

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

    Yes __6__ (15%)   No __33__ (85%)

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

    Yes __25__   No __11__

Percentages have been rounded off to next whole number.

Where percentages figures do not equal 100 there was a response missing.

Information on salaries is considered confidential and is not included in this report.

Fifty-four percent (54%) of the Fellows responding indicated that an $8,000 stipend for the ten weeks in 1987 would be adequate.

Eighty-five percent (85%) of the Fellows indicated that they are not currently members of the American Society for Engineering Education.

Fellows' Comments

The comments were as follows: an excellent job of coordination for the program; overall evaluation excellent...; limited technical and clerical support...limits amount that can be accomplished in ten weeks; warn fellows of problem i.e.: working in labs evenings and weekends; the stipend is adequate to provide housing and to cover summer expenses for a family of five. If the NASA/ASEE Summer Faculty program has more money available, it should be applied towards increasing the number of Fellowships; of the programs in which I have been involved none have been run as smoothly and professionally as this one...

Fellows' Recommendations

Recommendations included the following: Some additional assistance with locating housing for the fellows; the research time is very short, extend the program to twelve weeks; provide examples of successful grant proposals; provide more opportunities for informal discussion and interaction between fellows; more pre-program contact with research associates; clarify the relationship between the fellow and the research associate; additional technical and clerical support.

There seemed to be a desire for more information on the backgrounds, work interests, and research being done by other summer researchers. Also a desire for more interaction between the fellows on an informal level.

Research Associates-Survey

Most of the responses indicated that the Fellows were adequately prepared for the research assignment. The negative responsers were generated by late assignments or by assignments in a totally new area.

All Research Associates responding indicated satisfaction with the diligence, interest and enthusiasm of the Research Fellow. Some indicated that the Research Fellow went beyond what was anticipated for the project.

All Research Associate responding expressed an interest in serving in the program again.

The Research Associates expressed an interest in having the Fellow (while eligible) return for a second year.

Research Associates' Comments

It appears that the program works quite well from my stand point. I have had good luck with all my previous participants.

Having a Research Fellow allowed us to accomplish a project in an

area where we did not previously have a capability to accomplish.

Research Fellows are of great assistance.

It would be highly beneficial to the Business Data Systems Division and the Center to allow the Research Fellows to return for a second year to support our implementation program.

Good way to get a short term project done.

The program is and has been excellent - keep the program as is.

Very beneficial for Education Branch to associate with current college professors who represented areas common to our training needs.

Research Associates' Recommendations

Circulate schedule of activities to host branch.

Program could benefit from greater promotion and visibility among all LaRC staff, emphasizing the importance of supporting the Summer Fellow's work with our various skills. Division staff could help by facilitating communications between in-house personnel regarding the fellow's work.

Section VII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Comments from the Research Fellows and from the Research Associates indicate satisfaction with the program.

Many Fellows indicated the desire for additional informal contact with other fellows as a means for both social and professional development.

Contact with the Research Associate prior to arrival is considered essential.

The stipend is considered to be barely adequate but is not the prime consideration when accepting the appointment.

The program is considered important by the Fellows and Research Associates and should be continued.

Recommendations

Contact by Research Associate prior to arrival to permit pre-visit consultations.

ASEE program director should communicate directly with the division chiefs regarding the division presentation.

The Fellows recommend considering extending the program to twelve weeks.

Additional technical and clerical support at the branch or divisional level.

Additional in-house public relations work to promote the program on the site, especially highlighting interdepartmental communications and cooperation.

APPENDIX I

Participants - ASEE-NASA Langley

Summer Faculty Program

Returnees

Fellow	Age	Assigned to	Research Associate
Dr. Carlson, Patricia A. Professor Humanities Department Rose-Hulman Institute of Technology Terre Haute, IN 47803	40	Analysis and Computation Division	John N. Shoosmith Building 1268A Tel. 865-3466
Dr. Chen, Kwan-Yu Professor Astronomy Department University of Florida Gainesville, FL 32611	55	Space Systems Division	Russell J. DeYoung Building 1274A Tel. 865-3781
Dr. Day, Henry P. Assistant Professor Engineering Science and Mechanics Deparmtent Virginia Polytechnic Institute and State University Blacksburg, VA 24061	37	Low-Speed Aerodynamics Division	Bruce J. Holmes Building 1212 Tel. 865-2877
Mr. Ferguson, Milton W. Assistant Professor Chemistry/Physics Department Norfolk State University Norfolk, VA 23504	48	Materials Division	Sheila T. Long Building 1267 Tel. 865-3892

Dr. Kiefer, Richard L. Professor and Chairman Chemistry Department College of William and Mary Williamsburg, VA 23518	48	Materials Division	George F. Sykes Building 1205 Tel. 865-4555
Dr. Lindner, Douglas K. Assistant Professor Electrical Engineering Department Virginia Polytechnic Institute and State University Blacksburg, VA 24061	33	Guidance and Control Division	Lawrence W. Taylor Building 1268A Tel. 865-4591
Dr. Longman, Richard W. Professor Mechanical Engineering Department Columbia University New York, NY 10027	43	Structures and Dynamics Division	Jer-Nan Juang Building 1293T Tel. 865-2881
Dr. Maughmer, Mark D. Assistant Professor Aerospace Engineering Department Pennsylvania State University University Park, PA 16802	36	Transonic Aerodynamics Division	William D. Harvey Building 641 Tel. 865-2631
Dr. Nguyen, Duc T. Assistant Professor Civil Engineering Department Old Dominion University Norfolk, VA 23508	34	Interdisciplinary Research Office	Jaroslaw Sobieski Building 1229 Tel. 865-2887
Dr. Ogg, John C. Assistant Professor Aerospace Engineering Department University of Kansas Lawrence, KS 66044	41	High-Speed Aerodynamics Division	Dennis M. Bushnell Building 1247A Tel. 865-4546

Dr. Rublein, George T. Associate Professor Mathematics Department College of William and Mary Williamsburg, VA 23185	50	Guidance and Control Division	Ray V. Hood Building 1298 Tel. 865-3321
Dr. Scanlon, Charles H. Associate Professor Computer Science, Math and Physics Department Arkansas State University State University, AR 72401	49	Flight Management Division	Charles E. Knox Building 1168 Tel. 865-3621
Dr. Selby, Gregory V. Assistant Professor Mechanical Engineering and Mechanics Department Old Dominion University Norfolk, VA 23508	37	Transonic Aerodynamics Division	Blair B. Gloss Building 1229 Tel. 865-2601
Dr. Silverberg, Larry M. Assistant Professor Mechanical and Aerospace Engineering Department North Carolina State University Raleigh, NC 27695-7910	28	Space Systems Division	Gregory C. Andersen Building 1232 Tel. 865-4982
Mr. Stith, John J. Assistant Professor Physics Department Virginia State University Petersburg, VA 23803	41	Space Systems Division	Edmund J. Conway Building 1247A Tel. 865-3781

Dr. Trevino, George
Associate Professor
Mechanical Engineering and
    Engineering Mechanics Department
Michigan Technological University
Houghton, MI   49931

44   Flight Management Division

Roland L. Bowles
Building 1168
Tel.   865-3917

Dr. Yates, Charlie L.
Professor and Coordinator
Engineering Department
Hampton University
Hampton, VA   23668

50   High-Speed Aerodynamics Division

Griffin Y. Anderson
Building 1221
Tel.   865-3772

APPENDIX II

Participants - ASEE NASA Langley

Summer Faculty Program

First Year Fellows

1986

NASA-ASEE FELLOWS

HU-NASA LANGLEY

FIRST YEAR

Fellow	Age	Assigned to	Research Associate
Ms. Ames, Kathy R. Instructor Math and Computer Science Department Virginia Wesleyan College Norfolk, VA 23502	28	Space Systems Division	Joseph M. Price Building 1232 Tel. 865-2885
Dr. Battifarano, Ernest Assistant Professor Mathematics Department New Jersey Institute of Technology Newark, NJ 07102	34	Transonic Aerodynamics Division	Manuel D. Salas Building 1192D Tel. 865-2627
Dr. Bengtson, Neal M. Assistant Professor Computer Science Department North Carolina State University Raleigh, NC 27695-8206	39	Space Systems Division	W. Douglas Morris Building 1232 Tel. 865-2768
Dr. Bieniek, Ronald J. Associate Professor Physics Department University of Missouri-Rolla Rolla, MO 65401	37	Instrument Research Division	Reginald J. Exton Building 1230 Tel. 865-2791

Dr. Blue, Nelson A. Visiting Assistant Professor Computer Science Department North Carolina State University Raleigh, NC 27695	39	Flight Management Division	Kathy H. Abbott Building 1168 Tel. 865-3621
Dr. Cooke, Francis W. Professor Bioengineering Department Clemson University Clemson, SC 29631	51	Materials Division	Robert M. Baucom Building 1293A Tel. 865-4197
Dr. Foskey, Henry Chairman and Professor Industrial Arts and Technology Department Elizabeth City State University Elizabeth City, NC 27909	40	Personnel Division	Frederick M. Thompson Building 1195C Tel. 865-2611
Dr. Garg, Devendra P. Professor Mechanical Engineering Department Duke University Durham, NC 27706	52	Information Systems Division	L. Keith Barker Building 1268A Tel. 865-3871
Dr. Gorman, Michael R. Assistant Professor Engineering Mechanics Department University of Nebraska-Lincoln Lincoln, NE 68588-0347	34	Instruments Research Division	Joseph S. Heyman Building 1230 Tel. 865-3036
Dr. Hart, David C. Assistant Professor Mathematics Department University of Cincinnati Cincinnati, OH	39	Analysis and Computation Division	Robert E. Smith Building 1268A Tel. 865-3978

Dr. Johnson, Gerald H. Professor Geology Department College of William and Mary Williamsburg, VA 23185	50	Atmospheric Sciences Division	Joel S. Levine Building 1250 Tel. 865-2187
Ms. Long, Jacquelyn E. Assistant Professor Math and Computer Science Department Norfolk State University Norfolk, VA 23504	39	Acquisition Division	Archer V. Vann Building 1195A Tel. 865-3438
Dr. Lyons, William B. Associate Professor Earth Sciences Department University of New Hampshire Durham, NC 03824	39	Atmospheric Sciences Division	David S. Bartlett Building 1250T Tel. 865-4345
Dr. Mahanian, Saba Assistant Professor Mechanical Engineering Department University of Puerto Rico Mayaguez, PR 00708	28	Structures and Dynamics Division	Richard S. Pappa Building 1293T Tel. 865-3196
Dr. Payne, David G. Assistant Professor Psychology Department State University of New York Binghamton, NY 13901	31	Flight Management Division	Alan T. Pope Building 1168 Tel. 865-3917
Dr. Payton, Albert L. Associate Professor Chemistry Department Hampton University Hampton, VA 23668	42	Materials Division	Paul M. Hergenrother Building 1293A Tel. 865-3041

Mr. Preston, Kenneth L. Instructor Mathematics Department Hampton University Hampton, VA 23668	26	Flight Electronics Division	Robert V. Hess Building 1202 Tel. 865-2818
Dr. Shebalin, John V. Assistant Professor Electrical Engineering Department Old Dominion University Norfolk, VA 23508	36	Instrument Research Division	Harlan K. Holmes Building 1230 Tel. 865-3483
Dr. Swetits, John J. Professor Mathematics Department Old Dominion University Norfolk, VA 23508	43	Flight Electronics Division	Charles E. Byvik Building 1202 Tel. 865-3761
Dr. Vernon, Christie D. Associate Professor Librarian St. Leo College,Langley AFB Hampton, VA	57	Research Information and Applications Division	Jane S. Hess Building 1194 Tel. 865-2630
Mr. Wattson, Robert K. Associate Professor and Chairman Mechanical Engineering Technology Department Oregon Institute of Technology Klamath Falls, OR 97601-8801	63	Flight Management Division	Roland L. Bowles Building 1168 Tel. 865-3917
Dr. Zaki, Ahmed S. Professor School of Business Administration College of William and Mary Williamsburg, VA 23185	58	Business Data Systems Division	Frederick L. Moore Building 1152 Tel. 865-2721

APPENDIX III

ASEE-NASA Langley Summer Faculty Program

Lecture Series

1986

ASEE/NASA

Hampton University - Langley Research Center
LECTURE SERIES

Location: Bldg 1219, Room 225
Time: 9:00 a.m. to 10:30 a.m.
*1:00 p.m. to 2:00 p.m.

DATE	SPEAKER	TOPIC
June 6	Mr. Jerry C. South Chief Scientist, LaRC	An Overview of the Langley Research Center
June 13	Dr. Joel S. Levine Atmospheric Sciences Division, LaRC	The Earth's Atmosphere: Past, Present and Future
*June 27	Dr. Martin M. Mikulas Structural Dynamics Division, LaRC	Large Space Structural Concepts
July 11	Dr. H. Lee Beach Assistant Director for Aeornautics, LaRC	The National Aerospace Plane
July 25	Mr. Gerard E. Migneault Information Systems Division, LaRC	Computer Software Reliability

SCHEDULE OF PRESENTATIONS BY FACULTY FELLOWS
Location: Bldg 1219, Room 225
Date: 5 August 1986
Time: 9:00 a.m. to 3:00 p.m.

NAME/DIVISION/BRANCH	TOPIC
Kwan-Yu Chen Space Systems Division/High Energy Science Branch	Design of a Blackbody-Pumped Mixing Gasdynamic Laser
Kathy R. Ames Space Systems Division/Aerothermo- dynamics Branch	A General Purpose Plotting Program

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Francis W. Cooke Materials Division/Polymeric Materials Branch	Resorbable Composite Bone Fixation Hardware
Saba Mahanian Structures and Dynamics Division/Structural Dynamics Branch	The Effects of Cable Suspension on Bending Vibration of Large Beams
David C. Hart Analysis and Computation Division/ Computer Applications Branch	Grid Generation for Boundary-Layer Diverter Regions
Mark D. Maughmer Transonic Aerodynamics Division/ Fluid Dynamics Branch	Design for High Altitude Long Endurance RPV Airfoil
Nelson A. Blue Flight Management Division/ Vehicle Operations Research Branch	Models, Truth Maintenance and Knowledge Representation
Douglas K. Lindner Guidance and Control Division/ Spacecraft Controls Branch	Control Systems Design of the LCDM Actuator for the COFS Mass
Kenneth L. Preston Facilities Engineering Division/ Laser Technology and Applica- tions Branch	The Characterization of Diode Lasers for Injection Control of Tunable Solid State Lasers
Gerald H. Johnson Atmospheric Sciences Division/ Theoretical Studies Branch	The Early Atmospheres of Earth and Mars: Methane in the Early Atmosphere of Mars

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APPENDIX IV

ASEE-NASA Langley Faculty Fellows

Abstracts

A General-Purpose Plotting Program

by

Kathy R. Ames

Instructor
Computer Science
Virginia Wesleyan College
Norfolk, Virginia

Researchers frequently find the need to draw plots of their experimental or computational data to facilitate its analysis. Generating such plots by hand can be a very tedious and time-consuming process. Although writing a computer program to automatically generate a plot seems like a reasonable solution to this problem, the tedium of revising the program each time a slightly different plot is desired makes this solution as impractical as plotting by hand. A general-purpose program that could, after a brief interactive question and answer session with a user, selectively extract data from a file that conforms to a predescribed format and generate the requested plot would be a very useful tool. The purpose of this project was to begin the initial design and development of such a program.

The first phase of the project involved analyzing and prioritizing a list of plotting capabilities desired by the group of researchers at NASA Langley Research Center who had requested the program. Issues also taken into consideration at this time were the variety of computer systems used by this group, the graphics packages available on these systems, the feasibility of writing the program for one system in such a way that it could easily be moved to another system, and the feasibility of transferring data from systems that did not host the program to the system that did.

After a decision was made to initially target the program for the computer system supported by the Central Computing Complex and a graphics package was selected, the design and development of a program to generate line plots with a minimum of user interaction was begun. The final program accepts as input data files that conform to one of three standard formats. In each of these formats, the data is represented as a table of independent and dependent variables and the program can plot any dependent variable against any independent variable. In addition, two of the formats represent computational fluid dynamics grids and the user can specify that any variables be plotted along any grid line. Other features of the program include the automatic selection of appropriate tic mark intervals to cover the selected data and the ability to plot several curves on the same plot. The user has control over the association of the independent variable with either axis, the selection of a log or linear scale for each axis, and the selection of a plot title and axis labels.

A POSSIBLE EXTENSION OF THE COMPUTER PROGRAM FLO 52 TO COMPUTE AXISYMMETRIC FLOWS ABOUT BODIES OF REVOLUTION

Ernest Battifarano
Assistant Professor, Mathematics
New Jersey Institute of Technology
Newark, New Jersey 07102

FLO 52 is a computer program that computes steady-state solutions to the two-dimensional Euler equations

$$(1) \qquad w_t + f_x + g_y = 0$$

where

$$
w = \left\{ \begin{array}{c} \rho \\ \rho u \\ \rho v \\ \rho E \end{array} \right\} \quad , \quad
f = \left\{ \begin{array}{c} \rho u \\ \rho u^2 + p \\ \rho uv \\ \rho uH \end{array} \right\} \quad , \quad
g = \left\{ \begin{array}{c} \rho v \\ \rho uv \\ \rho v^2 + p \\ \rho vH \end{array} \right\}
$$

and where ρ, u, v, E, H, p denote density, x-velocity component, y-velocity component, total energy, enthalpy, and pressure, respectively. The system is closed by assuming the ideal gas law,

$$E = \frac{p}{(\gamma-1)\rho} + \frac{1}{2}\left(u^2 + v^2\right) \quad ,$$

$$H = E + p/\rho$$

where γ is the ratio of specific heats.[1]

FLO 52 computes the steady-state solution by employing a modified Runge-Kutta time-stepping scheme together with enthalpy damping, implicit residual smoothing, local time-stepping, and multiple grids. Convergence to steady state is generally very fast.[2,3,4]

The Euler equations for axisymmetric flow are

$$(2) \qquad (yw)_t + (yf)_x + (yg)_y + b = 0$$

where

$$
b = \left\{ \begin{array}{c} 0 \\ 0 \\ -p \\ 0 \end{array} \right\} \quad ,
$$

and where y is the radial variable, measuring distance from the axis of symmetry, and where v now denotes the radial velocity component.

If FLO 52 is modified in a straight-forward way to compute the steady-state solution to the axisymmetric Euler equations, then an instability results. This phenomenon has been noted by several independent investigators.[5,6]

The reason for the instability is not entirely understood. However, differentiating the vector $(yg)_y$ in equation (2) and dividing (2) by y produces

(3) $$w_t + f_x + g_y + (g+b)/y = 0$$

where the source term $(g+b)/y$ is singular when $y = 0$. Although all variables in FLO 52 are defined at cell centers so that y is never equal to 0, it is suspected that truncation errors near the axis of symmetry are too large and that upon division by y, they produce an instability as the mesh is refined.

A proposed solution to this problem is to use equation (3) at those cells along the axis of symmetry and, in addition, to difference the source term using L'Hopital's rule

$$\lim_{y \to 0} \left(\frac{g+b}{y} \right) = \frac{\partial}{\partial y} (g+b) \bigg|_{y=0} .$$

Elsewhere in the computational domain, (2) is used to compute the solution.

A second proposed solution is to use equation (3) throughout the computational domain and to difference the source term using L'Hopital's rule at those cells adjacent to the axis of symmetry.

Conclusive numerical results have not yet been obtained.

References:

1. Courant and Friedrichs, Supersonic Flow and Shock Waves, Springer-Verlag, 1976.

2. Jameson, Solution of the Euler Equations for Two-Dimensional Transonic Flow by a Multigrid Algorithm, Princeton University, MAE Report No. 1613, June 1985.

3. Jameson and Baker, Multigrid Solution of the Euler Equations for Aircraft Configurations, AIAA-84-0093.

4. Jameson, Schmidt, Turkel, Numerical Solution of the Euler Equations by Finite Volume Methods Using Runge-Kutta Time-Stepping Schemes, AIAA-81-1259.

5. Woan, Euler Solution of Axisymmetric Flows About Bodies of Revolution Using a Multigrid Method, AIAA-85-0017.

6. Wedan, personal communication, NASA Langley Research Center.

A COMPARISON OF USING THE SIMULATION LANGUAGE SLAM ON THE MICROCOMPUTER AND MAINFRAME

by

Neal M. Bengtson
Assistant Professor
Department of Computer Science
North Carolina State University
Raleigh, North Carolina

The use of simulation models to study the operational characteristics of future space transportation systems has become a standard practice in the conceptual studies at Langley. Using the simulation language SLAM on NASA's mainframe computers, which are CDC Cybers, has proven to be inconvenient due to the heavy demand on the machines. Access to the computers and turn around times once on are unpredictable. A lot of time can be wasted sitting in front of a terminal waiting for responses. An ever increasing annual leasing fee is also required to use SLAM on a mainframe. SLAM now comes in a full featured PC version. This study was conducted to look at the practicality of implementing NASA's Space Transportation Systems Operational Model (STS Ops Model) on an IBM AT using the PC version of SLAM.

SLAM is a FORTRAN based language. Systems being simulated are usually modeled as networks using special SLAM defined symbols and control statements. SLAM is constructed such that the user may write FORTRAN routines to accomplish simulated tasks which can't be easily modeled using the network and control statements provided by the language. The STS Ops Model is a network which has supplimental FORTRAN routines.

In order to run a SLAM simulation with FORTRAN subroutines on a PC a number of program files are needed. These files are supplied on three SLAM and four FORTRAN diskettes. In addition, one or two other diskettes containing the model to be simulated would also be used. The number of diskettes used may be reduced to five by copying and reorganizing necessary files. A great deal of disk swapping is still necessary to make a complete simulation run.

Using an AT presents two major questions:

1. Can running a SLAM simulation on an AT be made more convenient,

and

2. Will the slower execution times of an AT versus a mainframe make a significant difference in turn around times.

The use of an IBM AT with a hard disk makes a great deal of difference. All the files necessary to run SLAM were put in a directory on the hard disk.

A program was written that performs all the steps necessary to run a SLAM simulation model automatically. This program requires only the name of the file that contains the model to be run. Running the PC version of SLAM is now quite convenient.

Run time conparisons of the mainframe versus the AT were made in order to address the second question. The AT runs the STS Ops Model in a relatively constant 6.3 minutes. The turn around times on the mainframe varied a great deal. The best that was experienced was a range of from 5.7 to 19.5 minutes. This is not counting access time. A user could experience turn around times much in excess of 20 minutes. All the example programs from the SLAM [1] text were run for comparison. The turn around times for the mainframe were never better than for the AT. The best times that were experienced on the mainframe were usually 2 to 3 times greater than on the AT.

In conclusion, run times were expected to be the major drawback to running simulations on an AT rather than the mainframe. They were not. Turn around times on the AT were often much shorter than on the mainframe. In addition, times are predictable on the AT. Since the run time of a simulation model on an AT is known after the first execution the user is not tied to the machine while a job is running. Running on the AT can save the user a great deal on time and fustration. The program created to run SLAM also makes it user friendly and avoids most of the manual step by step process ordinarily necessary to run a PC SLAM simulation. There is also a financal benefit in using the AT. Once a set of SLAM disks are purchased they may be used indefinitely. PC version updates may be bought, but these are generally much less expensive than the annual leasing fee charged to run SLAM on a mainframe.

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[1] Pritsker, A. A. B., Introduction to Simulation and SLAM, 2nd edition, Halsted Press and Pritsker & Associates,Inc., 1984.

Theoretical Studies of the Spectroscopy
of Atoms in Collision

by

Ronald J. Bieniek
Associate Professor of Physics
Physics Department and Laboratory for Atomic and Molecular Research
University of Missouri - Rolla
Rolla, Missouri 65401

Dr. Bieniek chose to undertake three spectroscopy-related research projects under the auspices of this ASEE-NASA Summer Faculty Fellowship. Two were successfully completed, and one will be continued at his institution.

The first project was to write a computer code that would rapidly and accurately determine the vibrational-rotational levels of excited diatomic molecules, and yet would be easy to use. The theoretical basis of the approach rested on uniform semiclassical wave functions, rather than the more simple, but less accurate, JWKB wave functions (R. J. Bieniek, J. Chem. Phys. 72, 1225; 73, 4712). The program was employed to determine the bound and quasibound levels of CsXe*. Preliminary interpretations of an experimental spectrum taken at NASA Langley indicated only eight bound states existed. The computer program showed that about 28 levels were supported by the CsXe* potential.

The second project dealt with the redistribution of polarized radiation absorbed during the collision of two atoms (see K. Burnett, Phys. Rep. 118, 339). The frequency and temperature dependences of the degree of absorption and subsequent depolarization by nuclear motion can reveal much about the microphysical environment of the system. A simple classical theory has been proposed to describe redistribution (Lewis et al., J. Phys. B16, 553), but has only been used for qualitative understanding. Although it suffers from some questionable assumptions (e.g., straight line trajectories and simple quasi-static line shapes), it has been attractive because full quantal theories are quite complex (P. Julienne and F. Mies, Phys. Rev. A30, 831). During the NASA Fellowship period, a computer code was written to calculate the degree of polarization based on the simple formula of Lewis et al. It was used to calculate the depolarization in the Sr+Ar system, for which experimental results and accurate quantal calculations have become available. This was the first numerical test of the simple formula with reasonable potentials for a real system. The results were in the "right ballpark" but did not have the same character as the full quantal treatment. Dr. Bieniek modified the simple theory to include the effects of collisional deflection and multiple excitation points. This new quasiclassical formulation achieved significantly better agreement with quantal results, both in value and trends. Besides the relative ease of numerical calculations, the quasiclassical theory revealed two salient points: 1) nonlinear motion significantly affects depolarization, and 2) the polarization is very sensitive to the distance at which the atoms' electronic orbitals decouple from one another. This last point indicates redistribution experiments can reveal much about a "grey" region in the theory of atomic interactions.

The third project, still in progress, is to understand the source of the primary spectral satellites of the doublet lines of Cs collisionally broadened by various perturber (R. J. Exton and W. L. Snow, J. Quant. Spectrosc. Radiat. Transfer 20, 1). These are quite intriguing not only for their strength, but also because they maintain their same relative position to the fine-structure resonance lines throughout the entire principal series. This implies that the collisional phenomena that produces the satellite must be intimately related to fine-structure splitting. Research is now underway to correlate long-range atomic interactions to the fine-structure interaction, under the assumption that the primary satellites are produced by an extremum in the quasi-molecular difference potential at large separations. Progress has been made in expressing the position of the spectral satellites in terms of long-range potential parameters. Research will continue to relate these to fine-structure interactions.

MODELS, TRUTH MAINTENANCE AND KNOWLEDGE REPRESENTATION

by

Nelson Allen Blue

Visiting Assistant Professor
Computer Science
North Carolina State University
Raleigh, North Carolina

Adaptive systems, intelligent systems that must adapt to new or changing environments, must build and maintain dynamic models of the world or some aspect of it. Maintaining such models requires a truth maintenance system -- a system that makes assumptions and revises them when a contradiction is encountered. A major problem in truth maintenance is determining which belief(s) to reject when a contradiction is encountered. Such determinations can be facilitated by the assignment of priorities to beliefs. The system can then reject the belief(s) having the lowest priorities. The assignment of a priority to a belief can be based on a variety of factors, including the number of other changes to the system that would be required by the rejection of the belief and the degree of confidence we have in the veracity of any observations that support the belief. Another factor is the category to which the belief belongs. For example, because theories are built in an attempt to systematize our observations and allow us to make predictions, theoretical beliefs are generally given lower priorities, and are therefore more subject to revision, than beliefs obtained from direct observation. A knowledge representation system (KRS) suitable for use by such an adaptive system must therefore be able to assign different priorities to different beliefs and different beliefs to different categories. Such a KRS must also be able to represent competing theories or hypotheses in a manner that allows them to be compared easily and efficiently.

This project is a first step toward the development of a KRS having the above-mentioned characteristics. The system developed uses semantic network techniques to represent knowledge that can be expressed in first-order predicate logic restricted to one-place predicates. The system allows the user to separate its beliefs into any number of categories, using a different semantic network for each category.

Work that remains to be done includes the extension of the KRS to handle many-place predicates and the addition of machinery to perform deductions from assumptions in different categories. When completed, the KRS can provide a basis for research on adaptive systems, the development of scientific theories and common sense reasoning.

WRITING A USER-ORIENTED RESOURCE MANAGEMENT MANUAL FOR THE
LANGLEY CENTRAL SCIENTIFIC COMPUTING COMPLEX:
A PROBLEM IN USABLE TEXT DESIGN

by

Patricia Ann Carlson

Professor
Department of Humanities
Rose-Hulman Institute of Technology
Terre Haute, Indiana 47803

BACKGROUND

Documentation for any large computing complex needs to contain two
generic categories of information:

o Procedural Information: covering such things as the operating system
  (logon sequence, commands, routines, etc.) and various other instruc-
  tions for applying the resources of the system to an analytical or
  computational problem.

o Organizational Information: covering such management issues as
  resource allocation, user validation procedures, usage policies and
  charges, availability of user consultation, resource personnel and
  system administrators, tape library and archiving resources, organiza-
  tional charts, operations, shift utilization, and security.

The documentation library for the Langley Central Scientific Computing
Complex (CSCC) -- locally known as the "red cover" series -- adequately serves
the user's needs for procedural information. However, at present, there is no
document dedicated to the critical organizational information a user must have
in order to effectively and efficiently (as well as legally) make use of the
resources of the facility.

RESEARCH PROJECT

As my ASEE research project, I have elected to design an easy-to-use,
accurate, and concise manual covering the resource management information
pertaining to the CSCC. The project involves two levels of research:

LEVEL ONE -- Collecting Accurate and Complete Information on CSCC System
    Management: This task requires detailing the policies of three major
    systems (8 CYBERs, 5 PRIMEs, and one super-computer) and several
    special-purpose machines, as well as the software resources and pe-
    ripheral hardware which, taken together, support approximately 1,500
    interactive terminals. Sources include:

    o current documentation, which integrates some organizational
      information with procedural materials;

o interviews with system administrators, user consultants, user-training specialists, and operations personnel;

o computer bulletins, management memos, request forms, briefings, user training handouts.

LEVEL TWO -- Designing a Usable Text: To enable readers to find what they are looking for easily and precisely, the text (including aspects of language and layout) must reflect the intrinsic knowledge structure of the information and comply with a task analysis of how the reader will use the document. Research areas which contribute to decisions in document design include

o writing instructional materials;

o use of graphics and visual aids;

o non-traditional approaches to text, such as information mapping, structured writing, and discourse punctuation;

o cognitive psychology;

o readability.

THE PRODUCT

The document's design is a departure from the conventional format of the "red cover" series. Traditional paragraph structures have been replaced by the technique of "message design": a more graphic approach to the presentation of text.

Multiple type fonts and point sizes, dual columns in places, devices for data compression (such as decision tables and information maps), and meaningful use of white space reflect both advancing technical capabilities (in word processing software and laser printers) and modern theories of document design.

Taken together, these features provide the user with information that is concise and accessible. A reader questionnaire -- included at the back of the manual -- allows users to critique the document on facets of structure, style, and syntax.

DESIGN OF A BLACKBODY-PUMPED MIXING GASDYNAMIC LASER

by

Kwan-Yu Chen

Professor
Astronomy
University of Florida
Gainesville, Florida

In future space exploration, it is desired to develop continuous-wave lasers for many power requirements. The blackbody-pumped laser utilizes solar irradiation for excitation of gaseous molecules to produce laser action. The goal of the ASEE summer project was to design a blackbody-pumped transfer laser, using nitrogen heated in an oven and carbon dioxide as the lasing gas.

The principle of a transfer gas laser is such that an excited doner gas transfers vibrational energy to a lasing gas. The latter emit radiation. In this particular laser, nitrogen molecules are to be thermally excited, and after nozzle expansion are mixed with carbon dioxide.

The design of the apparatus is tailored to an existing oven which has a quartz tube with an inside diameter of 95mm as the heating chamber. The laser apparatus has three sections: (1) the nozzle block, (2) the optical cavity, and (3) the diffuser. The first section is a cluster of 25 de Laval nozzles, through which the hot nitrogen flows. While the gas temperature decreases rapidly in expansion, the vibrational temperature "freezes", i.e. it changes only very little. Spaced among and paralleled to these nozzles are 12 orifices from which carbon dioxide flows. The two gases are mixed in the optical cavity where lasing action takes place. The laser beam is transverse to the gas flow. Finally some flow pressure is recovered in the diffusser, and the gas is discarded into a retaining tank.

At a temperature of 1500 K and a pressure of 1 atmosphere, the mass flow rate of nitrogen through the nozzles is 5.15 g s^{-1}. If one considers that all the nitrogen molecules in the first vibrational state transfer their vibrational energy to carbon dioxide molecules, each of which emits a 10.6 μm photon thereafter, and if one assumes also that there is no losses in the system, one would theoretically get an output of 200 w from this system. Its performance will be determined in the laboratory and compared to theoretical calculations.

DEVELOPMENT OF TECHNOLOGY FOR ABSORBABLE
COMPOSITE ORTHOPAEDIC BONE SCREWS

by

Francis W. Cooke

Professor of Bioengineering
Clemson University
Clemson, South Carolina

One of the most promising advances in medical technology is the development of absorbable implants for use by orthopaedic surgeons in stabilizing bone fractures. These absorbable implants are composites made of a soluble polymer matrix, polylactic acid (PLA), and calcium phosphate glass fibers which are also soluble. Initially those composites are stiff enough and tough enough to serve as rods and plates to fix unstable fractures. After healing, the composite gradually dissolves and is eventually eliminated by the body. With standard metal devices, the implant must be left in place for the rest of the patients life or removed by a second surgical procedure. Both of these options carry risks for the patient; removal involves the danger, cost and inconvenience of a second operation, and neglect can lead to refracture or infection many years after the initial trauma. Controlled absorption of a composite fixation device provides a much more desirable alternative.

To take full advantage of the potential of absorbable fixation it is necessary that bone screws be available to the orthopaedic surgeon as well as plates and rods. Unfortunately there is very little technology available for the manufacture and use of composite screws. The purpose of this summers research in the Polymeric Materials Branch is to develop methods for making composite screws that meet the basic criteria required of all threaded fasteners.

When a screw is inserted in a threaded hole and torque applied, three modes of failure are possible; torsional shear at the cross section of the minor diameter (due to the applied torque), tensile failure also at the cross section of the minor diameter (due to the axial tension developed) and shear of the thread (stripping) along the cylinder defined by the minor diameter. The tensile and shear stresses on the minor cross section act together to create a complex stress situation which is intensified by the notch at the root of the thread. In a good thread design the torque to produce failure at the minor cross section should be about the same as that required to cause stripping of the threads. Unfortunately it is not possible to use simple elastic theory to determine the stripping shear stress from the applied torque. In practice the load is not distributed uniformly over all the threads but is greatly concentrated on the first thread.

For steel screws the load on the first thread is usually about three times the calculated average load. For most structural application this load will exceed the yield strength of the first thread at least locally. Such yielding prevents further rapid increase of stress in the first thread and leads to a more uniform transfer of load to the deeper threads. The relation

of the load on the first thread to the torque and axial tensile load is known only on an empirical basis and only for metal screws with a well defined yield strength and true plasticity.

This relationship is the basis for the standard machine screw thread designs used throughout the world. These designs and empirical relationships can not be transferred directly to brittle fiber reinforced polymeric composites because these materials do not exhibit true plastic deformation and they are not isotropic. Neither can we copy the current designs used for metal (e.g., stainless steel) bone screws because they rely heavily on the fact that the metal threads are about ten times stronger than the threads in the bone. This will not be true for composite screws.

In the current study it has been assumed that the width of the thread on the screw should be the same as that in the bone (which is not the case for metal bone screws) because the composite and bone have comparable strengths. It has also been adopted as a design guide that there must be reinforcing fibers in the axial direction to carry the tensile loads and that there must be fibers oriented so as to resist thread stripping. Composites of various designs (i.e., fiber arrangement) are being fabricated so that the axial (and torsional) failure load can be determined and compared with the thread stripping load. The objective is to identify a design where these two failure modes will occur at the same load.

The composites to be tested consist of 1) a random chopped fiber composite, 2) a laminated 0°/90° composite with the 0 fibers in the axial direction, 3) a structure with a uniaxial fiber core and an outer layer of fibers wrapped in a spiral with a pitch the same as that of the intended threads and 4) a similar core/wound structure in which the core is a 0°/90° laminate the same as in 3 above. In 3) and 4) the surface of the core is knurled to enhance adhesion of the outer layers.

As these composites are fabricated the threads are produced by machining. Cutting the threads in the laminated composite with a conventional die has proven difficult because of shearing between the plys and pull out of the axial fibers. More gentle cutting techniques (e.g., grinding) are being considered.

The mechanical testing program will be continued upon my return to Clemson.

LAMINAR SEPARATION BUBBLE PREDICTION
for COMPARISON with FLIGHT DATA

by

Henry Day

Assis. Prof, Engineering Science and Mechanics
Virginia Polytechnic Institute
Blacksburg, VA.

A project is being conducted to compare numerical models of laminar separation bubbles with flight data taken on a Gates Lear jet model 28/29. Preliminary work was made to compare the occurence and position of bubbles between flight data and numerical models.

Laminar separation bubbles are increasingly important today as more extensive laminar flow is achieved. These bubbles set an upper bound on the extent of natural laminar flow achievable. When they do occur they add drag, avoidable by forcing transition before the bubble. Ability to predict maximum lift often depends on ability to predict bubble behavior.

Several numerical models of laminar separation bubbles have been or are being developed by other groups. Successful comparisons have been made with wind tunnel data, but until now the flight data available has been limited. The ALESEP code developed by Carter, Vasta and Davis was chosen for the present study because it is available and has been successfully tested against wind tunnel data. This code models only short bubbles, and though it has a compressible boundary-layer model, the inviscid model was incompressible. A revised transition criterion has been added recently, and looks promising.

The flight data available for this study includes pressure profiles $Cp(x)$ and data from specially designed hot-film sensors that permit indentification of reversed-flow regions and transition locations. The flow-reversed sensors were placed at four locations, x/c = .013, .021, .026 and .280. By slowly changing flightspeed, the section lift coefficient was varied, causing bubbles to form and move across the fixed sensors. By noting the time a point of separation or reattachment passes one of the sensors, the corresponding Mach number and pressure distributions have been obtained, to use as input to the numerical model. Predicted and actual locations of separation and reattachment points will be compared.

This study is significant in that it allows comparison of a current laminar bubble code with flight data. Of particular interest will be reattachment locations, which are strongly dependent on the laminar-turbulent transition criterion, which in turn determines drag, bubble bursting, and other major effects of the bubble. The new transition criterion in the ALESEP code has not been tested against flight data. Progress to date includes the adaption of ALESEP to compressible flows, indentification and correction of problem in the flight data reduction, and successful comparison of flight $Cp(x)$ data with predictions of a two-dimensional transonic airfoil code which will provide the input for the bubble code. It was concluded that simple two-dimensional flow exists only outboard of the 50% span station (due to engine nacelle effects), so the fourth flow reversal sensors should provide useable data.

EFFECTS OF ELECTRON RADIATION ON GRAPHITE/POLYETHERIMIDE COMPOSITES

by

Milton W. Ferguson

Assistant Professor of Physics
Department of Chemistry/Physics
Norfolk State University
Norfolk, Virginia

During recent years, there has been considerable interest in fiber-reinforced polymeric matrix composites. The use of composites for aircraft structural components has increased due to their outstanding combination of high strength, high modulus, and low density. In addition, fabrication techniques permit the tailoring of these materials to meet specific load and stiffness requirements. However, if these composites are to be utilized as efficient high performance materials in aerospace applications, their long range radiation durability must be established.

Initial performance studies focused on the properties of the fibers and the polymeric matrix, but it was soon realized that the interactions at the fiber/matrix interface were highly significant. Since interfacial bonds transmit stress between the fiber and the matrix, the mechanical properties of the material may ultimately depend on the integrity of the interface. The interface also occupies a prominent role in the determination of the modes of failure and the behavior at failure of the material.[1]

In order to understand the modifications to the composite caused by radiation, characterization of the interface in terms of its chemical behavior must be accomplished. High energy electrons interact with the composite by exciting the bonding electrons of the material to higher energy states or by ionizing the atoms. This produces ionic systems or radicals. The subsequent molecular changes caused by the radiation induced radicals may alter the mechanical properties of the material.

The goals of the study were: (1) to determine and analyze the effects of radiation on the mechanical properties of graphite and Kevlar fibers; (2) to determine and analyze the effects of radiation on the mechanical properties of graphite/polyetherimide composites fabricated from the same types of graphite fibers; (3) to see if a correlation exists between the radiation durability of the component materials and the radiation durability of the composite.

Graphite (Celanese Celion 6000 sized with 0.1 percent polyimide, Celanese Celion 6000 nonsized) and Kevlar 49 fibers were exposed to 1-MeV electrons at a dose rate of 5 X 10^7 rads/hr for a total dose of 9.5 X 10^9 rads. Since the results of investigations on the radiation-durability of Ultem, a polyetherimide manufactured by General Electric, have been previously reported by my NASA associates, Drs. Edward R. Long and Sheila Long[2], Celion 6000 graphite/Ultem composites were fabricated. These composites, with fibers oriented uniaxially in the longitudinal direction, were exposed to the same dosage of radiation as the isolated fibers. Characterizations of the fibers and composites were performed by tensile tests and interlaminar shear tests,

respectively, before and after irradiation. Interlaminar shear measurements were made to determine the effects of radiation on the interfacial properties of the composites. Electron paramagnetic resonance (EPR) data were used to detect, identify, and to determine the densities of radicals created by the radiation.

The Kevlar fibers had an approximately 20 percent reduction in the ultimate tensile stress when irradiated, but there was no apparent change in the ultimate tensile stress of the irradiated graphite fibers when compared to the controls. A decrease of approximately 25 percent and an increase of approximately 40 percent were observed in the modulus and ultimate strain, respectively. EPR measurements indicated that while the radical density of the irradiated Kevlar fibers increased by an order of magnitude, the radical density of the nonsized graphite fibers had a slight decrease and that of the sized graphite fibers remained inert. The expected decrease in the radical density of the sized graphite fibers is believed to be obscured by the increase in radical density of the sizing material.

Irradiated C6000 nonsized graphite/Ultem composites showed an approximate 10 percent decrease in the interlaminar shear strength when compared to the nonirradiated specimens. An observed increase in the radical density of the composites is attributed to the radical density increase of the polyetherimide matrix.

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THE EFFECTIVENESS OF ELIZABETH CITY STATE UNIVERSITY
INDUSTRIAL TECHNOLOGY PROGRAM ON THE PREPARATION OF
STUDENTS WHO ENTER NASA-LARC'S ENGINEERING TECHNICIAN
PROGRAM

By

Henry Foskey, Jr.
Professor and Chairman
Industrial Arts and Technology Department
Elizabeth City State University
Elizabeth City, North Carolina

Introduction

Feedback concerning job performance of graduates from industry and various agencies is an effective evaluative tool for the development of technology programs. In an effort to assure compatibility of university training with the needs of employers, periodic evaluations should be conducted to determine if programmatic changes are warranted.

Statement of the Problem

The purpose of the study was to determine if Elizabeth City State University's (ECSU) B.S. Degree Program in Industrial Technology adequately prepared students to enter and succeed in NASA-LARC Engineering Technician Program.

Methodology

The researcher spent various time periods at locations which utilize technicians and co-ops from ECSU and other institutions. An interview was conducted with various levels of management and technicians to ascertain the job performance of ECSU students. Secondly, to determine the actual technical activities performed by technicians. A study of students records, grades earned from the Apprentice School and employee evaluation was also conducted.

Findings

Data concerning ECSU's students consisting of grades earned from the Apprentice School and evaluations from supervisors revealed that their performance was average to above average. Data from interviews indicated that ECSU's students were successful in the performance of technical assignments. Some supervisors felt that some of ECSU's students were able to continue a technical assignment beyond the level of expectation for an apprentice.

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Conclusions

Results of the study concluded that ECSU's B.S. Degree Program in Industrial Technology adequately prepares students to enter and succeed in the NASA-LARC Apprentice School. General comparisons are often made between Thomas Nelson Community College (2-year) and ECSU (4-year) students. Individuals who make such comparison often do not understand the distinct different in objectives of both programs. This group tend to believe that B.S. Degree technology graduates should be "super technicians."

Managers from the Electronics Directorate were skeptical of employing B.S. technology students as engineering technicians. Their rationale is the probable dissatisfaction developed by the students because of a noncareer path for the engineering technologist at NASA-LARC. ECSU's B.S. Degree Industrial Technology students perform the same jobs and is paid the same salary as their counterpart who obtain A.S. Degrees.

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MODELING AND FEEDBACK CONTROL OF ROBOTIC SYSTEMS

by

Devendra P. Garg
Professor of Mechanical Engineering
Duke University
Durham, NC 27706

This project deals with the application of teleoperation and robotics in the context of space station construction. Teleoperation is the study and use of manipulators which receive instructions from a human operator and perform some action based on those instructions at a location remote from the operator. The remote manipulator system used in the space shuttle was an excellent example of the state-of-technology. Telepresence indicates a teleoperation situation in which the operator receives sufficient cues to feel present at the remote location. Whereas, in the full operational version, it is proposed to have the various functions in the space station highly automated; in the initial operational version, teleoperation will play a major role. The evolving, multipurpose-space-infrastructure facility will combine artificial intelligence, robotics, and teleoperation.

Automation implies the use of machines to control and/or carry out processes in a predefined or modeled set of circumstances without human intervention. Robotics is the study and use of machines capable of manipulation and/or mobility with some degree of autonomy. It will be highly desirable to incorporate automation and robotics in the Space Station related tasks in order to increase productivity, decrease operating costs, enhance flexibility and reliability, perform tasks unsuited to humans, take over repetitive and time consuming functions, and reduce environmental hazards. Astronaut prductivity can be increased by assigning to the telerobots a variety of control and monitoring functions which do not necessarily require human intervention. In addition, productivity can be enhanced by mechanical devices which interact with humans. For example, a teleoperated or robotic system could be employed to assist the astronaut on an EVA mission by grasping tools, moving objects in position, and advancing human capabilities in general.

The Man-Equivalent TeleRobot (METR) system is a concept developed by Martin Marietta based upon the remote manipulation experience accumulated at Oak Ridge National Laboratory over the years. The METR system study was sponsored by the Automation Technology Branch of the NASA Langley Research Center. The main objective of the research and development effort was to design a telerobotic work package for space application to increase astronaut and overall system safety, productivity, and flexibility. To meet these criteria, the METR system incorporates a dual-arm system, replica master control, bilateral force reflection, flexible, graphics-based control, and several monocular television cameras for viewing.

The proposed system consists of a seven-degree-of-freedom arm mechanism that provides kinematic redundancy for obstacle avoidance. The arm has three identical pitch/yaw joints which combine to provide shoulder, elbow and wrist joints, and an output roll motion at the wrist. Each joint in the assembly consists of a differential drive mechanism, two servomotors

with speed reducers, two torque sensors, and two encoders. The advantages claimed on account of this mechanical construction includes low back driveability, smoothness of operation, high stiffness, simplicity, zero backlash, built-in clutch protection, and output position encoding. The design incorporates brush type DC servomotors to power the differential mechanism. These motors drive through speed reducers and torque sensors. A change in METR performance characteristics, for example, speed and load limits, can be affected by a variation in reduction ratio. A cabling arrangement is used within the differential mechanism. It consists of a flat cable bundle wound in two coils and positioned about the pitch and yaw axes.

The research effort this summer was devoted to a review of the METR system. In addition, design techniques for robotic systems proposed by the European Space Agency were examined. Laboratory research consisted of designing and implementing controllers for the PUMA 600 robots available in the Intelligent Systems Research Laboratory (ISRL). Feedback controller parameters were tuned using the Ziegler-Nichols optimization procedure. The utility of CTRL-C, a software package, was investigated for control system analysis and design.

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ACOUSTIC EMISSION IN COMPOSITE MATERIALS

by

Michael R. Gorman

Assistant Professor
Engineering Mechanics
University of Nebraska-Lincoln
Lincoln, Nebraska

Composite materials like graphite/epoxy are being used in the aircraft and aerospace industry for a variety of structures such as horizontal and vertical stabilizers, flaps, and rocket motor cases. A deeper understanding of composites will lead to their use on more critical components of aircraft like wings and fuselages because of the increased performance which can be realized from the weight savings composites offer. A large research effort exists at NASA LaRC aimed at improving understanding of the constitutive properties of these materials as well as the fracture and failure mechanisms.

More often than not these structures operate near their design limits so it is important to detect any flaws and determine whether they are or could grow to be critical. The field dealing with this problem is called nondestructive evaluation (NDE). One of the techniques which holds promise as both a materials science tool and an NDE tool is acoustic emission (AE) and NASA has determined that an effort should be undertaken to build the science base necessary to exploiting the use of this tool. Under a NASA/ASEE fellowship, the first step was taken in this direction.

Acoustic emission is an elastic wave resulting from rapid stress relief at fracture sites in solids. The wave frequencies are generally in the ultrasonic region and thus require sensors such as piezoelectric devices in order to be detected. AE has been measured in metals for some years to detect dislocation movement and various kinds of internal fracture. The technology has been adapted for composite materials, but with only limited success. This has been attributed to the complexity of fracture modes in composites and also to lack of understanding of wave propagation in these heterogeneous, anisotropic materials.

Therefore, both acoustic emission and material variables were identified and relationships were postulated. Initial experiments were designed to test the relationships. These experiments take advantage of the knowledge and experience gained in the micromechanics program ongoing in the Fracture and Fatigue and Polymer Chemistry Branches. The single fiber specimens being studied there eliminate most of the wave propagation concerns while at the same time simplifying the identification of the fracture mechanism.

Fundamental measurement needs were assessed and it was determined that available monitoring techniques were inadequate. New ideas for performing measurements have been put forth and discussed within the MCIS Branch, NDE

Section at LaRC. In order to characterize an AE source more fully, it was decided that transducers with a wider bandwidth than heretofore used in AE studies were needed. Also the importance of phase cancellation when waves arrive from multiple sources or impedance change reflections implies that the size of the transducer be small. However, this implies a smaller output signal and hence, better electronic amplifiers or signal enhancement techniques may be needed.

Finally, a thorough review of the literature was conducted. Notably, research interest on the subject of acoustic emission in heterogeneous, anisotropic materials has grown considerably around the world in the last two years. Workers in many different fields such as microcontinuum mechanics, percolation theory, and seismology are recognizing the fundamental similarities in the underlying theoretical structure to the problem of AE source identification in composites. The end result of all this work will be the ability to make quantitative measurements of parameters which are related in a straightforward fashion to mechanical variables. In this way, prediction of the remaining strength and life of multi-million dollar structures built with composite materials will reach the assurance levels needed.

GRID GENERATION
FOR BOUNDARY-LAYER DIVERTERS

David Hart
ASEE Fellow, 1986
University of Cincinnati

Computational aerodynamics involves the numerical solution of differential equations in a region exterior to an aircraft. This region must be mapped to a regular computational domain and discretized: this process is called "grid generation." Various constraints are imposed upon the mapping by the demands of accuracy and economy.

A goal of computational aerodynamics is to model realistic high-performance aircraft. Among the geometric complexities frequently encountered here is the boundary-layer diverter, a cavity separating the air inlet and the fuselage. These are typically associated with "vanishing singularities," sharp corners which merge smoothly into the fuselage as one progresses streamwise down the body. Singularities are a major source of numerical difficulties, and vanishing singularities are particularly intractible.

Several approaches were taken to the problem of developing a grid for the boundary-layer diverter of a proposed jet fighter design. The region in question may be treated as a wedge tacked onto the main flow domain, or the main region may be pushed into the cavity. In either case, one may use patched (abutted) or overlapping grids; each has advantages and disadvantages. Grids were generated for each of these approaches, using the two-boundary grid generation program developed at Langley Research Center by R. E. Smith (NASA TP2533, March 1986).

THE GEOLOGIC FATE OF ALKANES ON MARS

by

Gerald H. Johnson

Professor of Geology
Department of Geology
College of William and Mary
Williamsburg, Virginia 23185

During the formative stage of Mars and Earth about 4.6 million years ago, gases were released from the interior of the planets to form primordial atmospheres. Various researchers (Fanale, 1971 and others) have postulated that the early martian and terrestrial atmospheres were composed principally of methane, hydrogen, nitrogen and water vapour. Recent studies on the stability of reduced gases in primitive planetery atmospheres casts doubt on the stability of methane under these conditions (Levine and others, 1982). According to Lasaga and others (1971) and Yung and Pinto (1978), polymerization of methane and its deriviatives by solar ultraviolet radiation in the primordial terrestrial and martian atmospheres formed a blanket of alkanes between 1 and 10 m thick over the entire surface of both planets. If alkanes were formed on Mars and they could be located on future manned missions to Mars, this would resolve the issue of the composition of the primordial atmosphere of Mars and by analogy, that of Earth; the early geologic record on Earth has been destroyed by subduction, crustal melting, weathering and erosion. Furthermore, the presence of a methane-rich atmosphere in the early history of Earth has major implications for the origin of life and the climatic history of both Earth and Mars (Levine and others, 1986).

Recent studies on the photochemistry and climate of Mars (Levine and others, 1986) using the assumptions of Yung and Pinto (1978) that the martian atmosphere was comprised of methane, hydrogen, and nitrogen at a ratio of 60:6:1 by volume, with a relative humidity of 50 percent, and an atmospheric pressure of 100 mb, indicate that the temperature of the surface of Mars would have been between 190° to 205° K with a solar constant of about 70 percent. At these temperatures the alkanes would be liquid.

Once the alkanes were synthesized, they would have been removed from the atmosphere through condensation, freezing, adsorption onto particles, or in solution; the latter would be relatively insignificant in the cold, relatively dry martian atmosphere. The fate of the alkanes on or near the planetary surface would have been dependent upon the rate of accumulation and on the geologic processes that were active. Assuming that the alkanes were formed in 10 to 100 million years, the rate of accumulation would have been 1 mm per 1000 to 100,000 year during the period of outgassing and alkane formation. In this interval, meteoritic impacts, sporadic volcanism, and surface processes would have

destroyed, removed, and buried the slowly accreting alkanes.
Alkanes falling onto the surface would have adsorbed to clay and
other mineral surfaces, vaporized, metamorphosed and dissociated
by the intense heat of meteorite impact and associated volcanism.
During thermal excursions, the alkanes would be carried downward
into the regolith by water or redistributed on the planetary
surface by wind and fluvial activity. Alkanes introduced into
the regolith may be preserved as inclusions in cements, adsorbed
to mineral surfaces or dissolved in or concentrated at the
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THE EFFECT OF DOSE RATE, TEMPERATURE, AND POST-IRRADIATION HANDLING ON IRRADIATED POLYSULFONE AND POLYETHERIMIDE

by

Richard L. Kiefer
Professor
Department of Chemistry
College of William and Mary
Williamsburg, Virginia

Space structures in geosynchronous orbit will be subjected to radiation doses of about 10^{10} rads over a 30 year lifetime. In addition, daily thermal cycling will occur. These structures will likely be constructed of polymer-matrix composite materials because of their light weight, high strength, and low thermal expansion. Radiation is known to initiate chain sission and crosslinking in polymeric materials, both of which affect their structural properties. Thus, a study of the effect of radiation on polymers is important in estimating the impact of the space environment on composite structures.

In this study, two commercially available polymer films were used; a polyetherimide, and a polysulfone. The polyetherimide was produced by the General Electric Company with the trade name Ultem. The polysulfone was produced by the Union Carbide Corporation as P1700. The two polymers were chosen for study because they had been well characterized, they were commercially available in good quality films, and they are both linear systems. Both films were irradiated in vacuum with 85 keV electrons. Properties of the films before and after irradiation were monitored by tensile elongation measurements, ultraviolet/visible spectroscopy, glass transition temperature measurements, gel permeation chromatography, and infrared spectroscopy.

The polyetherimide, Ultem, becomes colored when it is irradiated, a characteristic common to many polymer films. However, when Ultem is exposed to air after irradiation, the color fades. In order to quantify this color change, ultraviolet/visible (UV/VIS) spectra of irradiated Ultem films were recorded at various times after the irradiation beginning at 5 minutes and extending to at least 4 hours, as shown in Figure 1. The spectra were recorded on a Perkin-Elmer model 330 spectrophotometer. Irradiations were performed with total doses of 100, 320, 640, 2000, and 4000 Mrads. Dose rates ranged from 4.2 to 170 Mrads/hr. The precent transmittance was determined at a specific wavelength (490 nm) for each spectrum so that a plot of %T vs time after exposure could be made as shown in Figure 2. It can be seen that the %T at 490 nm increased with time after exposure up to a maximum value which was always less than that of the unirradiated film. The %T at each time was then subtracted from this maximum or equilibrium value. The log of the remainder is plotted as a function of time after exposure in Figure 3. This plot shows the decay of the color and thus the decay of the specie causing the color. Figure 3 shows two distinct groups of points, those from films irradiated at high doses (2000 and 4000 Mrads) and those irradiated at lower doses (320 and 640 Mrads). The color of the films irradiated at high doses decayed with a 90 minute half-life while that of the films irradiated at the lower doses decayed with a 40 minute half-life. It has been shown by ESR

spectroscopy that for a 1600 Mrad irradiation of Ultem, the radicals decay with a 90 minute half-life.[1] Thus, there is good evidence that the decay of the color centers is due to radical decay. It has also been shown that the critical gel dose for Ultem is about 1100 Mrads.[2] Therefore, it appears that above the critical gel dose, the radicals decay more slowly due to a decrease in mobility or to a change in decay mechanism. The UV/VIS data as a function of total dose is summarized in Figure 4.

Because the Ultem contains radicals which decay with a measurable half-life when exposed to air, tensile elongation studies were run as a function of time after irradiation to see if the radical decay affected the mechanical properties of the polymer. Total doses and dose rates were the same as those used for the UV/VIS studies. In these studies, the irradiated films were removed from the vacuum chamber and immediately immersed in liquid nitrogen. Films were then removed and exposed to air for a period of time before the tensile elongation test was made. Time periods of 0, 15, 30, 60, and 120 minutes were used. Within experimental limits, no effect of time in air on the tensile elongation was noted at any total dose studied. In addition, two samples were irradiated at 320 Mrads and allowed to remain in vacuum for 4 days before making the tensile elongation measurements. Again, no effect with time was noted. The data are summarized in Figures 5, 6, and 7. The infrared spectrum was also measured as a function of exposure time in air, and again, no effect was noted.

The Ultem irradiations show that for optical properties, post-irradiation effects are important, particularly for the first several hours. Post-irradiation handling appears to have no effect on the tensile elongation and the infrared spectrum.

To compare the behavior of Ultem with that of another polymer, poly-sulfone (P1700) was irradiated and treated in an identical manner as the Ultem. No effect was found in either the tensile elongation or the UV/VIS spectrum as a function of exposure time in air. Figure 8 shows the UV/VIS spectrum for polysulfone as a function of exposure time in air. This can be compared with Figure 1.

Since polysulfone showed no post-irradiation effects, it appeared to be an ideal polymer to use for a study of dose rate and temperature effects on the tensile elongation. In the dose rate study, the total dose was held constant at 350 Mrads and the temperature was constant at 25° C while the dose rate was varied between 1.8 and 260 Mrads/hr. The results are shown in Figure 9. Tensile elongation is the most sensitive measure of crosslinking in a polymer. Apparently, at the higher dose rates the steady-state radical concentration is saturated so that the crosslinking also saturates. Thus, the tensile elongation is constant at about 95%. For lower dose rates, the steady-state radical concentration varies with the dose rate down to some baseline value. This is also reflected in the elongation data.

For the temperature study, the total dose and dose rate were constant at 350 Mrads and 87.5 Mrads/hr respectively while the temperature was varied between 25 and 175° C. The results are shown in Figure 10. Above 110° C, the tensile elongation drops to zero. This probably occurs because the critical gel dose decreases at the higher temperatures so that by 125° C it is below

350 Mrads. Brown and O'Donnell have shown that for gamma irradiation of polysulfone (P1700), the critical gel dose decreases from 400 Mrads at 35° C to 100 Mrads at 125° C.[3] This is qualitatively in line with our data. There appears to be a slight increase in tensile elongation as the temperature increases from 25° to 110° C. It has been shown for this polysulfone that the ratio of chain sission to crosslinking, $G(S)/G(X)$, increases with increasing temperature.[3] This would cause an increase in tensile elongation with increasing temperature up to the point where the critical gel dose is exceeded.

The data clearly indicate that for polysulfone (P1700), dose rate and temperature both affect the tensile elongation and thus both affect the structural properties.

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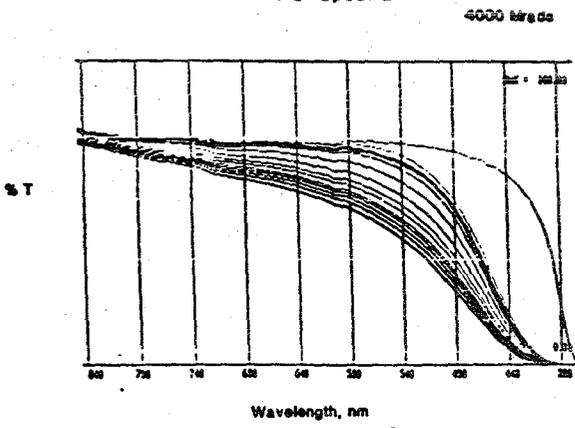
Polyetherimide
UV/VIS Spectra

Fig. 1
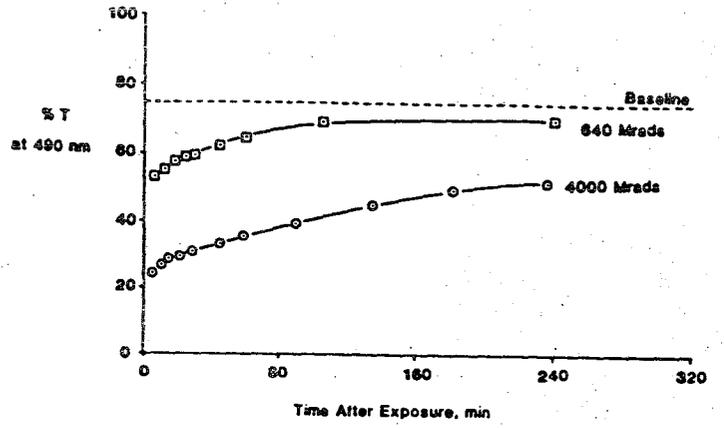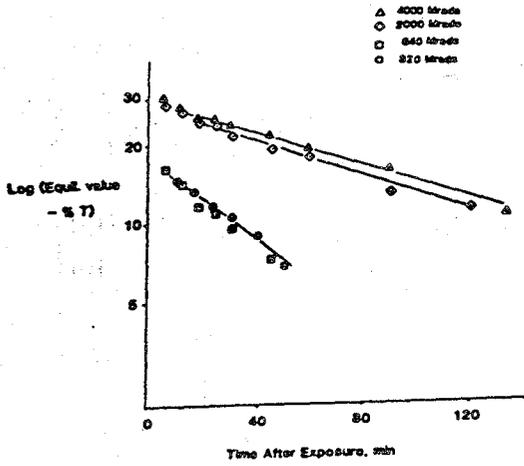
Polyetherimide

Fig. 2

Polyetherimide

Fig. 3

Polyetherimide
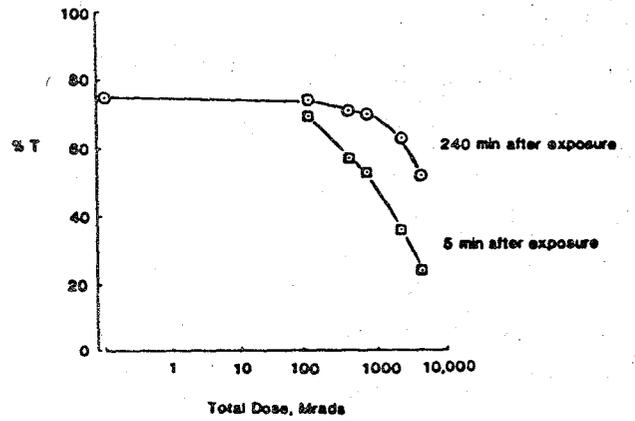
Fig. 4

Polyetherimide

Fig. 5

Polyetherimide
Total Dose 350 Mrads — Tested immediately

Fig. 6

63

Polyetherimide

320 Mrads (stored in vacuum 4 days before test)

2000 Mrads (tested immediately)

4000 Mrads (tested immediately)

Tensile Elongation %

Time Before Test Initiation, hrs
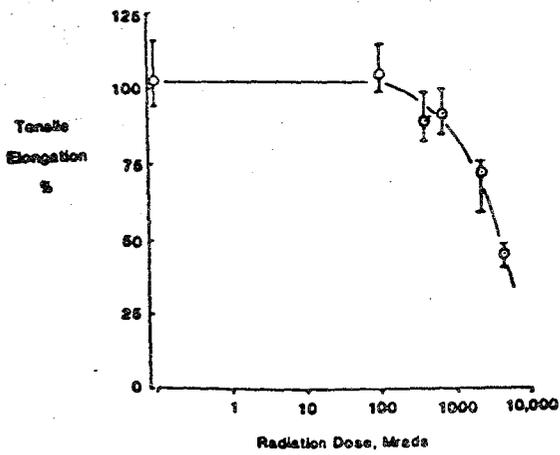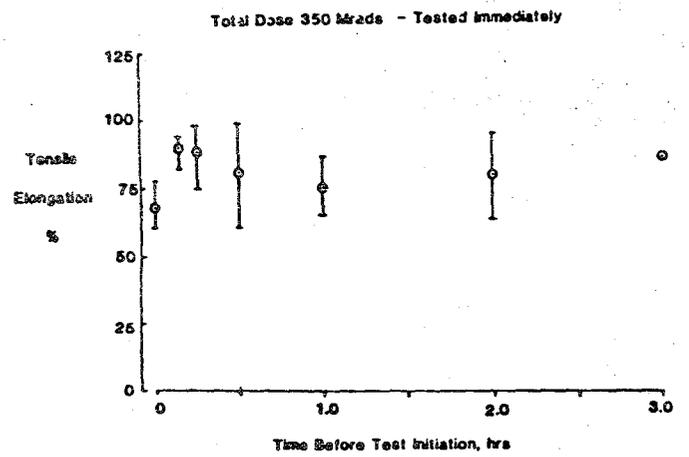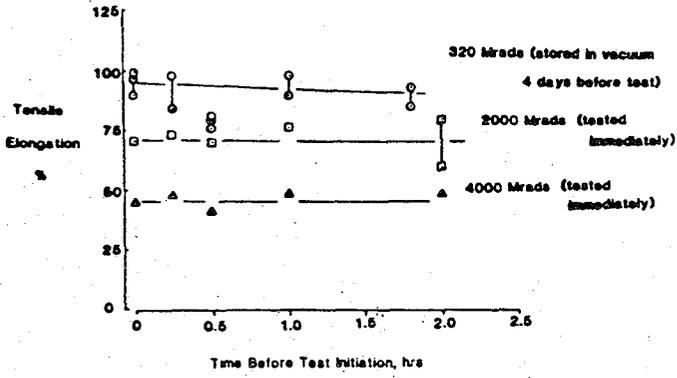
Fig. 7

Polysulfone
UV/VIS Spectra

100 Mrads

% T

Wavelength, nm

Fig. 8

Polysulfone

350 Mrads Total Dose

25 deg C

Tensile Elongation %

Dose Rate, Mrad/hr

Fig. 9

Polysulfone

350 Mrads Total Dose

87.5 Mrads/hr

Baseline

Tensile Elongation %

Temperature, degrees C

Fig. 10

64
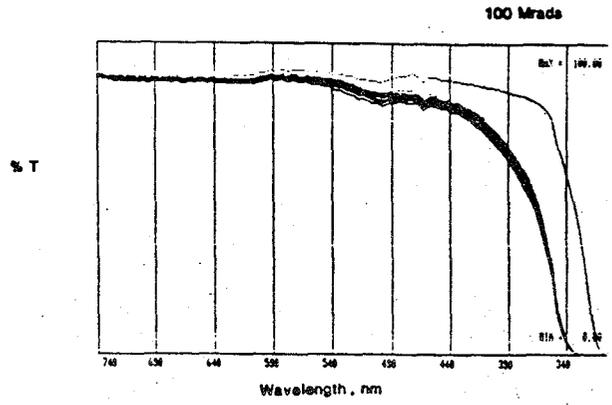
Control System Design of the LDCM Actuator for the COFS Mast

By

Douglas K. Lindner

Assistant Professor
Department of Electrical Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

The COFS program is designed to evaluate and compare various algorithms for the identification and control of large space structures. To this end a sixty m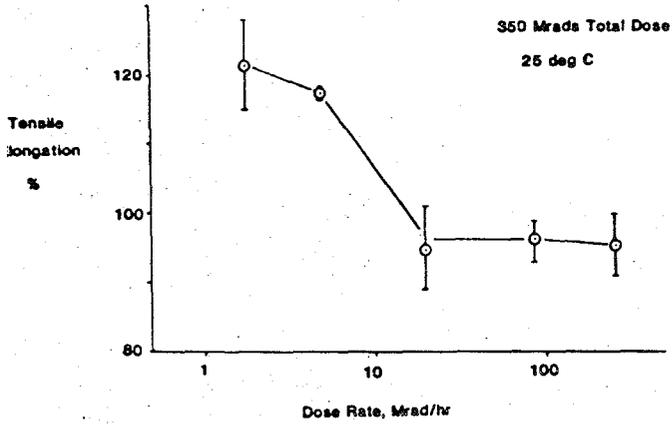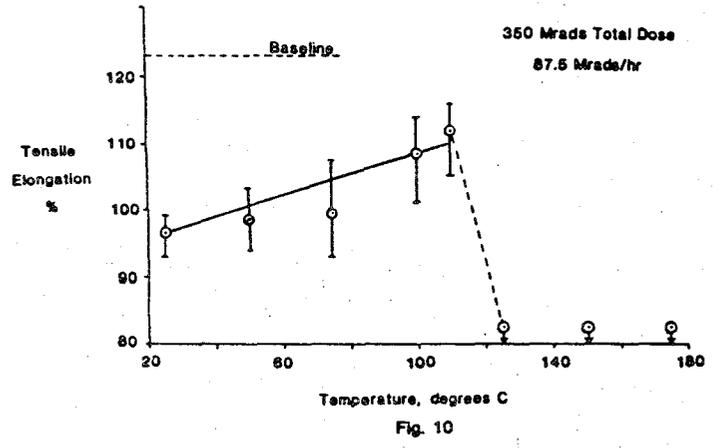eter deployable beam, called the COFS Mast, is being designed for space experimentation aboard the shuttle. The goal of the first phase of this program is to excite, identify, and control the flexible modes of the Mast.

Excitation and control of the flexible modes of the Mast will be accomplished with Linear Direct Current Motor (LDCM) actuator (Fig. 1). Through current excitation, a force is exerted on a proof mass. As the proof mass accelerates, an equal and opposite force is imparted, through the base of the actuator, to the Mast. For this actuator to be useful for experimentation purposes, it should be operated in its linear range; i.e. the proof mass should not hit the stopps. When this actuator is operated open loop (just current excitation), the proof mass has a tendancy to drift. Thus, the actuator eventually becomes unusable without recentering.

Here, we propose a control system for the LDCM actuator to keep the proof mass centered. The basic idea is to add a position sensor to the actuator and create a postion feedback loop. The analysis and design of this modified actuator includes:
1. A compensator to stablize the proof mass.
2. Analysis of the effect of disturbance signals. These include noise from the position sensor and force ripple from the commutator strips.
3. Evaluation of the maximum force commanded.

The modified actuator is then evaluated on the COFS Mast. Excitation capability is determined and typical control laws are simulated.
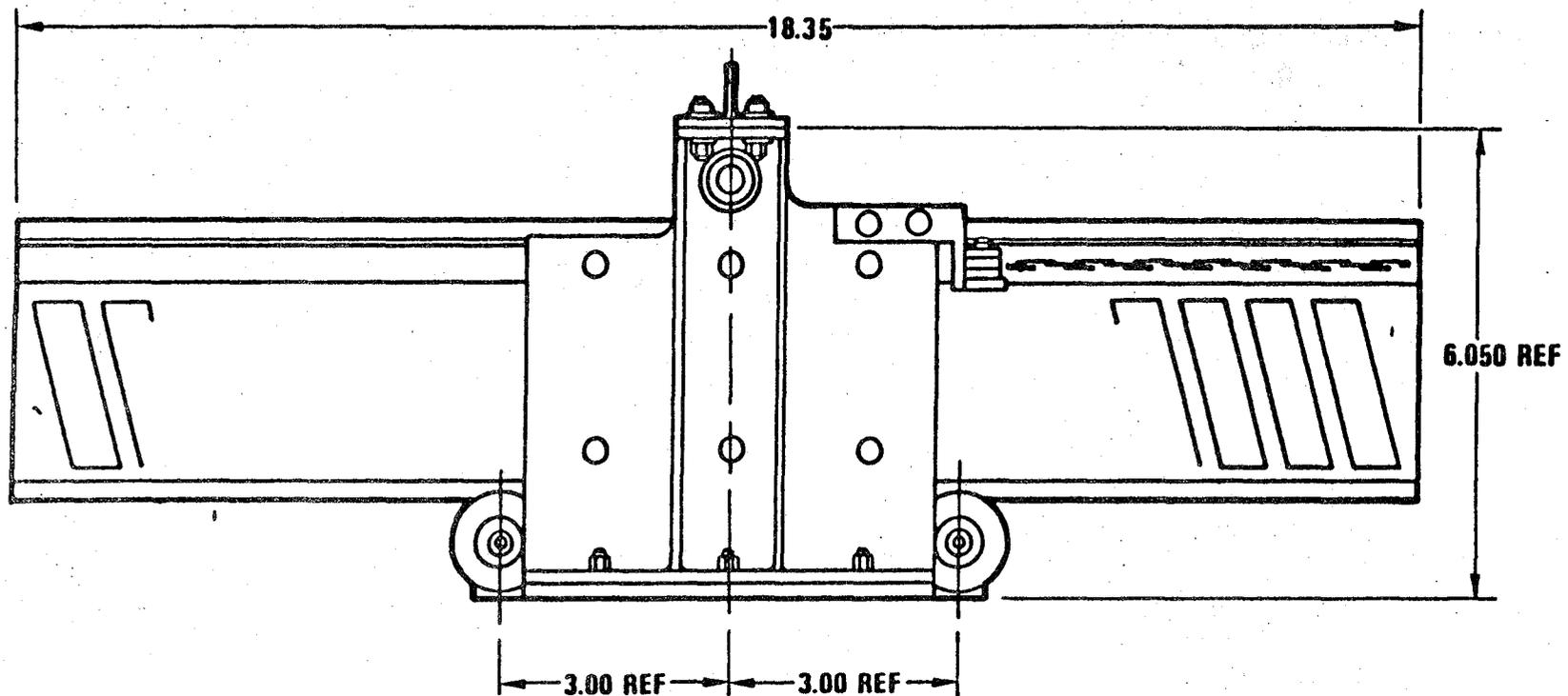
Linear DC Motor (LDCM) - Side View

FIGURE 1

A Study of the
Langley Acquisition Management System
by

Jacquelyn E. Long
Assistant Professor
Department of Mathematics and Computer Science
Norfolk State University
Norfolk, Virginia

A study was made of the procurement system at Langley Research Center and the Langley Acquisition Management System, the computerized system for managing, tracking, and reporting procurement data. During the process, information was recorded to be included in a document giving an overview of the procurement system and an instructional guide for the use of the computerized management system.

The various menus and options available in the acquisition management system were tried for some test data. Based on the results of these trials, recommendations were made for making the system easier to use by acquisition personnel. Also, recommendations were made for extending the use of the Langley Acquisition Management System to other areas within the Acquisition Division and for the computerization of other processes.

TOPICS IN IDENTIFICATION AND CONTROL OF FLEXIBLE SPACECRAFT

by

Professor Richard W. Longman
Columbia University
New York, New York

During this second summer of support on the NASA/ASEE summer faculty program, Professor Longman was involved in a number of different projects which continued or followed from the research work of the previous summer.

One of these projects which has just been completed appears as a paper entitled "A Recursive Form of the Eigensystem Realization Algorithm for System Identification," which was presented at the AIAA/AAS Astrodynamics Conference in Williamsburg, Virginia, on August 20, 1986. This work developed a simple and fast algorithm for identifying linear systems from sampled data. The algorithm, together with certain confidence criteria, represents an alternative form of the Eigensystem Realization Algorithm (ERA) developed by Dr. Juang at NASA Langley over the past few years. It has proved to be a very valuable tool in the structures community for development of mathematical models from model testing. The standard form of ERA operates on a large Hankel matrix of data and truncates based on singular values to achieve the final identified model. The algorithm produced here is based on Gram-Schmidt orthonormalization, and recursively builds up the order of the model until the appropriate order is reached. As a result, the new algorithm is very efficient and requires very little storage. It automatically gives the identified system matrix in upper Hessenberg form, which has advantages for eigensystem analysis once the identification is completed. It also has the property that given the identification results for any chosen order, the identification for any lower order models are immediately obtained by truncation of the system matrices. Examples are given which show that the advantages of the new algorithm are obtained with very little degradation in accuracy of identification compared to the standard ERA algorithm.

The research for a second paper has also been completed, on the subject "Computation of Standard Deviation of Scatter in ERA Identified Parameters." After my departure computer runs will be made at NASA to evaluate the method developed. If the results fulfill the promise of the method, it will represent a very important contribution to the ERA identification method. The user of the method indicates the noise level of the sensors used in terms of their covariance of the identified parameters from the linearized equations. This allows one to indicate in an approximate way the confidence limits one has in the identification results. To date, no such estimate of the confidence of the results has been available.

A third closely related research area has been started, that of developing estimates of the biases in the identified parameters. The least squares method which underlies the ERA method does not produce a unbiased estimate,

and by changing the dimension of the Hankel matrix used one often gets results which are much better in terms of the scatter in the results produced by noise, but this improvement is done at the expense of increasing the bias in the estimate. Dr. Juang and I believe that we now have a lead that will allow us to produce estimates of the bias. If the computation involved is not too large, it too can be used as indicators of the confidence one has in the ERA results. Professor Longman will continue to work on this after his return to Columbia University.

The Structural Dynamics Branch has awarded a research contract to Professor Longman through Columbia University which started shortly before the beginning of the summer. Three Ph.D. students were employed on the contract during the summer. One of these students, Mr. Mink Phan, was at NASA Langley throughout the summer, while the other two were working at Columbia University. The research of these people involves three separate topics. Mr. Phan's work under Dr. Longman's direction, was on the use of p-integrators to control flexible spacecraft. The concept of a p-integrator comes from digital control theory, and is used here to design controllers for slewing of spacecraft. The p-integrator concept is particularly attractive since it represents a simple method of implementing controllers that can learn from their previous performance and improve. It is particularly useful for spacecraft whose mission requires repetitions of the same maneuver. The work this summer was to develop a p-integrator control design for a laboratory spacecraft model that is being used for flexible spacecraft studies related to space station. Work is continuing on the project, and if the computer simulators are as expected, it is expected that experimental verification be performed at NASA.

The other projects in progress involve the development of nonlinear control methods for large-angle slewing of flexible structures, and the development of new control methods to determine feedback deadbeat control laws that include bounds on the actuator strengths. If the latter objective is achieved, it will produce a very useful and practical control method to kill vibrations in structures as quickly as possible. Work is in the early stages on both of these projects, and will be continuing through the next year.

BELOW GROUND GEOCHEMICAL PROCESSES
IN A TIDAL WETLAND, LEWES, DELAWARE:
IMPLICATIONS FOR SULFUR GAS FLUXES

by

W. Berry Lyons
Associate Professor
Department of Earth Sciences
University of New Hampshire
Durham, NH 03824

Tidal wetlands are thought to be locations for quantitatively important emissions of biogenically produced sulfur gases into the global troposphere. These gases include hydrogen sulfide (H_2S), dimethylsulfide (CH_3-S-CH_3), carbonyl sulfide (COS) and carbon disulfide (CS_2). Because sulfur aerosols in the atmosphere contribute to acid precipitation, as well as influence the earth's radiation budget, it is important to quantify natural biogenic fluxes as well as to understand what controls these fluxes.

In June, 1986, an experiment was conducted to measure simultaneously biogenic sulfur gases, nitrogen oxide gases and methane gas emissions along a salinity gradient in a tidal wetland in Lewes, Delaware. This experiment included a number of university and NASA investigators and was funded through the NASA Global Biology Program. During this experiment, my primary responsibility was to collect and analyze sedimentary pore water samples in areas where gas fluxes were being measured. My work was done in conjunction with Dr. M. E. Hines of the University of New Hampshire.

Four marsh locations were sampled. These locations included a fresh water end-member, a dessicated, hypersaline site and two locations more representative of the wetland as a whole. All locations had Spartina alterniflora as the primary type of vegetation. Pore water samples were collected by an in situ technique using teflon "sippers" under an inert atmosphere. This was done to eliminate artifacts which can result from oxidation and root cutting. Samples were analyzed for pH, Cl^-, SO_4^{2-}, titration alkalinity, Fe^{2+}, NH_4^+, PO_4^{3-}, SiO_2, and H_2S.

The pore water data indicate that the hypersaline site (site LV) as well as one of the marsh locations (site AA) were relatively oxidizing while the other two sites (freshwater end-member, HC, and the other marsh site, CT) were more reducing in nature. At the oxidizing sites, the pH's were lower and the SO_4:Cl ratios were higher than normal seawater, indicating that the oxidation of sulfide minerals had occured. At the other two locations, H_2S was present and the pH's were higher. Nutrient (NH_4+ and PO_4^{3-}) concentrations were low at all locations, suggesting uptake of these compounds by the roots of the Spartina grass.

In general, the more reducing sediments yielded the higher H_2S gas fluxes while the more oxidizing locations showed higher COS gas fluxes. However, the fluxes at the typical marsh locations (AA and CT) were dominated by grass emission of dimethyl sulfide.

THE EFFECTS OF CABLE SUSPENSION
ON BENDING VIBRATION OF LARGE BEAMS

by

Saba Mahanian

Assistant Professor
Mechanical Engineering Department
University of Puerto Rico
Mayaguez, Puerto Rico

Satellite antennas and space stations, extensively, use large truss-beam structures. Before these structures can be launched, proper structural ground tests are performed to ascertain among other things the vibrational characteristics of the structure. Efforts are made in these ground tests to simulate zero-gravity orbital environment and prevent any gravitational effects that can drastically alter the structural characteristics of the joints or other components through excessive deformation.

Cable suspension is one of the methods that has been frequently used in ground tests to counteract the force of gravity. Herr (1974) performed experimental investigations on the effects of cable suspension on the first flexural frequency of free-free uniform beams. This paper explores analytically, the effects of cable suspension on the transverse bending vibration of a 60-meter, cantilevered, uniform, beam.

The equations of motion are derived for a beam suspended by a multiple cable arrangement. The beam is modeled by a series of rigid body links; each attached to the next by a torsional spring. The equations of motion derived, are versatile enough to accommodate any number of rigid links and springs to model the continuous beam. Furthermore, any number of cables or cable arrangements can be accommodated without having to rederive the equations of motion.

For this preliminary investigation the equations of motion are linearized for small motion about the static configuration. Modal analyses are subsequently performed by numerical methods to determine the effects of cable suspension. The resulting modal analyses contain both the effects of rigid body pendulum modes and the effects of flexible beam modes.

The natural frequencies of the pendulum motion are observed to be spaced very closely together and contained in the interval $\omega_1 = \sqrt{g/L}$ to $\omega_n = \sqrt{3g/L}$ where g = acceleration due to gravity, L = cable length and n = total number of modes or degrees of freedom. However, the natural frequencies due to flexible modes span over a much larger range. Thus it is found that for the case where the first natural frequency of the beam almost equals the first natural frequency of the pendulum (about 0.3 Hz), the first natural frequency of the beam-cable assembly increases by more than 40% but the 2nd natural frequency increases only by about 1% and the higher natural frequencies by even less. Thus, it is shown that the higher the mode, the more neglegible the effect of the pendulum modes. None of the mode shapes of the beam are

appreciably affected by the cable suspension system.

Within the boundary of small deformations, the number of cables and different cable arrangements do not appreciably alter the effects of cable suspension on the natural frequencies of the beam. However, when the cables are placed at the nodes of a particular mode shape, the error due to cable suspension in the associated natural frequency can be minimized. Unfortunately, due to the absence of any node in the first mode shape, this method can not be applied to eliminate the errors in the first natural frequency.

Cable length, as expected, is the most dominant parameter in the problem. The higher the length of cables the smaller the pendulum frequencies and thus the smaller the effect of cable suspension. Each natural frequency of the cable-beam assembly is found to be the square root of the sum of the squares of the pendulum frequency and the beam frequency.

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THE DESIGN OF AN AIRFOIL FOR A HIGH-ALTITUDE, LONG-ENDURANCE REMOTELY PILOTED VEHICLE

Mark D. Maughmer
Assistant Professor of Aerospace Engineering
The Pennsylvania State University
University Park, Pennsylvania

Currently, there is interest in the development of high-altitude, long-endurance remotely piloted vehicles for a number of proposed missions including communications relaying, weather monitoring, and providing targeting information or early warning for outgoing or incoming cruise missiles. The preliminary design and sizing of such aircraft is complicated, however, by the fact that data regarding suitable airfoils are limited. This is due to the fact that such vehicles, unlike those for which the majority of airfoils have been developed in the past, operate at fairly high lift coefficients and at relatively low Reynolds numbers. Thus, to provide realistic airfoil performance information for preliminary design efforts, a generic airfoil has been designed which is suited for use on aircraft whose missions are similar to those noted.

The airfoil developed is unflapped and has a thickness ratio of 15 percent. The design Reynolds number range is from 7×10^5 to 2×10^6. Operationally, the airfoil achieves low drag at lift coefficients ranging from 1.5, corresponding to the maximum endurance design condition, down to .4, the lift coefficient providing high-speed dash capability. Further, the airfoil is designed specifically such that the maximum lift coefficient, approximately 1.8, is unaffected by surface contamination. Consequently, take-off and landing in rain, or with insect residue on the wings, should present no special difficulties.

All of the airfoil performance characteristics are summarized in the accompanying figure.
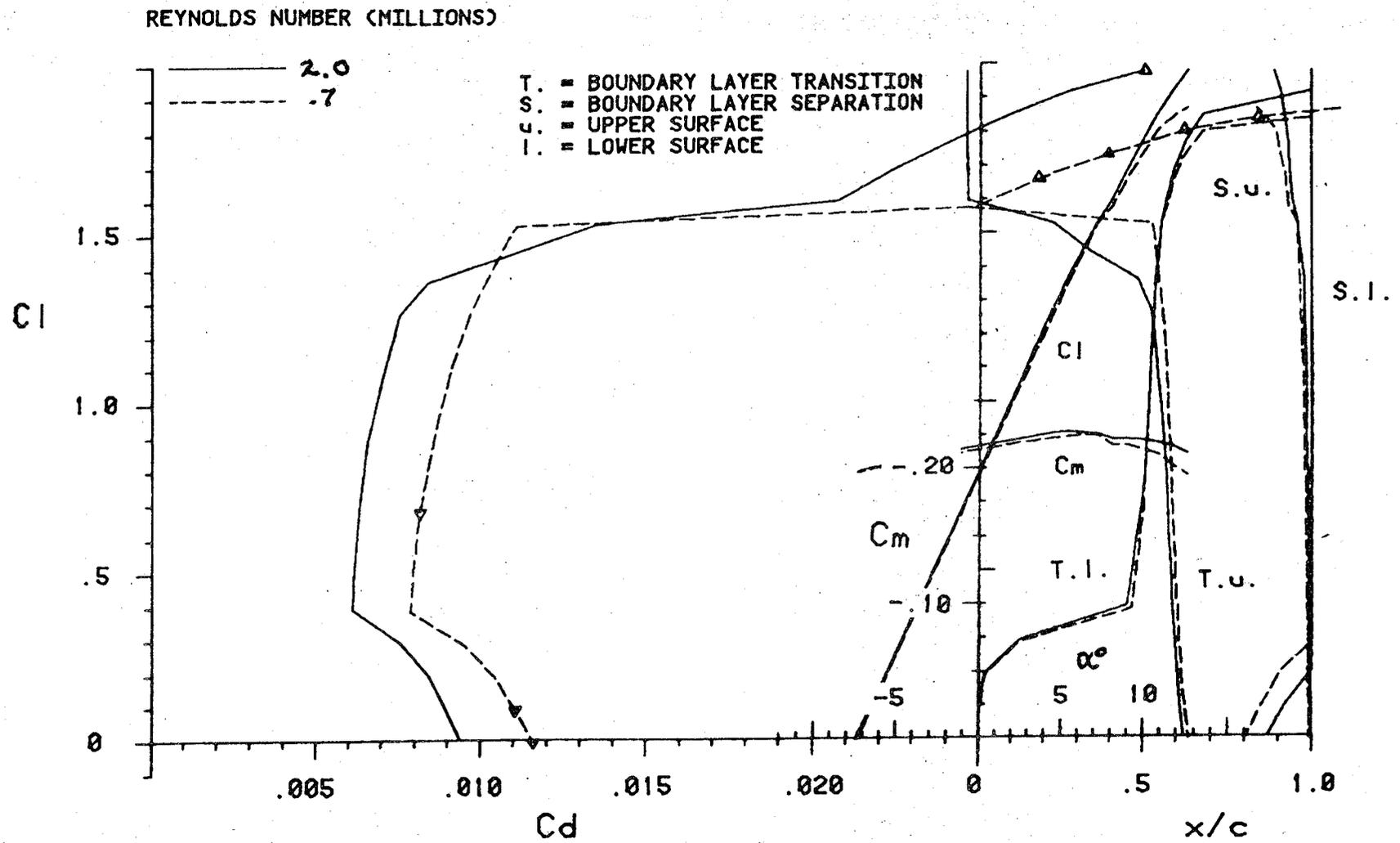
Aerodynamic characteristics of high-altitude, long endurance remotely piloted vehicle airfoil.

MULTILEVEL DESIGN SENSITIVITY ANALYSIS
PART I: SEQUENTIAL COMPUTER ENVIRONMENT

by

Duc Thai Nguyen
Assistant Professor of Civil Engineering
Old Dominion University
Norfolk, VA 23508

Existing computer hardwares and available solution techniques for nonlinear mathematical programming problems allow the engineers today to optimally design more complex and larger structures as it has been done in the past. Efforts have been concentrated in recent years to develop solution methods in both areas of sensitivity analysis [1-3] and optimization [3-6] for efficient design of truely large scale systems.

A multilevel approach has been presented by Sobieski and his co-workers [7,8] where each substructure is optimized independently. The coupling effects between substructures are included by using information based upon sensitivity of optimum solution. A number of successful applications have been documented. An improved computational approach for multilevel optimum design has recently been proposed by Haftka [9] to avoid the discontinuous behavior of derivatives that are transferred from the lower levels to the upper levels and efficient methods for calculation of optimum design sensitivity have been suggested by Vanderplaats [10]. The method in Refs. [7,8], however, is still being developed toward a state of maturity required for industrial applications.

A new multilevel design sensitivity approach has been proposed by Nguyen [11]. The algorithm is based upon the multilevel substructuring concept to be coupled with the adjoint method of sensitivity analysis [3]. The proposed method has been tested by solving a simple example where the numerical solutions can be obtained with a hand calculator.

The key features of the present multilevel algorithm are the following:

(a) there are no approximations involved in the present algorithm except the usual approximations introduced due to the discretization of the finite element model

(b) data handling in the proposed method is simple

(c) the algorithm can be implemented (with minimum effort) in the new generation of computer hardwares with parallel processing capability.

Based upon the multilevel algorithm presented in Ref. [11], a computer program is being developed. The numerical performance of the proposed method will be evaluated by solving small to medium scale examples on the CY173 computer at NASA Langley Research Center.

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NEW CONCEPTS FOR CONTROLLING

AERODYNAMIC VORTICES

by John Ogg
NASA/ASEE 1986 Summer Fellowship
Asst. Professor University of Kansas

New concepts for controlling and altering longitudinal vortices are needed to improve fighter aircraft performance. Current fighters frequently operate at very high angles of attack and often encounter strong unpredictable, unsteady aerodynamic loads under these conditions. These loads are due to flow separation from aircraft surfaces and the interaction of the aircraft with the separated flow. Vortices are the primary identifiable structure of these flows, so that understanding and managing vortices is a key technology required to control the aerodynamic loads due to separated flow. Vortices are also key phenomena for lift enhancement, drag reduction and super-maneuverability.

The size and location of vortices may be controlled during vortex formation. The trajectory of the vortex may be altered by interaction with other vortices, turbulent wakes or aerodynamic surfaces. Vortex properties may also drastically alter due to vortex bursting.

Vortices are inherently three dimensional unsteady viscous flows. Because of this complexity, detailed knowledge of vortex physics is not available. But, vortices can be controlled without complete knowledge of the detail physics. The control of vortex flow is a topic of current interest (Ref. 1) and a great deal of work is currently being done in vortex control and in analyzing the underlying physics of vortex flow. Some new concepts for controlling vortices which should be investigated are described below.

One important parameter which affects the formation, trajectory and bursting of longitudinal vortices is the transverse pressure gradient. The transverse pressure gradient may be used to mitigate the effect of the strong axial adverse pressure gradients present on aircraft wings. It is well documented (ref. 2) that strong adverse pressure gradients cause bursting of longitudinal vortices. But it is not known how the presence of transverse pressure gradients can be used to offset this effect. Transverse pressure gradients also determine the structure of vortices during their formation.

The mechanisms for creating transverse pressure gradients are several. The sweep and shape of the wing planform and cross-section may be used to create transverse pressure gradients. The location of tail surfaces, stabilizers and canards all may be used. The use of spoilers located on the lifting surfaces or on the fuselage may also be used in inducing cross-flow pressure gradients. Since the bursting effects are dependent on the viscous and turbulent behavior of the flow, potential flow methods will not be adequate to investigate bursting in cross-flow pressure gradients. Numerical methods which include the effects of viscosity and turbulence are too slow to be used for complex aircraft configurations. The most direct method for studying cross-flow pressure gradient effects is physical experiments.

Because there are no reliable scaling laws for vortices, experiments will have to be basic studies designed to uncover the cause and effect relationships between pressure gradients and vortices. The preliminary experiments may be simple flow visualization studies about aircraft type wings in cross-flow pressure gradients. These gradients can be created using aerodynamic bodies, wind tunnel wall venting, flow curvature or cross jet. injection of air. A purpose of these studies would be to move bursting away from the aircraft and its surfaces.

Another three dimensional effect which was demonstrated by McAlister and Tung (ref. 3) is the effect of shearing on vortex bursting. They indicate that vortices may survive modest pressure gradients more easily than they can shear along their axis. This effect of shearing on vortices could be used to reduce the intensity of aircraft wakes. These effects could be readily studied in wind tunnel experiments similar to the ones discussed above for adverse pressure gradients except that velocity gradients could be introduced by differential blocking of wind tunnel upstream of the contraction. This blocking may be done using screens, wires or tape to create a transverse velocity gradient.

Impulsively applied pressure gradients should be used to investigate the time response of vortex bursting. It may be possible to take advantage of vortex bursting delay time and hysteresis for unsteady high angle of attack maneuvers, so called super-maneuverability.

In both separated and unseparated flow, longitudinal vortices may be formed from leading edges of wings. This should be investigated using the full potential equations coordinated with experiments. The potential methods work very well for vortex roll-up and predicting aerodynamic forces but the experiments are required to find the location of separation of the vortex from the boundary layer.

The above proposed experiments should be done initiallv using flow visualization and mean flow measurements, later tests will require more detailed measurement of the flow.

A closing comment is that no reliable scaling laws have been found for vortices or vortex bursting. Because of this. it is not possible to directly correlate wind tunnel data to flight. Consequently, much of the current literature can be compared in a qualitative way only. The data base required to understand vortices is prohibitively large so that scaling law must be found to accelerate the acquisition of vortex knowledge.

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VOICE CONTROL FOR VIDEO CAMERA OPERATION
IN A SPACE STATION ENVIRONMENT

by

David G. Payne

Assistant Professor
Department of Psychology
State University of New York at Binghamton
Binghamton, New York

The Space Station will contain a large number of video cameras that will be controlled via remote controls. There will be many times when it will not be possible to use manual controls to activate and coordinate these cameras and thus an alternative control system is required. The purpose of this project was to develop a special recognition interface that could serve as the video camera control system.

The first phase of the project involved addressing and resolving operational issues related to the voice input/output (I/O) system. Some of these issues include the effect of the size of the command set upon system recognition rates, the confusability of alternative command terms, and the feasibility of using verify-before-execute strategies. Another set of issues concerned development of procedures for "training" the speaker-dependent voice recognition system so that high recognition rates were obtained.

Phase two of the project consisted of the development of a task that simulated the essential aspects of controlling a remote camera. The task developed involved presenting an operator with a target (a rectangle of a specified size) and a cursor (also a rectangle) displayed on a color monitor driven by a microcomputer. The operators task is to use a series of commands to reposition the cursor (in an X-Y coordinate space) over the target and to manipulate the size of the cursor so that it matches the size of the target. The commands used correspond to movement within the X-Y space (e.g., up/down, right/left, slow cursor movement/fast cursor movement) and also to the size of the cursor (i.e., increase/decrease).

This simulation is analogous to the task facing a Space Station astronaut who wishes to position a remote controlled video camera and to establish a specific field of view (i.e., zoom position). Acquiring the viewing angle is functionally similar to positioning the cursor, and establishing the field of view is similar to matching the size of the cursor to that of the target. The simulation task thus has many functional similarities to the actual application for which the voice activated control system is being developed.

The third phase of the project was an experiment employing this simulation task. Subjects were tested on how quickly and accurately they could use the command structure to reposition the target over the cursor. Different subjects used either voice control, manual control (i.e., keyboard input), or alternated voice and manual control across blocks of trials. This

experiment demonstrated that people can use the voice control I/O interface to accomplish a task that simulates controlling a remote video camera. It was also demonstrated, however, that the voice control system was more sluggish and required more commands per trial than did the manual control system. This latter finding has implications for other real time voice I/O applications.

The goal of phase four of the project was to interface the speech I/O system with an operational remote camera to assess operators performance under more realistic conditions. This fourth phase also further examined alternative command structures and again compared voice control with manual control.

SYNTHESIS AND CHARACTERIZATION OF SELECTED

POLYIMIDESULFIDES AND POLYIMIDESULFONES

Albert L. Payton
Department of Chemistry
Hampton University
Hampton, Virginia 23668

Chronic acid oxidation of 4,4"-thiodiphthalic dianhydride afforded bis-(3,4-dicarboxypheny) sulfone dianhydride in 79 - 85% overall yield. These dianhydrides provided two series of poly (amic acids) and their corresponding polyimides through separate reactions with each of the following aromatic diamines: 3,3'-diaminodiphenylsulfone, 4,4' - diaminodiphenylsulfone, 4,4'-oxydianiline, and 4,4' - thiodianiline. Reactions were typically run in various organic solvents at 15 and 25% solids compositions. The most commonly used solvent was N,N-dimethylacetamide, but best results were obtained in diglyme and sulfolane for reactions of the sulfone dianhuydride with the diaminodiphenyslsulfones. Inherent viscosities of poly(amic acids) and polyimides at 0.5% solid concentration in N,N-dimethylacetamide were used to gauge molecular weight buildup. Polyimidesulfides and polyimidesulfones were typically isolated as heat cured thin films of predetermined thicknesses. These polyimides were characterized by determining their glass transition temperatures (tg's), Fourier Transform Infrared Spectra, and solubility properties.

INTRODUCTION

Polyimides are widely recognized for their high level of thermooxidative stability (1,2,3). Consequently, they have found wide application as spacecraft and missle thermal protection materials (4). However, existing polyimides exhibit less than ideal thermal and thermooxidative stability and inertness to solvents (inclusive of water solutions of certain atmospheric gases). Polyimidesulfones are a class of polyimideds which show great potential for improvement upon these particular mechanical properties. Since the number of known polyimidesulfones appears to be scarce, it seemed appropriate to synthesisize and evaluate new ones for the engineering applications noted above.

Several new polyimidesulfides were targeted for synthesis. These should not only provide a possible source of polyimidesulfones tharough chemical oxidation of the sulfide group to a sulfone group, but would also provide models for studying any proclivity of sulfone groups towards further oxidation at high temperatures or under intense irradiation.

Synthesis of several novel polyimidesulfones required _bis_- (3,4-dicarboxypheny) sulphone dianhydride as a key reactant. Although this compond is a known one, it is not commercially obtained 4,4' - thiodiphthalic anhydride was envisioned as a practical route to the sulfone dianhydride. Several such methods were tried and one was found to be an efficient, practical method. The sulfone dianhudride was used to successfully sunthesize several new polyimidesulfones.

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Experimental Investigation of the Characteristics

of Diode Lasers

by

Kenneth Preston

Instructor

Department of Mathematics

Hampton University

Hampton, VA

Ti:Sapphire - Ti:Sapphire injection control experiments have been per-
formed. The injection laser was tunable from 750 - 790 nm with a 2 nm
bandwidth. Injection control of a tunable Ti:Sapphire laser using a narrow
bandwidth pulsed dye laser operating at a wavelength removed from the peak
of the Ti:Sapphire laser gain curve has also been reported. In that
report, injection at 727 nm resulted in essentially complete energy extrac-
tion at 727 nm in a 2.5 pm bandwidth matching the injection source.
Continuing efforts are being made to obtain narrower bandwidth injection
sources. This report will summarize experiments performed using laser
diodes. An experimental analysis of the characteristics of one of these
laser diodes is reported with the aim of formulating a narrower bandwidth
injection source.

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ALGERBRAIC PROPERTIES OF COPRIME FACTORIZATIONS

by George Rublein

College of William and Mary
Department of Mathematics
Williamsburg, Virginia

The relationship between polynomial and stable coprime factorization of multi-input multi-output systems is important in understanding the physical characteristics of the system. For instance, each type of factorization has its own advantages in the analysis and design of feedback compensators.

In the case of a scalar transfer function $T(s) = \alpha(s)/\beta(s)$, written as a ratio of coprime polynomials, there is an immediate passage to a stable factorization on account of a theorem of A.S. Morse: If $\beta(s)$ has degree n which is at least as large as the degree of α (this merely means that T is proper), then $\alpha(s)/(s+1)^n$ and $\beta(s)/(s + 1)^n$ are coprime (stable) transfer functions whose ratio is again T.

The relationship between polynomial and stable coprime factorizations of matrix transfer functions is more complicated. Here is a conjecture (as yet unproven). Suppose $T(s) - N(s)D^{-1}(s)$ is a polynomial coprime factorization, where T is proper and D is a lower triangular nxn matrix. If the elements on the diagonal of D all have the same degree, say, k, then $D/(s+1)^k$ and $N/(s+1)^k$ will be (right) stable coprime factors of T.

For now, we have some examples of varying complexity where the conjecture may be verified. Here is the nastiest one:

$$\begin{bmatrix} \dfrac{s-2}{s+7} & 0 \\[2ex] \dfrac{s-4}{(s+1)\,(s+7)} & \dfrac{s-1}{s+4} \\[2ex] \dfrac{-(s-6)}{s+1} & \dfrac{1}{s+3} \end{bmatrix}$$

This pair $\begin{bmatrix} D \\ N \end{bmatrix}$ may be shown to be coprime, and it arises from the polynomial factorization:

$$\begin{bmatrix} (s-2)((s+1) & 0 \\[1ex] s-4 & (s-1)\,(s+3) \\[1ex] -(s-6)\,(s+7) & s+4 \end{bmatrix}$$

by a method of division similar to that stated in the conjecture. We can supply "Bezout" factors for the stable factorization. They are too messy to write out here. They give a kind of clue to a proof but the author has not succeeded in working out details.

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DATA COLLECTION AND ANALYSIS IN THE MLS
ADVANCED APPLICATIONS STUDY

by

Charles H. Scanlon

Associate Professor
Mathematics and Computer Science
Arkansas State University
Jonesboro, Arkansas

NASA Langley Research Center (LaRC) in a joint effort with the FAA has begun a study of advanced applications of the microwave landing system (MLS). This program has the objective of defining an envelope of usable MLS approach paths considering pilot-vehicle performance, pilot-passenger acceptance, and ATC integration factors.

The MLS consists of three major components: 1) ground-based scanning beam transmitters, 2) ground based precision distance measuring equipment (DME/P), and 3) airborne MLS equipment for azimuth, elevation, and range determination. These components together with area navigation (RNAV) computation will be used to fly complex MLS procedures which include straight line segments and curved paths. The wide area coverage of the MLS permits curved path approaches representing a relatively new pattern or landing configuration for pilots, and requires modification of existing control and data display.

Various levels of airborne equipment sophistication will be explored in the MLS study. The lower end of cockpit sophistication will be represented by conventional electro-mechanical instrumentation. The upper end of cockpit sophistication will be represented by an advanced configuration with fly-by-wire type controls and electronic displays. The conventional configuration studies will be conducted with the LaRC Visual Motion Simulator (VMS) and the LaRC DC9-30 fixed base full systems simulator, representing a category C aircraft. The advanced configuration studies will utilize the LaRC Transport Systems Resarch Vehicle (TSRV) fixed base simulator, which also represents a category C aircraft. Studies in the VMS have begun.

The VMS is a six-degree-of-freedom, motion-base simulator capable of presenting realistic acceleration and attitude cues to the pilot. A general purpose, scientific mainframe computer with a nonlinear, high fidelity digital representation of DC9-30 twin-jet commercial transport airplane provides inputs to drive the VMS motion base system. Audio cues for engine thrust and aerodynamic buffet will also be provided. The simulator has a generic cockpit with conventional flight controls and instrumentation. Flight controls include a column and control wheel, rudder pedals, and throttle, speed brake, and flap controls located on a center console. Flight instrumentation includes conventional flight and navigation instruments and engine instrumentation.

An initial test in the VMS has been run which was designed to obtain comparative measures of the dependence of pilot workload and performance on different methods of presenting lateral guidance using the horizontal situation indicator (HSI). In one presentation, continuous lateral deviation from a predetermined curved path was displayed on the HSI. In another, lateral guidance was displayed by the usual method of resetting the deviation indicator to the straight line segment. Data has been recorded in this test and analysis is currently being performed. During this test, simulator motion was used and recorded variables include performance data, oculometer measures, heart rate, and pilot control inputs.

Currently, testing to measure the effects of motion cues upon pilot performance strategies, and workload has begun. Subject test pilots chosen from a list of LaRC research pilots, U.S. Air Force pilots, and commercial airline pilots are flying MLS approaches in the VMS and data is being recorded. Independent variables in this test include motion, turbulence, wind, and task complexity. Recorded dependent variables include aircraft and engine performance data, oculometer measures, heart rate, and pilot control input. The results of this test will be needed in the transition phase between the motion based and fixed base simulations.

ANALYTICAL INVESTIGATION OF THE RESPONSE CHARACTERISTICS
OF A FIVE-HOLE PRESSURE PROBE

by

Gregory V. Selby

Assistant Professor
Mechanical Engineering and Mechanics
Old Dominion University
Norfolk, Virginia

Stationary direction-sensing probes are frequently used to measure flow direction in three-dimensional flows. For two-dimensional flow direction measurements, two pressure orifices are typically placed 180° apart on the surface of a wedge or hemisphere. For three-dimensional flows, four pressure orifices are typically placed 90° apart on the surface of a hemisphere or square pyramid, as in the present study. Upon incorporating a fifth pressure orifice to measure total pressure (truncated square pyramid), the instrument becomes a five-hole pressure probe or, simply, a combination probe. Rationale used in the selection, design, calibration and operation of five-hole pressure probes is presented in References 1 and 2.

The present work involved the generation of analytical probe response characteristics for use as comparison data during the calibration of one type of five-hole pressure probe. The probe is calibrated in a rotatable mode, but operated in a stationary mode. In the analytical study, as in the calibration, freestream speed and direction are fixed and the probe is rotated through predetermined values of elevation angle (θ) and azimuthal angle ($\emptyset$) in order to define the calibration curves in terms of the standard flow angles, α and β (Figure 1), as a function of the parameters FP_3 and FP_4 defined in Reference 2 as:

$$FP_3 = \frac{P_2 - P_4}{P_5 - \frac{1}{4}(P_1+P_2+P_3+P_4)} \quad \text{and} \quad FP_4 = \frac{P_3 - P_1}{P_5 - \frac{1}{4}(P_1+P_2+P_3+P_4)}$$

Analytical expressions derived for these functions were:

$$FP_3 = \frac{8 \cos\theta \, \sin\theta \, \sin\emptyset}{2\cos^2\theta - \sin^2\theta} \quad \text{and} \quad FP_4 = \frac{8 \cos\theta \, \sin\theta \, \cos\emptyset}{2 \cos^2\theta - \sin^2\theta}$$

Analytical expressions were also derived for other parameters, including α and β, and typical results are presented in Figures 2 and 3 with α being depicted as a strong function of FP_4 and weak function of FP_3. Conversely, β is a strong function of FP_3 and a weak function of FP_4.

An analysis was also performed to determine the level of error to be expect- ed, due to the interpolation process, when experimental FP_3 and FP_4 data are inputs to an appropriate algorithm (based on subroutines IBIRAN and IBI and containing calibration data) for the determination of the experimental flow angles.

The present study complements research being performed in the National Transonic Facility by the NTF Operations Branch relating to measurements in wake flows.

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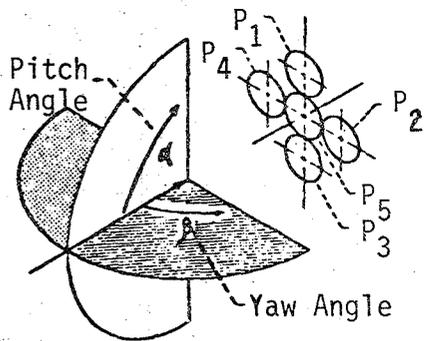
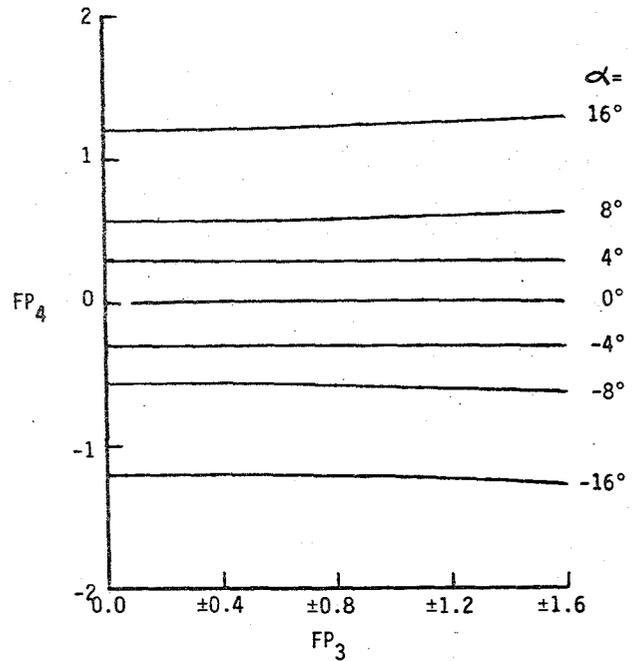Figure 1. Flow Direction Angles with respect to Pressure Orifice Locations

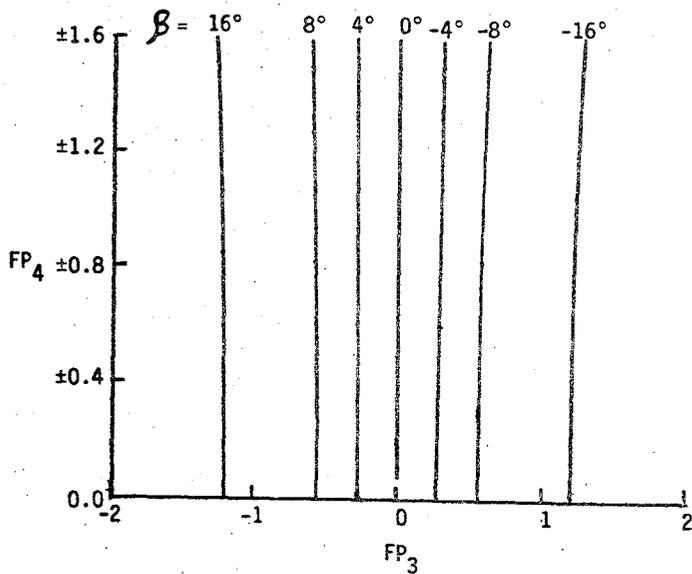Figure 2. FP_4 vs. FP_3 for α = constant

Figure 3. FP_4 vs. FP_3 for β = constant

DEVELOPMENT OF AN AIR FLOW VISUALIZATION DEVICE
UTILIZING LIQUID CRYSTAL AND PIEZO-ELECTRIC TECHNOLOGIES

John V. Shebalin
Department of Electrical and Computer Engineering
Old Dominion University, Norfolk, Virginia 23508

PVF2 (polyvinylidene fluoride) is known to exhibit a stronger piezo-electric response to stress than any other commonly available engineering material and has had wide application, ranging from stereo headphones to sonar transducers. CLC (cholesteric liquid crystals, also known as chiral nematic liquid crystals) respond to heat, shear, and other stimuli over a specific temperature range by changing color and their applications have included flow visualization, localization of hot spots in electronic circuits and in cancer treatments. Here, we begin to explore combining PVF2 and CLC's in order to allow their individual properties to compliment one another and in so doing produce a more efficacious flow visualization device.

This project will consist of three phases: First, we will examine and characterize CLC response with regard to applied voltage, carefully maintaining cognizance of temperature, pressure, humidity and other pertinent variables (there is little data in the open literature in this regard). This phase requires designing and building a suitable experimental set-up, a project which is currently underway. Second, we will similarly examine and characterize the PVF2. Lastly, we expect to use the knowledge gained in the first two phases to sandwich together thin films of PVF2 and CLC in order to produce a robust flow visualization device.

A good candidate CLC is cholesteryl chloride (CC) or, generally, cholesteryl with any attached halogen or hydroxyl group[1]. The chemical structure[2] and voltage response (in mixture with chol. nonanoate)[1] of CC are shown in Figure 1, and the color response to temperature of CC in mixture with other CLCs[3] (CE: chol. eructate; CBr: chol. brassidate; CO: chol. oleate; CE1: chol. elaidate) is shown in Figures 2 and 3. These figures indicate that suitable responses for most applications can be found by using the proper mixture of cholesteryls (the cholesteryls can be obtained from, for example, E. Merck, Inc., of Hawthorne, NY).

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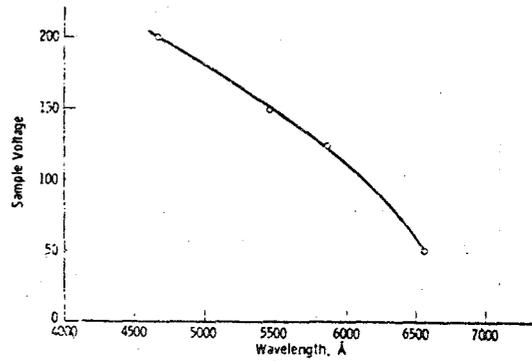
cholesteryl chloride[a] (Leder, 1971)
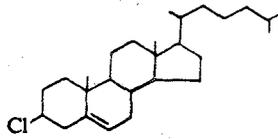
K 96 I (64 N*)

[a] This compound has a monotropic mesophase, which is only observed during supercooling of the isotropic liquid. Monotropic transition temperatures and phases are placed between parentheses.

Wavelength of maximum scattering as a function of sample voltage.

Figure 1a

Figure 1b

Fig. 2. Wavelength of selective scattering versus temperature in the mixtures CE - CC (•) and CBr - CC (o) at different weight percentage of CC:

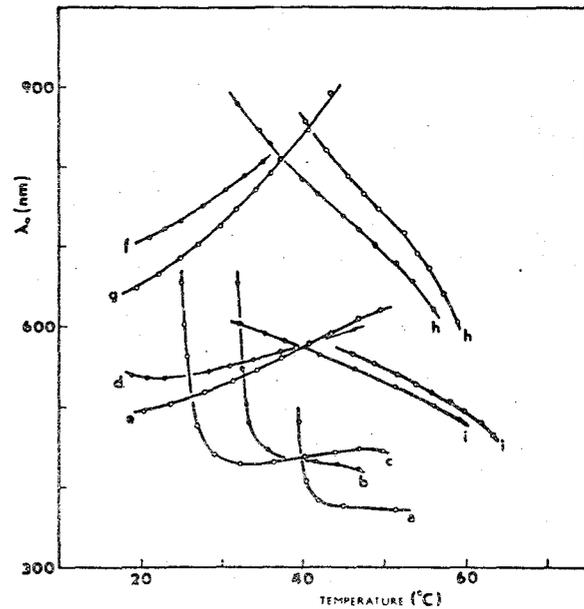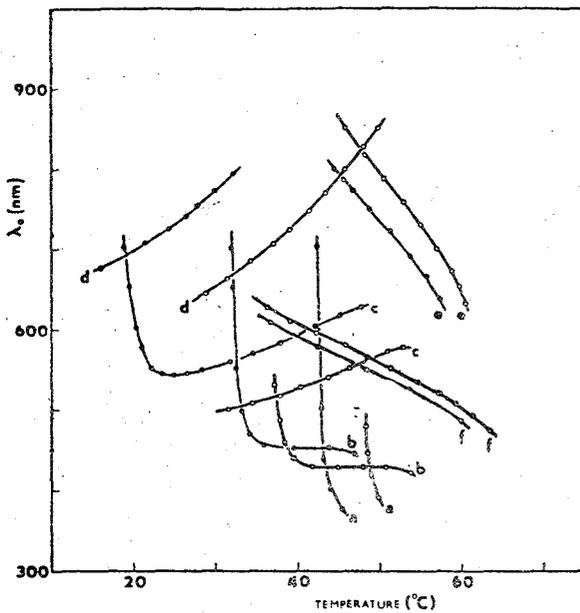|		
a - 10 w.t. % CC	b - 20 w.t. % CC	c - 30 w.t. % CC
d - 40 w.t. % CC	e - 80 w.t. % CC	f - 90 w.t. % CC

Fig. 3. Wavelength of selective scattering versus temperature the mixtures CO - CC (•) and CB1 - CC (o) at different wei, percentage of CC:

a - 10 w.t. % CO	b - 12,5 w.t. % CC	c - 20 w.t. %
d - 24 w.t. % CC	e - 30 w.t. % CC	f - 35 w.t. %
g - 40 w.t. % CC	h - 80 w.t. % CC	i - 90 w.t. %

Nonlinear Dynamics of Rotating Flexible Spacecraft

by

L. Silverberg
Assistant Professor

North Carolina State University
Mechanical and Aerospace Engineering
Raleigh, North Carolina, 27695-7910

This paper describes the nonlinear dynamics of rotating flexible space-craft. The dynamic characteristics of flexible spacecraft are reviewed. The spacecraft momenta are shown to be related to the translational, rotational and elastic components of the motion. By introducing a coordinate system tracking the rigid-body motion of the spacecraft, the equations of motion are decomposed into three linear translational equations, three nonlinear Euler equations, both associated with the tracking coordinates, and an infinite set of linear time-varying modal equations associated with the elastic motion relative to tracking coordinates.

It is shown that the rigid-body motion is decoupled from the elastic motion, and that the elastic motion is excited by the rigid-body motion through a Coriolis term, a centrifugal term and an angular acceleration term. The decoupling of the equations of motion for the spacecraft requires the natural modes of vibration and natural frequencies associated with the non-rotating flexible spacecraft either in closed-form or those obtained through spatial discretization. As a special case, the nonlinear dynamics of a free-free beam in combined bending vibration are described and stability conditions for the elastic motion are given.

COMPUTER SIMULATION OF RADIATION DAMAGE
## IN SEMICONDUCTORS

by

John J. Stith

Assistant Professor
Physics
Virginia State University
Petersburg, Virginia

Electronic devices manufactured from semiconductors are vital to the space program. These devices must be capable of surviving and operating in an environment where various types of radiation are present. In order to design the devices for maximum tolerance to the radiation encountered in the space environment, the damaging effects of the radiation on the devices must be studied. Extensive laboratory testing and/or computer simulations of the effects of the specific radiation on the device performance is required. The present study was done with computer simulation.

The binary-collision simulation code MARLOWE has been modified to run on NASA LaRC computer system and used to simulate radiation damage produced in a gallium arsenide crystal when it is exposed to electron and proton radiation. Primary recoil atoms possessing energies of 20 and 30 ev, corresponding to the average energy transfer between a 1-Mev electron and gallium and arsenic atoms, and primary recoil atoms of 80 and 90 ev, corresponding to the average energy transfer betwwen a 100-Kev proton and a gallium or arsenic atom were used to start the displacement cascades in the crystal. The 1-Mev electron is used in the equivalent fluence testing of devices and the 100-Kev proton has been shown through theory and experiment to be most effective in damaging the .5 and .8 micron junction gallium arsenide solar cells.

Analysis of vacancy-interstitial pairs were made. Graphs were plotted to show the distribution of the separations of the pairs for the four primary recoil energies that were used. The distributions include close, near, and distant pairs. The graphs for the 30 and 90 ev energies are shown in figures 1 and 2, respectively. When the two distributions are compared, it is clear that there is a greater number of interstitial-vacancy pairs for the high energy cascades than for the low energy cascades. There is a high probability that the atoms and vacancies in the close pairs will combine with each other while some of the atoms and vacancies of the near pairs will combine and some will become stable defects within the crystal. The vacancies and interstitial atoms of the distance pairs will likely remain stable defects in the crystal even through the annealing process. There is a sizeable difference between the number of distance pairs for the high energy primary recoil over the number of distance pairs for low energy. This is in good agreement with the experimental

results that demonstrated a high degree of difficulty in annealing
proton radiation damage as compared with annealing electron
radiation damage for the same devices.

Figure 1

Figure 2
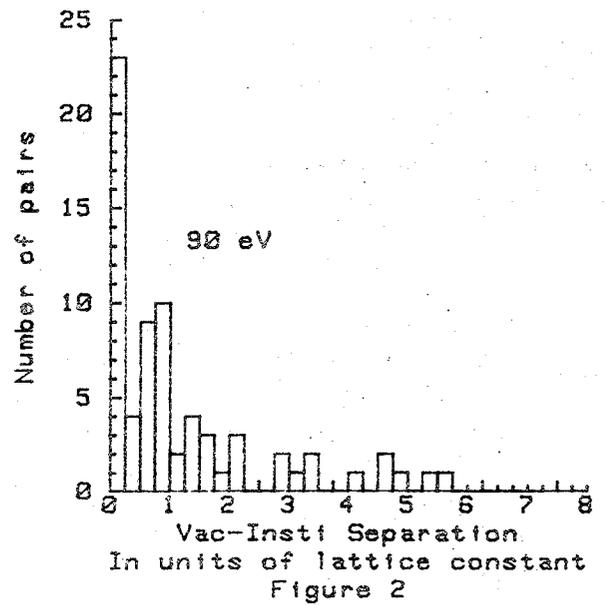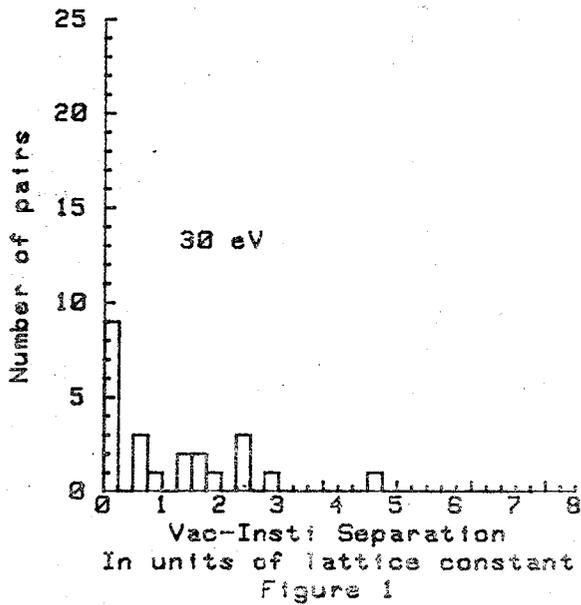
ANALYSIS OF A RATE EQUATION MODEL FOR A SOLID STATE LASER SYSTEM

by

John J. Swetits
Department of Mathematical Sciences
Old Dominion University
Norfolk, Virginia 23508

Modelling of a four level titanium: sapphire solid state laser has led to the development of a rate equation model which is a system of three non-linear ordinary differential equations. The system is given by

$$dx/dt=(c(1,1)-W(t))x+(c(1,2)-gW(t))y-agxz+W(t)$$

$$dy/dt=c(2,1)x+c(2,2)y+axz$$

$$dz/dt=c(3,1)x+c(3,2)y+c(3,3)z+axz+I(t)$$

where $W(t)$, $I(t)$ are step functions and $a,g,c(i,j)(i=1,3;j=1,3)$ are constants.

Extensive numerical testing with both a fixed step fourth order Runge-Kutta method and a variable step size Runge-Kutta method indicate that the initial value problem $(x(0)=0,y(0)=0,z(0)=0)$ is very well behaved for physically reasonable values of the constants and the functions $W(t)$, $I(t)$.

For reasonable choices of the parameters, the system has two equilibrium points with non-negative coordinates. One of the equilibrium points appears to be strongly unstable; that is, if the coordinates of the equilibrium point are perturbed slightly and used as initial values for the differential equations, the solution breaks away from this point and (in the cases considered) converges to the second equilibrium point as time tends to infinity. Thus the second equilibrium point appears to be asymptotically stable in a very strong sense. Indeed, standard results from stability theory can be used to prove this.

TURBULENCE STRUCTURE IN MICROBURST PHENOMENA

by

George Treviño

Associate Professor
Mechanical Engineering-Engineering Mechanics
Michigan Technological University
Houghton, MI 49931

It is rapidly becoming evident that knowledge of the interplay between turbulence and the underlying wind is a major key to the understanding of the microburst phenomena (ref. 1); particularly if the attendant hazards to airplane safety and performance are to be faithfully simulated in a regulated laboratory environment (ref. 2). Such simulations are of cardinal importance in control-motivated pilot training. The question of how isotropic turbulence "scales" in a wind shear is of primary interest, and the study of same duly constitutes the essence of the fundamental microburst problem. Fortunately the equation which governs the relation between mean wind and turbulence is well-known and understood--it is the Navier-Stokes equation of hydrodynamics-- and in the present endeavor this equation was used to model the effect on turbulence of a variable headwind/tailwind along the flight path of an aircraft. The considered headwind-to-tailwind swing is characteristic of the scenario where an aircraft encounters a microburst as it is attempting to land in a thunderstorm. It was shown that the effect is to steadily decrease the magnitude of the correlation length of the sensed turbulence, a feature which makes the turbulence "more and more random" than what is ordinarily encountered in the upper atmosphere. This effect coupled with the accompanying loss of aerodynamic lift is what creates the hazardous environment for an aircraft encountering a microburst as it attempts to land in a thunderstorm.

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COMPARISON OF THE SERIAL CONTROL FUNCTIONS OF THE

FAXON LINX AND NOTIS (ARIN) AUTOMATED LIBRARY SYSTEMS

by

Christie D. Vernon

Associate Professor and Librarian
St. Leo College, Langley AFB, VA.

BACKGROUND:

NASA libraries, including the Langley Research Center Library, are in the process of implementing a new integrated library system, ARIN (Aerospace Research Information Network).

Langley Research Center Library currently uses the FAXON LINX system for serials control. This system is maintained by the national serials vendor, the Faxon Company, and provides online access to the vendor, a comprehensive data base of publishers and serials information, automatic claiming of missing issues, and interlibrary loan capabilities.

Faxon, an international serials vendor now in its second century of operation, provides a comprehensive list of services as well as access to one of the largest serials data bases in the world. Since Faxon is a leader in serials automation, it has been suggested that its services be incorporated into the NOTIS serials module, or used in place of it.

NOTIS is a serials control software package which, with modifications, will provide the NASA ARIN system, an integrated library materials control system which will connect all NASA libraries in a single network.

PLAN OF STUDY:

The research project included, as time permitted, the following activities:

1. Review of the literature based on Library Literature and a DIALOG search.

2. Comparison of operator manuals of both systems.

3. Preparation of a matrix comparing the characteristics of both systems.

4. Identification of the functions which produce a significant impact on the NASA Library serials department.

5. Interviews with personnel using the NOTIS system and the FAXON system and with administrators concerned about their functions.

6. Hands-on comparison of the two systems, using a list of typical transactions.

PRELIMINARY FINDINGS:

The areas in which the NASA Library would be most significantly impacted by the loss of the FAXON LINX services are:

1. Loss of automatic claiming of missing issues by the vendor (Faxon), which would result in a higher loss rate of late issues. With NOTIS, the library staff must identify missing issues and send claims in the mail.

2. Loss of the capability to send Interlibrary Loan messages directly to over 75 libraries. NOTIS has fewer participants and requests are handled by correspondence.

3. Loss of the comprehensive, online, FAXON catalog. This data base provides daily updated information on all serials titles, availabilities, and prices as identified by this international serials vendor. This is an invaluable tool for pre-order searching and for verifications. NOTIS has no comparable data base.

4. Loss of comprehensive information about publishers and their publications which is contained in a data base maintained by the vendor and updated daily. NOTIS' file of publishers' addresses is maintained and updated by local library staff and contains no information about the publications themselves. Communication with publishers is by correspondence.

5. Loss of the financial accounting services provided by FAXON. All ordering information is maintained by FAXON, which provides order and invoice numbers; numbers of checks sent for payments to publishers; totals of expenditures; 3-year "scope" reports which track periodicals costs for the member library; records of claims, credit memos, and so on. With NOTIS, library staff must input all the ordering and financial information and the updates, in order to be able to generate similar reports.

6. NOTIS provides a MARC format for serials check-in and very good public access to the holdings records. However, FAXON check-in service provides a history of the arrival dates of all serials, and access to the check-in records of their own holdings as well as the check-in records of all participating FAXON LINX customers. This provides invaluable verification information to the NASA Library serials department.

IMPACT OF WIND SHEAR ON AIRPLANE PERFORMANCE

by

Robert K. Wattson, Jr.

Associate Professor and Head
Mechanical Engineering Technology Department
Oregon Institute of Technology
Klamath Falls, Oregon

Airplanes flying in wind shears have frequently displayed anomalous responses to control inputs. Speculation has arisen as to whether the aerodynamic "rules" that govern flight in still atmospheres have not somehow been repealed and new ones instituted which do not allow use of conventional piloting techniques. Procedures for flying through wind shears have been advocated, which would be unsuccessful if employed for flight even in still air.

This report deals with analyses of the performance of airplanes flying in simple horizontal wind shears. Use of no more than the usual aerodynamic and performance methods is shown to result in plausible descriptions of airplane behavior in shears, and predictions of techniques for successful negotiation of shears can be made.

A horizontal wind shear, whether characterized by an accelerating air mass such as is found in a downburst outflow field, or by a simple change of head wind component, can be described in simplest form by

$$\dot{W}_x = C$$

An airplane penetrating this field in the direction of increasing wind velocity is confronted by a continuously dying headwind, as it were, and must thus accelerate continuously to maintain airspeed. Climbs, for example, may be portrayed by either of two equivalent approximations:

$$R/C = R/C_u \frac{1}{1 + \dfrac{V}{g}\dfrac{\dot{W}_x}{R/C}} \quad \text{and} \quad R/C = R/C_u - \dot{W}_x \frac{V}{g}$$

Thus the constant-airspeed climb in a shear may be seen to be the equivalent of an accelerated climb in still air. A shear of sufficient intensity may require the allocation of so much energy to maintaining airspeed that the rate of climb becomes negative. On the other hand, all or some of the unaccelerated climb rate may be temporarily retained by deliberately allowing airspeed to fall.

Best piloting technique in a shear depends on whether or not the shear is of such intensity as to render steady climb impossible. The need to get through the shear transcends any operational objective, so the idea of holding to climb or glide paths should be discarded as soon as entry is known to be unavoidable. With the shear intensity unknown beforehand, initially all that

can be done is to cancel any climb or glide and start storing kinetic energy for use in the encounter. Entry speed should not be less than that for best still-air climb angle. Speed for best climb angle, at least, should be maintained until the rate of climb falls to zero.

Technique in a "supercritical" shear - one in which no positive climb angle can be maintained at any constant airspeed - is one of proper energy management. The objectives are to avoid altitude loss and to postpone reaching stalling speed until as late as possible. Utilizing energy to gain height is typically of little avail, since the potential increments are small and the losses due to drag large. The technique which will maximize distance remaining before stall is thus one in which at any instant normal acceleration is being used only to the extent that will just maintain height.

Shears occurring very near the ground can be categorized as accompanying a change in wind direction or a downburst outflow. In the first case plausible simple models are

$$W_x = kh \quad \text{or} \quad \dot{W}_x = kh$$

between some height limits, and in the second they may be taken as profiles either of W_x or of $\dot{W}_x$ which resemble a ground boundary layer. Four possibilities are thus presented; in the first and third takeoff transition and climb can be deteriorated, and in the second and fourth a sufficiently strong shear can limit the height to which a transition or climbout can be carried or can keep the airplane on the ground.

Estimation of warning time required for successful avoidance of a downburst type shear indicates that the time required varies with burst radius at time of encounter, and with relative approach speed. Slightly longer times are required for larger bursts and for lower approach speeds. Typical minimum times, based on conservative assumptions for pilot decision and reaction time and engine spin-up time, are of the order of 28 seconds before projected penetration.

Pilot reactions to shear onsets have typically been late, not only because of accompanying "noise" but also because the airplane accelerations due to the shears build insidiously and are not perceptible until penetration is well advanced. On the other hand, it is conceptually possible to use ground-based and airborne sensing and data processing equipment not only to provide real-time cockpit information on shear location size and intensity, but also to assess the instantaneous capability of the aircraft to avoid or negotiate the shear and to provide warnings and appropriate flight director information.

THE EFFECTS OF CONTAMINANTS ON GROUND-BASED
TESTS OF SCRAMJET ENGINES

by

Charlie L. Yates

Professor
Physics and Engineering
Hampton University
Hampton, Virginia

Ground-based, combustion testing of scramjet engines at conditions that
simulate flight operation requires preheating of the test air medium prior to
its expansion to supersonic speeds. In current practice, such preheating is
accomplished by one of three methods: storage, electric arc, or combustion
heating. Within their common region of applicability, which presently corre-
sponds to Mach numbers below 5-6, storage heating is preferred because it
produces relatively clean air by using energy previously stored in either a
refractory or a metal material bed. For testing at higher Mach numbers,
either arc or combustion heating is a necessity, but both are characterized by
the production of a contaminated test medium. It is with such contaminants
that this investigation is concerned.

In the case of arc-heated air, oxides of nitrogen--e.g., NO and NO_2, or NO_x
generically--are the major contaminants. These have their origin in the arc
plasma, and they persist during the air expansion process at levels that
significantly exceed their equilibrium values. For combustion heaters, in
which a fuel is burned in the test air, the major contaminants are H_2O for
hydrogen-fueled heaters, and H_2O and CO_2 for hydrocarbon-fueled heaters. In
addition, there may exist unburned fuel and products of incomplete combustion,
such as CO, and also equilibrium levels of active species and radicals, such
as O, H, and OH.

The presence of contaminants in an engine test medium can have consequences
which, for discussion purposes, may be put into two, broad classifications:
1) effects that influence properties of the test medium; and 2) effects
that influence the behavior of the test item. For both categories, there
exist effects that reflect the differences in thermodynamic and transport pro-
perties caused by the equilibrium compositional difference between atmospheric
air and a contaminated air test medium. There also exist effects that result
from the influence of contaminants on finite-rate processes, such as chemical
kinetics and vibrational relaxation.

One objective of this study is to provide an assessment, based on the open
literature, of the importance of air contamination to engine test results. A
second objective is to establish a basis for recommending a strategy for
testing in contaminated air which will maximize the usefulness of test results
for the purpose of predicting engine performance at actual flight conditions.

BUSINESS DATA BASE EVALUATION

by

Ahmed S. Zaki
Professor
School of Business
College of William and Mary
Williamsburg, Virginia

The purpose of this research was to investigate and analyze the data base at the Business Data Systems Division (BDSD). The analyses was performed by interviewing the users at both the programmer and management levels to:

a) Define their data and information needs.

b) Get as accurate an estimate as possible about the frequency of their different types of usages.

c) Identify the users and programmers conception about what they think the data base at BDSD should provide now and in the forseeable future.

The interviews and subsequent analyses brought up many interesting and useful remarks concerning:

a) The use of the NATURAL language. The consensus is that the language is not user friendly to the non-programmer users.

b) There are many programs without adequate and sometimes any documentation.

c) The data base contains a substanial amount of unnecessary redundancy.

d) The data dictionary directory needs to be properly kept and updated.

e) A seperate query data base for semi-structured queries would be attractive for both BDSD and users from the research directories. This data base would have macros and/or canned programs for some of the most widely used information requests.

f) The response time is not fast enough and expected to become even slower. The proposition of a seperate query data base in (e) above will decrease the current load on the main data base and consequently alleviate the problem of response time.

A report on the findings was presented to the BDSD Division Chief.

APPENDIX V

ASEE-NASA Langley Summer Faculty Program

Sample Questionnaires

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?

   Very much so _____
   Somewhat _____
   Minimally _____

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

   Very much so _____
   Somewhat _____
   Minimally _____

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 _____
   Somewhat _____
   Minimally _____

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

   Yes _____   No _____

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 _____
   Somewhat _____
   Minimally _____

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.

   Reinvigorated _____
   Redirected _____
   Advanced _____
   Just maintained _____
   Unaffected _____

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 _____
Positively _____
Without enthusiasm _____
Not at all _____

3. 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 _____
By starting new courses _____
By sharing research experience _____
By revealing opportunities for future employment in government agencies _____
By deepening your own grasp and enthusiasm _____
Will affect my teaching little, if at all _____

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 _____   No _____

C. Administration

1. How did you learn about the Program? (please check appropriate response)

_____ Received announcement in the mail.
_____ Read about it in a professional publication.
_____ Heard about it from colleague.
_____ Other (explain). _____

_____

_____

2. Did you also apply to other summer faculty programs?

Yes _____   No _____
_____ DOE
_____ Another NASA Center
_____ Air Force
_____ Army

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3. Did you receive an additional offer of appointment from one or more of the above? If so, please indicate from which.

_____

4. Did you develop new areas of research interest as a result of your interaction with your Center and laboratory colleagues?

   Many _____
   A few _____
   None _____

5. Would the amount of the stipend ($700) be a factor in your returning as an ASEE Fellow next summer?

   Yes _____
   No _____
   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 _____   No _____

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

   Yes _____   No _____

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

   Yes _____   No _____

9. How do you rate the seminar program?

   Excellent _____
   Very good _____
   Good _____
   Fair _____
   Poor _____

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

| Check one per Activity | | Time Was | | |
Activity	Adequate	Too Brief	Excessive	Ideal
Research				
Lectures				
Tours				
Social/Recreational				
Meetings				

11. What is your overall evaluation of the program?

Excellent _____
Very good _____
Good _____
Fair _____
Poor _____

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

_____

_____

_____

_____

_____

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

_____

_____

_____

_____

_____

_____

D. **Stipend**

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

        $_____ per _____.

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

        Yes _____   No _____   In part _____

    3.   What, in your opinion, is an adequate stipend for the ten-week program during the summer of 1987?

        $_____

E. **American Society for Engineering Education (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 _____

PLEASE USE THIS PAGE FOR YOUR COMMENTS TO ANY QUESTIONS

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NASA-ASEE

SUMMER FACULTY RESEARCH PROGRAM

QUESTIONNAIRE FOR RESEARCH ASSOCIATES

Please complete and return to John Spencer by August 8, 1986, NASA MAIL STOP 105A.

1. Would you say that your Fellow was adequately prepared for   YES   NO
   his/her research assignment?

   Comments: _____

   _____

   _____

   _____

2. Would you comment on the diligence, interest, and enthusiasm with which
   your Fellow approached his/her research assignment.

   _____

   _____

   _____

   _____

3. Would you be interested in serving as a research associate   YES   NO
   again?

   Comments: _____

   _____

   _____

   _____

4. Would you be interested in having your Fellow (if eligible) return a
   second year?

   Comments: _____

   _____

   _____

   _____ 112

5. Any recommendations regarding improvement of the program will be appreciated.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Signature _____

APPENDIX VI

Group Picture of 1986 Summer Fellows

Group Picture of 1986 Summer Fellows

Bottom Row - Left to Right:
Henry Foskey, Kenneth Preston, Ernest Battifarano, David Payne,
Saba Mahanian, Patricia Carlson, Kathy Ames, Richard Kiefer

Second Row:
Ronald Bieniek, Neal Bengtson, Mark Maughmer, Ahmed Zaki,
John Spencer, John Stith, Kwan-Yu Chen, William Lyons

Third Row:
George Rublein, John Swetits, Devendra Garg, Milton Ferguson,
David Hart, Jacqueline Long, Francis Cooke

Fourth Row:
Albert Payton, Robert Wattson, Nelson Blue, Henry Day,
George Trevino

Top Row:
Charlie Yates, Richard Longman, Gregory Selby, Michael Gorman,
Samuel Massenberg

Not Shown:
Gerald Johnson, Douglas Lindner, Duc Nguyen, John Ogg,
Charles Scanlon, John Shebalin, Larry Silverberg,
Christie Vernon

Standard Bibliographic Page

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15. Supplementary Notes
Langley Technical Monitor: Dr. Samuel E. Massenberg

16. Abstract
Since 1964, the National Aeronautics and Space Administration (NASA) has supported a program of summer faculty fellowships for engineering and science educators. In a series of collaborations between NASA research and development centers and nearby universities, engineering faculty members spend 10 or 11 weeks working with professional peers on research. The Summer Faculty Program Committee of the American Society for Engineering Education supervises the programs. Objectives: (1) To further the professional knowledge of qualified engineering and science faculty members; (2) To stimulate and exchange ideas between participants and NASA; (3) To enrich and refresh the research and teaching activities of participants' institutions; (4) To contribute to the research objectives of the NASA center. Program Description: College or university faculty members will be appointed as Research Fellows to spend 10 weeks in cooperative research and study at the NASA-Langley Research Center. The Fellow will devote approximately 90 percent of the time to a research problem and the remaining time to a study program. The study program will consist of lectures and seminars on topics of general interest or that are directly relevant to the Fellows' research project. The lecturers and seminar leaders will be distinguished scientists and engineers from NASA, education or industry.

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